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# SGI Reflections

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# SGI Reflections

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# CONTENTS

# Compliance modeling and identification of 5-axis vertical articulated robot for machining applications

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**Abstract:** This paper describes analytically and experimentally based compliance modeling and identification of 5-axis vertical articulated machining robot. The conventional method for the calculation of Cartesian space compliance based on joint compliances and Jacobian matrix is expanded and used for experimental 5-axis machining robot. Analytical analysis was conducted for effects of compliances of each joint individually on Cartesian space robot compliance. Experimentally, the Cartesian space compliance is obtained by direct measurement of the absolute displacements evoked by static forces along 3- orthogonal directions at the tool tip in the robot workspace for the case of 3-axis machining.

**Key words:** robot, machining, compliance modeling

## INTRODUCTION

Industrial robots are promising cost-effective and flexible alternative for certain multi-axis milling applications. Compared to machine tools, robots are cheaper and more flexible with larger workspace. It is well known that poor accuracy, stiffness and complexity of programming are the most important limiting factors for wider adoption of robotic machining in machine shops [1]. In order to contribute to efficient use of robots for machining applications, research and development of reconfigurable robotic machining system were initiated [2]. The research and development comprise two groups of problems: the realization of a specialized 5-axis machining robot with integrated motor spindle in order to improve robotic machining accuracy, and the development of the machining robot control and programming system which can be directly used by CNC machine tool programmers and operators [2].

This paper describes analytically and experimentally based compliance modeling and analysis of 5-axis machining robot. The conventional method for the calculation of Cartesian space compliance based on joint compliances and Jacobian matrix [3-5] is expanded and used. Analytical analysis was conducted for effects of compliances of each joint individually on Cartesian space robot compliance. Experimentally, the Cartesian space compliance is obtained by direct measurement of the absolute displacements evoked by static forces along 3- Cartesian directions at the tool tip in the robot workspace for the case of 3-axis milling.

## PROBLEM STATEMENT

A basic module of the proposed concept of the robotic machining system [5] is the specialized 5-axis robot, Fig. 1a, with integrated motor spindle and with larger workspace, higher payload and stiffness.

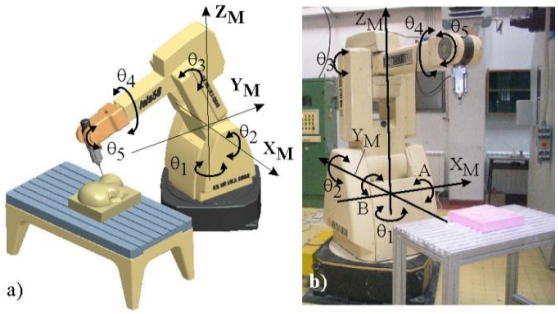


*Fig.1. 5-axis machining robot*

Due to its advantages in respect of stiffness and singularities, such robot would operate as a specific vertical 5-axis milling machine (X, Y, Z, A, B) spindle-tilting type. The development of specialized 5-axis vertical articulated machining robot is a joint project with robot manufacturer. For the development of control and programming system as well as for the analysis and development of the mechanical structure of 5-axis machining robot from Fig. 1a, a 6-axis vertical articulated robot with payload of 50kg, Fig. 1b, was used as a testbed, in a way that the sixth axis was blocked. The robot is equipped with high speed motor spindle with maximum speed of 18,000 $min^{-1}$.

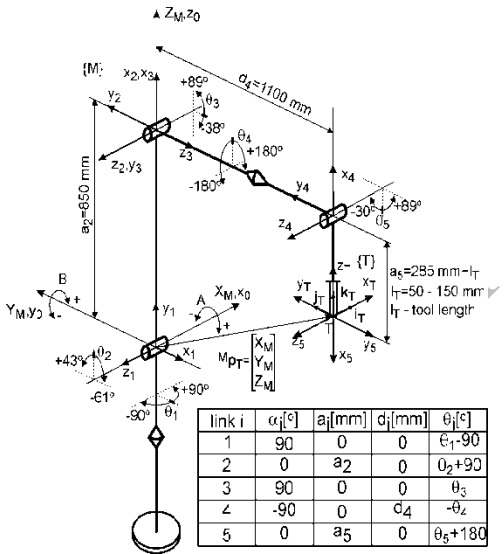
The focus of current research, one part of results being presented in this paper, is related to compliance modeling and analysis of the experimental 5-axis machining robot, which includes:

- Analytically based robot compliance modeling.
- Experimentally based robot compliance modeling.
- Machining experiments.

**JACOBIAN MATRIX AND WORKSPACE**

As it was mentioned, the 5-axis robot from Figure 1a will be considered below as a specific configuration of the 5-axis vertical milling machine (X, Y, Z, A, B) spindle-tilting type. Figure 2 represents a geometric model of the robot.

The robot reference frame {M} has been adopted according to the standard of this machine type and coincides with the robot based frame $(x_0, y_0, z_0)$.The tool frame {T} is attached to the milling tool tip T in a way that axis $z_T$ coincides with tool axis and also coincides with axis of the last link of the robot to which motor spindle is attached. The thus configured machining robot, where machining is performed on a work table in front of the robot as well as limited motions in joints relative to the reference position allows for: taking into account only one solution of inverse kinematic, avoiding the robot singularities, conveniences related to the stiffness.




| link i | $\alpha_i$[°] | $a_i$[mm] | $d_i$[mm] | $\theta_i$[°] |
|---|---|---|---|---|
| 1 | 90 | 0 | 0 | $\theta_1$-90 |
| 2 | 0 | $a_2$ | 0 | $\theta_2$+90 |
| 3 | 90 | 0 | 0 | $\theta_3$ |
| 4 | -90 | 0 | $d_4$ | -$\theta_4$ |
| 5 | 0 | $a_5$ | 0 | $\theta_5$+180 |

*Fig.2. D-H link coordinate frames and kinematic parameters*

The robot reference frame {M} has been adopted according to the standard of this machine type and coincides with the robot based frame $(x_0, y_0, z_0)$.The tool frame {T} is attached to the milling tool tip T in a way that axis $z_T$ coincides with tool axis and also coincides with axis of the last link of the robot to which motor spindle is attached. The thus configured machining robot, where machining is performed on a work table in front of the robot as well as limited motions in joints relative to the reference position allows for: taking into account only one solution of inverse kinematic, avoiding the robot singularities, conveniences related to the stiffness.

Joint coordinates vector for this 5-axis vertical articulated robot is represented as $\boldsymbol{\theta} = [\theta_1 \quad \theta_2 \quad \theta_3 \quad \theta_4 \quad \theta_5]^T$ where $\theta_i$ are scalar joint variables controlled by actuators. Given that the robot has 5 DOF, only the direction of tool axis $z_T$ is controllable, while axes $x_T$ and $y_T$ will have uncontrollable rotation about it. The position and orientation of the tool frame {T} relative to robot reference frame {M}

is described by world coordinates vector expressed as $\mathbf{x} = [X_M \quad Y_M \quad Z_M \quad A \quad B]^T$.

To model the robot, the Denavit-Hartenberg (D-H) notation [6] was used. To perform kinematic analysis, first coordinate frames are rigidly attached to each link. The homogeneous transformation describing the relation between one link and the next link is traditionally referred to as an $A$ matrix. Matrix ${}^{i-1}_{i}A$ designates D-H transformation matrix relating frame ($i$) to frame ($i-1$). Figure 2 shows D-H coordinate frames and link kinematic parameters for the experimental 5-axis robot from Figure 1b i.e. Figure 2 in the reference position taking into account the ranges of joint motions.

After the D-H coordinate frame is assigned to each link, the transformation between successive frames ($i-1$) and ($i$) is described as follows:

$$ {}^{i-1}_{i}A = Rot(z,\theta_i)\cdot Trans(z,d_i)\cdot Trans(x,a_i)\cdot Rot(x,\alpha_i) = $$
$$ = \left[\begin{array}{ccc|c} {}^{i-1}\mathbf{i}_i & {}^{i-1}\mathbf{j}_i & {}^{i-1}\mathbf{k}_i & {}^{i-1}\mathbf{p}_{Oi} \\ 0 & 0 & 0 & 1 \end{array}\right] \quad (1) $$

Substituting D-H parameters of the links in equation (1) the transformation matrices ${}^{i-1}_{i}A$ are obtained first. As noticeable from Figure 2 the frame {T} can be described relative to the frame $(x_5, y_5, z_5)$ by homogeneous transformation matrix as ${}^{5}_{T}T$ [2]. Now, as it is well-known [6], the tool position and orientation i.e. the position and orientation of frame {T} with respect to the robot reference frame {M}, Figure 2, for the given joint coordinates vector $\boldsymbol{\theta}$ and specified link parameters can be determined as

$$ {}^{M}_{T}T = {}^{0}_{1}A\cdot{}^{1}_{2}A\cdot{}^{2}_{3}A\cdot{}^{3}_{4}A\cdot{}^{4}_{5}A\cdot{}^{5}_{T}T \quad (2) $$

The position and orientation of arbitrary frame $i$ attached to the link $i$ with respect to the robot reference frame {M} i.e. robot based frame $(x_0, y_0, z_0)$ can be expressed as

$$ {}^{O}_{i}T = {}^{M}_{O}T\cdot{}^{0}_{1}A\cdot{}^{1}_{2}A\cdots{}^{i-1}_{i}A = \prod_{j=1}^{i}{}^{j-1}_{j}A = \left[\begin{array}{ccc|c} {}^{i-1}\mathbf{i}_i & {}^{i-1}\mathbf{j}_i & {}^{i-1}\mathbf{k}_i & {}^{i-1}\mathbf{p}_{Oi} \\ 0 & 0 & 0 & 1 \end{array}\right] \quad (3) $$

for $i = 1,2,3,\ldots,n = 5$ where $n$ is number of joints.

The robot Jacobian matrix relates joint velocities to Cartesian velocities of the tool tip. The mapping between static forces applied to the end-effector and resulting torques at the joints can also be described by Jacobian matrix [6,9]. Considering that the robot consists of five revolute joints, the Jacobian matrix has as many rows as there are degrees of freedom and the number of columns is equal to the number of joints

$$ J = [J_1 \quad J_2 \quad \ldots \quad J_n] \quad (4) $$

with column vectors

$$ J_i = \begin{bmatrix} {}^{i}\mathbf{k}_{i-1} \times \left({}^{0}\mathbf{p}_n - {}^{0}\mathbf{p}_i\right) \\ {}^{0}\mathbf{k}_{i-1} \end{bmatrix} \quad (5) $$

Substituting vectors from equation (3) in equation (5) Jacobian matrix columns $J_i$, $i = 1,2,3,\ldots,n = 5$ are obtained.

Workspace for 3-axis machining is shown in Fig. 3.

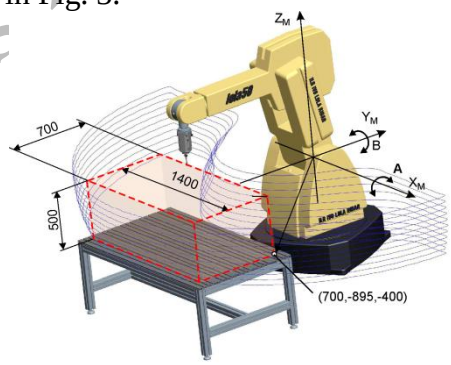



*Fig.3. Workspace in the case of 3-axis machining*
*($A=0^o$, $B=0^0$)*

## COMPLIANCE MODELING

As stated in [1,5,7,8] elastic properties of robot segments are insignificant, so there follows below the analysis of compliance model in Cartesian space based on joint compliances. The analysis will be conducted on the existing experimental machining robot from Fig. 1b.

Based on the principle of virtual work, the convectional formulation for the mapping of joint compliance matrix $C_\theta$ into the Cartesian space compliance matrix $C_X(\boldsymbol{\theta})$ [3-5] is expressed as

$$C_X(\boldsymbol{\theta}) = J(\boldsymbol{\theta}) \cdot C_\theta \cdot J(\boldsymbol{\theta})^T \qquad (6)$$

where $C_\theta$ is the compliance matrix in joint space which has the diagonal form as

$$C_\theta = diag(C_{\theta 1}, \ldots, C_{\theta n}) \qquad (7)$$

and $J(\boldsymbol{\theta})$ is Jacobian matrix.

Equation 6 is practically used in [4] to determine the robot compliance center and in [5] for machining robot compliance analysis where it is stated how suitable it is, for it allows mapping of the joint compliance matrix $C_\theta$ into Cartesian compliance matrix $C_X(\boldsymbol{\theta})$ without calculating any inverse kinematic functions. Since $C_\theta$ is diagonal, the Cartesian space compliance matrix $C_X(\boldsymbol{\theta})$, Eq. 6, is the sum of the joint compliances associated with each individual joint as

$$C_X(\boldsymbol{\theta}) = C_{X1}(C_{\theta 1}) + \ldots + C_{Xn}(C_{\theta n}), \quad n = 5 \qquad (8)$$

Where

$$C_{Xi}(C_{\theta i}) = C_{\theta i} \cdot \mathbf{J}_i \cdot \mathbf{J}_i^T, \; i = 1,2,\ldots,n, \; n = 5 \qquad (9)$$

while $\mathbf{J}_i$ are column vectors of Jacobian matrix $J(\boldsymbol{\theta})$.

Equations 8 and 9 provide insight into the impact of compliance of each joint individually on the Cartesian space compliance. This means that impact of the corresponding joint is obtained incorporating in the Eq. 8 only its compliance, while the other joints are considered stiff. This is of crucial importance for the present paper, because it can be useful for robot manufacturer's experts in the design of specialized machining robot.

For an articulated robot, $C_X(\boldsymbol{\theta})$ is symmetric non-diagonal and configuration dependent matrix. Thus, if $C_\theta$ can be experimentally determined, the Cartesian space compliance matrix $C_X$, Eq. 6 and the linear displacement of robot tool tip under external static force vector $\mathbf{F} = [F_x \;\; F_y \;\; F_z]^T$ at any location in the workspace can be estimated as

$$\delta\mathbf{x} = C_X(\boldsymbol{\theta}) \cdot \mathbf{F} \qquad (10)$$

Table 1 shows the experimentally identified compound joint compliances.

*Table 1. Experimentally identified joint compliances*

| Joint number *i* | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| $C_{\theta i}$ [rad/Nm] $\cdot$ | 7.14 | 10.12 | 12.30 | 17.32 | 91.35 |

Using experimentally determined compound joint compliances, the Cartesian space compliance matrix is calculated in workspace shown in Fig. 3.

Figure 4 shows the distributions of analytically determined compliances in the $Z_M = 0$ plane.

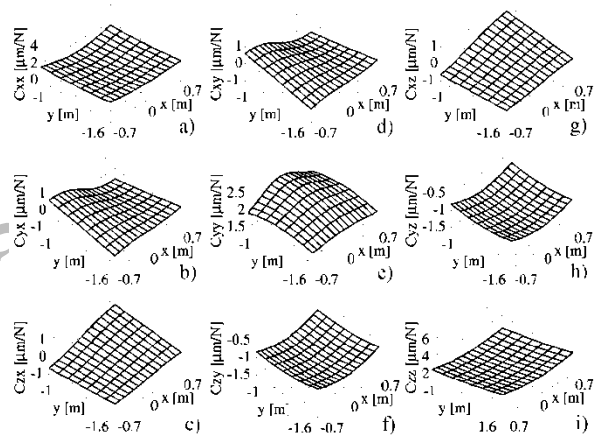



*Fig.4. Distributions of analytical compliances in the plane $Z_M$=0*

The distributions of direct-compliances $C_{xx}, C_{yy}$ and $C_{zz}$ are presented in Figs. 4a, 4e and 4i respectively. The distributions of cross-compliances $C_{yx}, C_{zx}$ and $C_{zy}$ are given in Figs. 4b, 4c and 4f respectively. Figure 4 can be also viewed as the Cartesian space compliance matrix $C_X(\boldsymbol{\theta})$ in the $Z_M = 0$ plane in the workspace shown in Fig. 3.

The distributions of dominant components of direct-compliances originating from individual joints are shown in Fig. 5.

## EXPERIMENTAL COMPLIANCE

Another approach to obtain the Cartesian compliance of the machining robot is the

direct measurement of the absolute displacement evoked by a load at the tool tip.

The original and deformed positions of sphere-tip tool caused by deadweight of 250N are measured with FARO Portable CMM 3D, from which translational displacements $\delta x, \delta y$ *and* $\delta z$ are calculated.

Displacements of the sphere-tip tool are measured in the workspace shown in Fig. 3 at 40 points with the fixed $X_M$- and $Y_M$-coordinates in 6 $Z_M$-levels ($Z_M = -400mm$ to $Z_M = 100mm$). Experimental compliances are determined based on sphere-tip tool displacements evoked by static amount of the milling force of 250N in all 3 Cartesian directions. Figure 6 shows an example of displacements measurement for the case of robot loading in $Y_M -$ direction.

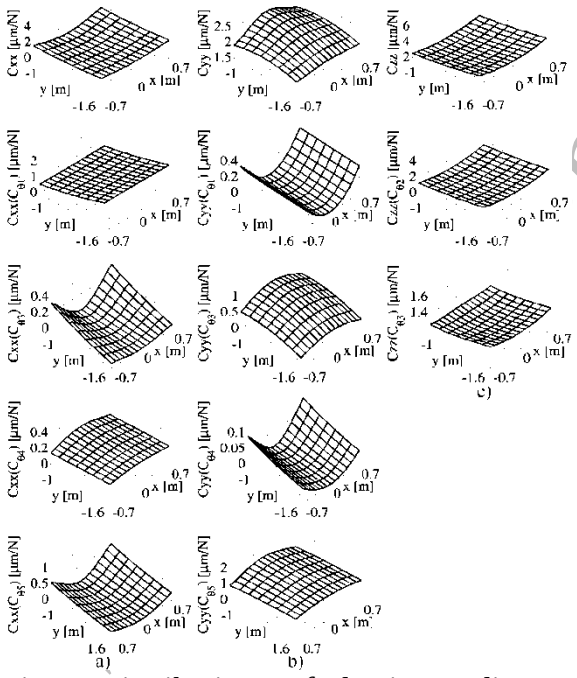


*Fig.5. Distributions of dominant direct-compliances components*

EXPERIMENTAL COMPLIANCE

Another approach to obtain the Cartesian compliance of the machining robot is the direct measurement of the absolute displacement evoked by a load at the tool tip.

The original and deformed positions of sphere-tip tool caused by deadweight of 250N are measured with FARO Portable CMM 3D, from which translational displacements $\delta x, \delta y$ *and* $\delta z$ are calculated.

Displacements of the sphere-tip tool are measured in the workspace shown in Fig. 3 at 40 points with the fixed $X_M$- and $Y_M$-coordinates in 6 $Z_M$-levels ($Z_M = -400mm$ to $Z_M = 100mm$). Experimental compliances are determined based on sphere-tip tool displacements evoked by static amount of the milling force of 250N in all 3 Cartesian directions. Figure 6 shows an example of displacements measurement for the case of robot loading in $Y_M -$ direction.

Figure 6 shows the distributions of experimentally obtained compliances in the $Z_M = 0$ plane. The distributions of experimental direct-compliances $C_{xx}, C_{yy}$ and $C_{zz}$ are shown in Figs. 7a, 7e and 7i, respectively.

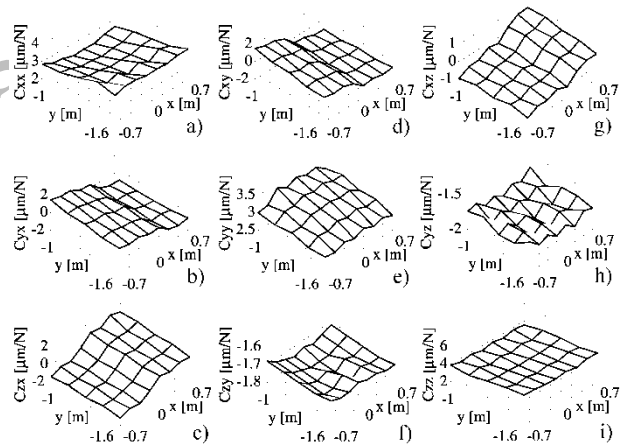


*Fig.6.Distributions of experimental compliances in the plane $Z_M$=0*

Experimental cross-compliances are presented in Figs. 6b, 6c and 6f, respectively. Comparing them with analytically determined compliances, Fig. 4, it can be inferred that the character of their distributions is similar, but experimentally determined compliances are slightly higher. Higher values of experimentally determined compliances compared to those determined analytically originate from compliances of structure elements, motor spindle and tool itself.

## CONCLUSION

The paper presents analytically and experimentally based compliance modeling and analysis of 5-axis machining robot based on conventional approach for the mapping of joint compliances into robot Cartesian space compliance. By expanding this modeling approach, it has been shown that it is possible to analyze each joint compliance impact on robot Cartesian space compliance. Satisfactory correlation between analytically and experimentally determined robot Cartesian space compliances confirms the usability of each joint compliance effects on tool tip displacements. Suitable model of the process forces and compliance model proposed in this paper also enable the development of virtual robotic machining system for further research. The present research has laid foundations for an advanced design method for one machining robot as well as for the development of strategy for real-time tool tip displacement compensation based on captured process forces.

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# SURFACE ROUGHNESS PREDICTION IN ELECTRICAL DISCHARGE MACHINING

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**Abstract**: *This work proposes for the prediction of surface roughness by a regression model and two different artificial neural networks (ANNs) models: Back propagation neural (BPN) network and radial basis function neural (RBFN) network for the prediction of surface roughness (Ra) in Electrical Discharge Machining (EDM). A series of extensive EDM experiments were conducted on AISI D2 to obtain the experimental data for which the models used the pulse current (Ip), the pulse duration (Ton) and duty cycle ($\tau$) as input variable with a constant voltage 50 volt. The developed models are validated with a new set of experimental data, and predictive behavior of models is compared and relative advantages of each model are analyzed.*

***Keywords:*** Electrical Discharge Machining, Regression Analysis, Back Propagation Neural Network, Radial Basis Function Neural Network, Surface Roughness.

## 1. Introduction

Electrical discharge machining (EDM) is a well known non conventional machining process, with distinct characteristic lies in using thermal energy to machine electrically conductive components regardless of hardness and complexity of the geometry that has been its unique advantage in the manufacture of mold, die, and automotive, aerospace, and surgical components. The mechanism of material removal is very complex that involves the formation of a plasma channel between the tool and work piece electrodes; the repetitive spark causes melting and even results in evaporating the electrodes. Since the complex and stochastic nature of the EDM process is not fully understood yet, it generates tremendous inquisitiveness among the researchers to model the process accurately. Several research attempts have been made to study the responses such as surface roughness and material removal rate relating to the input variables.

The Effects of EDM process parameters have been investigated. Wang and Yan [1], Lin et al. [2] and Lin and Lin [3] studied the effect of current, polarity, voltage, and spark on-time on the EDM process by using the Taguchi method. Petropoulos et el. [4] presented a multi-parameter analysis of Ra and investigated the machining conditions and found close correlation between Ra and EDM input variables and developed a single and multiple statistical regression models. Guu et el. [5] studied the surface phenomena caused by EDM and proposed an empirical model based on experimental data which indicates that the higher the discharge energy, the faster the machining time, which introduces machining damage in the solid surface layer and deteriorates the surface roughness. The increase of crater depth with the applied pulsed current and pulse-on duration appears minimal under a small input energy. Tsai and Wang [6] illustrated six different neural-networks models and a neuro-fuzzy network for the purpose of comparison of the surface finish for various work material with the change of electrode polarity and concluded by comparing the results and checking errors in these models by experimental results that are found complying with the predictions. Lee and Li [7] studied the effects of process parameters in EDM of

tungsten carbide. Hocheng et al. [8] investigated the correlation of current and spark on-time and the crater size produced by a single spark of SiC/Al work-material. Pradhan [9] presented a neuro-fuzzy model to predict MRR with different process parameters such as Ip, Ton and duty cycle, and the model predictions were found to be in good agreement with the experimental results. Qu et al. [10, 11] examined the EDM process parameters in a cylindrical EDM process. Assarzadesh et el. [12] Presented a 3-6-4-2-size BPN model to establish a process model considering Ip, Ton and voltage as input to the network and MRR and Ra as output, which is capable to predict process performance with reasonable accuracy, under varying machining conditions. Mandal et el. [13] attempted to model the EDM process using artificial neural network (ANN) with back propagation as the learning algorithm taken Ra, MRR and tool wear, as various input parameters. Markopoulos [14] proposed an ANN model for the prediction of surface roughness using Ip, Ton, and the processed material as input parameters and found satisfactory prediction of Ra.

This assessment establishes the lack of research in EDM of AISI D2 steel materials and the study related to the comparison of regression and ANN models for the prediction of Ra in EDM. Modeling using regression analysis, BPN and RBFN are conducted to investigate on Ra in die-sinking EDM of D2 tool steel. The material was selected for its wide applications in die and mold industries such as hammer and hydraulic forging die. In the regression analysis, the task was to find out the process parameters (factors) and how its interactions affect the Ra. This is usually done by means of analysis of variance (ANOVA). Furthermore, regression analysis is used to establish the correlation between factors and response (Ra). The appropriate degree of the polynomial regression equation is found which is thought to be useful assessment of the predictive equation [15]. The result predicted from this equation is tested with another set of test data to know the predictive capabilities

## 2. EXPERIMENTATION

### 2.1 Experimental setup

Several experiments were conducted to study the effects of various machining parameters on EDM process. These studies have been undertaken to investigate the effects of current (Ip), voltage (V), spark on-time (Ton) and duty cycle (τ) on MRR, where duty cycle is the ratio of Ton to sum of Ton and spark off-time (Toff) in percentage. The selected workpiece material in the research work is AISI D2 tool steel. D2 is selected due to its growing range of applications in the field of manufacturing tools in mold industries. The electrode material for these experiments is copper. Experiments were conducted on Electronica Electraplus PS 50ZNC die sinking machine. A cylindrical pure copper, with a diameter of 30 mm, was used as a tool electrode (of positive polarity) and workpiece materials used were AISI D2 steel square plates of surface dimensions 15×15mm$^2$ and of thickness 4 mm. Commercial grade EDM oil (specific gravity= 0.763, freezing point= 94˚C) was used as dielectric fluid. Lateral flushing with a pressure of 0.3 kgf/cm$^2$ was used. The test conditions are recorded in the Table 1. To obtain a more accurate result, each combination of experiments (52 runs) was repeated three times and every test ran for 15 min.

Table 1: Experimental Machining parameter

| Parameter of Experiment | Values |
|---|---|
| Current (Ip, A) | 1 5 10 20 30 50 |
| Pulse on Time (Ton) | 510 20 30 50 100 200 |
| Discharge Voltage (V) | 50 |
| Duty Cycle (τ ) | 1 6 & 12 |
| Polarity | Positive (+) |

### 2.2 Surface roughness measurements:

Roughness measurement was done using a portable stylus type profilometer, Talysurf (Taylor Hobson, Surtronic $3^+$). The profilometer was set to a cut-off length of 0.8 mm, filter 2CR, traverse speed of 1 mm/sec and 4 mm evaluation length. Roughness measurements in the transverse direction on the work pieces were repeated four times and average of four measurements of surface roughness parameter values was recorded. The measured profile was digitized and processed through the dedicated advanced surface finish analysis software Talyprofile for evaluation of the roughness parameters.

### 2.3Surface roughness

Ra is an important parameter in the EDM process. The parameters that affect roughness are Ip, Ton, τ and V. It is a measure of the technological quality of a product which mostly influence the manufacturing cost of the product. It is defined as the arithmetic value of the profile from the centreline along the length. This can be express as

$$R_a = \frac{1}{L}\int \left\| y(x) \right\| dx \qquad (1)$$

Where L is the sampling length, y is profile curve and x is the profile direction. The average surface roughness Ra is measured within L = 0.8 mm. Centre-line average Ra surface roughness measurements of electro-discharge machined surfaces were taken to provide quantitative evaluation of the effect of EDM parameters on surface finish.

## 3. REGRESSION MODELLING

Statistical regression analysis is a potential tool for modeling a process. It can provide a relationship between the input and the output parameters based on some experimental results the regression modeling was applied to efficiently obtain estimates of Surface Roughness. Since basic linear estimates may not adequately capture nuances in the response-predictor relationship, the most advanced techniques were considered to account for potential predictor interaction and non-linear relationships. Standard statistical techniques have been presented for assessing model effectiveness and predictive ability.

## 4. NEURAL NETWORK MODELLING

An ANN is a new computing tool that processes information using neurocomputing approach. This is different from the classical computation. Several studies have been reported on the development of neural networks based on different architectures. Neural networks are characterized by their architecture, activation function and learning algorithms. Each type of neural networks has its own input-output characteristics; therefore, it could be applied only in some specific process. A neural network is represented by weighted interconnections between processing elements. These weights are the parameters that actually define the non-linear function performed by the neural network. The process of determining such parameters is called training or learning, relying on the presentation of many training patterns.

The architecture of the neural network having *n* inputs and *m* outputs is given in the Figure. 1.

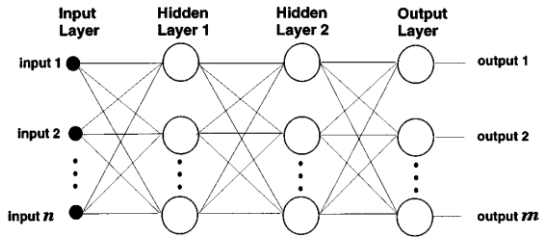


**Figure 1 Architecture of Neural Network**

In this study, two neural networks are used for modeling the Ra in the EDM process. Two networks are discussed as follows.

A. Back-propagation Network (BPN)
B. Radial basis network (RBN)

### 4.1 Back-propagation Network

The most widely used neural network is the Back Propagation algorithm due to its relative simplicity and universal approximation capacity. The back-propagation algorithm defines a systematic way to update the synaptic weights of multi-layer perception networks. Back-propagation uses a gradient descent approach to minimize output error in the network. Mainly there are two stages in the learning algorithm such as the feed-forward and the feed- backward. The first phase learning is carried out when a set of input training patterns is propagated through a network consisting of an input layer, one or more hidden layers and an output layer. In the second phase, the errors calculated in the output layer are then back propagated to the hidden layers where the synaptic weights are updated to reduce the error. This learning process is repeated until the output error value, for all patterns in the training set, are below a specified value. The definition of the network size (the number of hidden layers and of neurons in each layer) is a compromise between generalization and convergence. Convergence is the capacity of the network to learn the patterns in the training set and generalization is the capacity to respond correctly to new patterns. The idea is to implement the smallest network possible, so it would be able to learn all patterns and, at the same time, provide good generalization. The Back-propagation, however, has two major limitations: a very long training process, with problems such as local minima and the restriction of learning only static input-output mappings.

### 4.2 Radial Basis Function Network

The RBFN is basically composed of three different layers: the input layers, one hidden layer, and one output layer. RBFNs compute activation functions at the hidden neurons in a way that is different from what we have seen in the case of BPNs. Without employing an inner product between the input vector and the weight vector, hidden neuron activations in RBFNs are computed using an exponential of a distance measure (usually the Euclidean distance or a weighted norm) between the input vector and a prototype vector that characterizes the function at hidden neuron. Many transfer functions may be used for the hidden units but the most common is Gaussian, which gives a response that drops off rapidly as the distance between the hidden unit and the input vector that increases and, is symmetrical about the radial axis; hence, named as Radial Basis Function. The rate with which the response drops is determined by the "spread" of the hidden unit. The output layer of an RBFN is linear. The challenge of designing an RBFN lies in properly placing hidden layer neurons and choosing an optimal value for the spread constant such that, the entire input space of interest is covered with minimum overlap. These decisions are usually made empirically, rather than through automatic training methods. Radial Basis Functions have attracted a great deal of interest due to its rapid training, generality and simplicity. When compared with traditional multiplayer perceptions, RBFN constitute a much faster training, without complying with traditional Back Propagation problems, such as the local minima.

## 5. RESULT AND DISCUSSION

### 5.1 Regression Analysis

In this study, a regression model is also developed to find out a relationship between the four input process parameters such as Ton, Toff, Ip, with response Ra based on a set of 52 experimental results. Initially a linear model, linear and square, linear and interaction and a full quadratic models are discussed as depicted in Table 2, which indicates that the full factorial model is the best one compared with others. It can be used with these factors and factor levels by $R^2$ adj test (The R-Sq ($R^2$) value that indicates the predictor explains 97% of the variance in Ra). The $R^2$ (adj) is 96.1%, which accounts for the number of predictors in the model. Both values

indicate that the model fits the data well. Table 3 shows the coefficients of factors and factor effects in regression model. Table 4 shows the ANOVA table for regression analysis.

Table 2 – Table of $R^2$ and $R^2$ adj test for regression model for Ra analysis.

| Degree | R-Sq | R-Sq (adj) |
|---|---|---|
| Linear | 87.7 | 86.5 |
| Linear + square | 96.9 | 96.4 |
| Linear Interaction | 93.3 | 91.9 |
| Full Quadratic | 97.0 | 96.1 |
| | | |

Table 3 – Table of regression model for Ra analysis

Regression model

| Term | Coef | SE Coef | T | P |
|---|---|---|---|---|
| Constant | 2.24404 | 0.347395 | 6.460 | 0.000 |
| Ip(A) | 0.24128 | 0.079051 | 3.052 | 0.005 |
| Ton(μs) | 0.03860 | 0.007818 | 4.938 | 0.000 |
| τ | 0.0841 | 0.033103 | 2.544 | 0.017 |
| Ip*Ip | 0.00576 | 0.003201 | 1.798 | 0.083 |
| Ton* Ton | 0.00006 | 0.000034 | 1.862 | 0.073 |
| Ip*τ | 0.00647 | 0.003464 | 1.869 | 0.072 |
| S =0.6858 R-Sq = 94.7% R-Sq(adj) = 93.5% | | | | |

Table 4 Test results of analysis of variance(ANOVA)

| Source | DF | Seq SS | Adj SS | Adj MS | F | P |
|---|---|---|---|---|---|---|
| Regression | 6 | 234.05 | 234.05 | 39.009 | 82.9 | 0.000 |
| Linear | 3 | 228.287 | 35.17 | 11.724 | 24.9 | 0.000 |
| Square | 2 | 4.125 | 4.318 | 2.1594 | 4.59 | 0.019 |
| Interaction | 1 | 1.643 | 1.643 | 1.6430 | 3.49 | 0.072 |
| Residual Error | 28 | 13.169 | 13.16 | 0.4703 | | |
| Total | 34 | 247.224 | | | | |

Eq. (2) presents the relationship between factors, their interaction and response (Ra), which is the result of full quadratic regression analysis.

$$Ra = 2.24404 + 0.24128 * Ip + 0.03860*Ton - 0.0841 *\tau - 0.0057 (Ip)^2 - 0.00006(Ton)^2 + 0.0064 Ip*\tau \quad (2)$$

It can be noted from the final equation for surface roughness (Eq. (2)) that there are some coefficients omitted. This is done based on t-test at 95% confidence level. Significant and insignificant coefficients are determined by comparing its value with some standard tabulated data at their corresponding degree of freedom and 95% confidence level.

It is very important to see the adequacy of the proposed model. This is done based on $R^2$ and ANOVA test. The test results for ANOVA are listed in Table 1. The p-value shows that the model is significant at α-level of 0.05. Model adequacy is checked by means of plot of residuals versus fits, plot of residuals versus order of the data, and normal plot of residuals. Figure 2 shows the plot of residuals versus fits. It is clearly observed from this plot that residuals have constant variance. The present discussion implies that the predictive model is adequate.

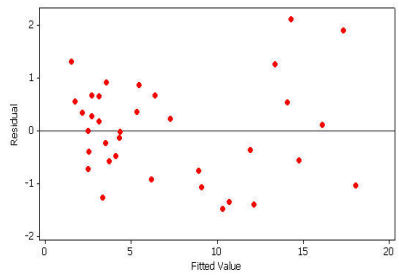


Figure 2 Plot of residual vs fit

## 5.2 Neural network analysis

Initially, the architecture and the topology of the networks i.e. the number of hidden layers and the number of neurons in each layer in the networks are decided. The process parameters the discharge current (Ip), pulse on time (Ton), duty cycle (τ) and Voltage (V) are taken as the inputs and Surface Roughness (Ra) is taken as output.

Thus, there are four input nodes and one output node. The variations of process parameters for different experimental set (Run) are presented in the Table1. As such, the data for training is selected judiciously. 35 training data sets are considered for both the networks to compare the performances. Besides, 8 testing sets outside the training data set are selected for testing the neural networks. The training data sets and the test data sets are taken from Experiment. Both the ANNs were trained with the above datasets to reach the error goal. The performance of two neural network models is studied with the special attention to their generalization ability and the training time.

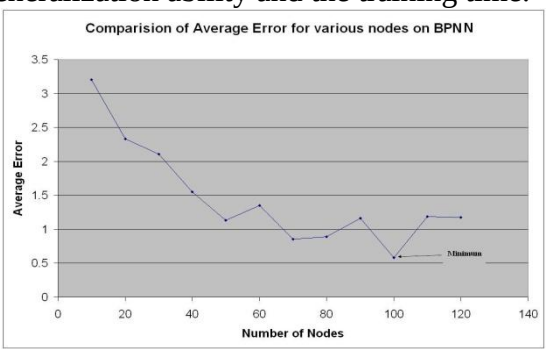


**Figure 3 Comparison of average errors for various nodes on BPNN**

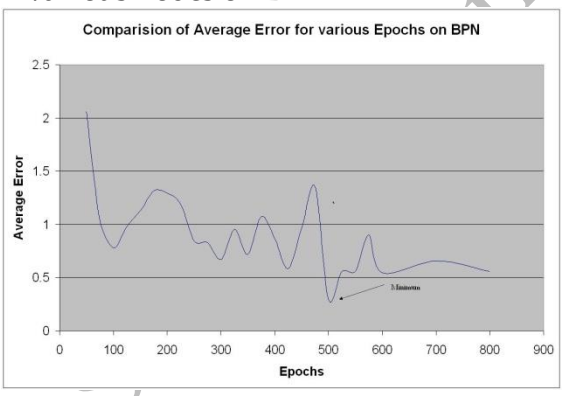


Figure 4 Comparison of average errors for various epochs on BPNN

For the best performance of the BPNN, the proper number of nodes in the hidden layer is selected through a trial and error method based on the number of epochs needed to train the network. It was observed that the network performed well with 100 nodes and 500 epochs as shown in Figure 3 and Figure 4.

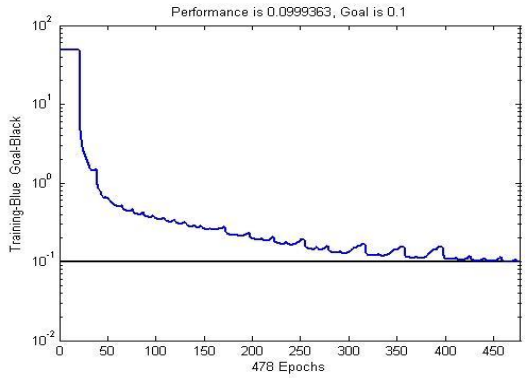


**Figure 5 Learning behaviour of BPNN model for surface**

The learning behaviour of BPNN model for surface roughness is shown in Figure 5. The RBF network is auto configuring in the sense that it has only one hidden layer with a growing number of neurons during learning to achieve an optimal configuration. The only parameter to be varied to obtain the best generation ability is the spread factor (SF). Computations are carried out for different values of spread factor. It was observed that the best generalization ability of the network achieved with a spread factor of value 45 as shown in Figure 6

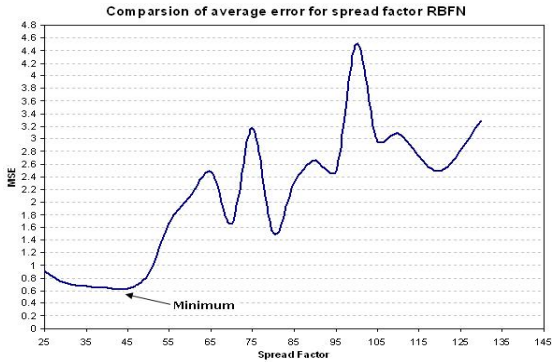


**Figure 6 Comparison of average error for various nodes and spread factor**

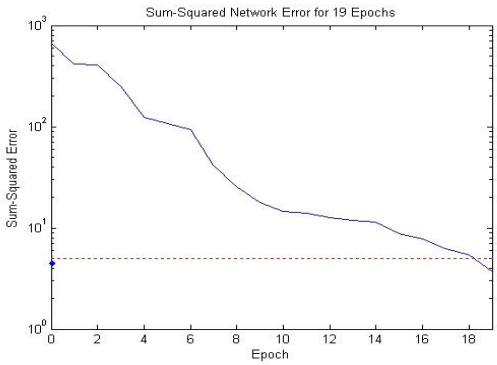


**Figure 7 Learning behavior of RBFNN model for surface roughness**

The training performances of the same training data sets are shown in Figure 7. The error goal is reached in only 18 epochs in RBFNN, while 500 epochs are required by the BPNN.

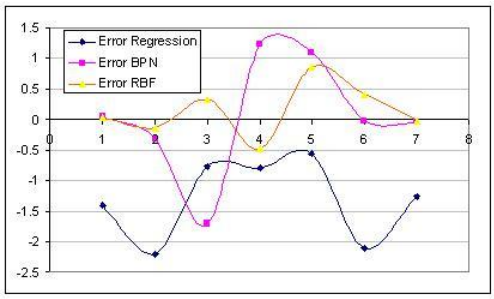


**Figure 8 Residuals calculated as the difference between experimental and predicted values for the data set.**

ANN's are compared separately with results obtained by experiments and the average error obtained for both the networks. RBFNN model is poorer at two input values but for the rest of the input range, within which the normal operating range lies, both the models have almost identical generalization ability. The test results accuracy measured in terms of mean absolute error (MAE) for 8 test data are found to be 0.297188 for the BPNN and 0.574888 for RBFNN. In the case of RBF network, the number of epochs is equal to the number of neurons in the single hidden layer of the network. The error goal is reached in only 19 epochs, while 478 epochs are required by the BPNN. The amount of the work done in each epoch is not equivalent for both ANN's.

Figure 8 shows the error for each model, calculated as the difference between the experimental findings and predicted values. It was found that except at two places, both the models predicts the roughness

## 6. CONCLUSION

In this research, surface roughness values are predicted using a regression model and two artificial intelligence techniques: namely BPNN and RBFNN. The resulting predictions are compared with the experimental results from the EDM process done on the AISI D2 steel materials with different machining parameters using copper electrode. The proposed prediction networks are validated with the experimental results and also comparison was made among them. The following is the outcome of this study:

1. The regression model is quite comparable to the ANN models for prediction of Ra and they can provide a satisfactory prediction. The predicted process parameters on validation are found to be close correlation with the actual experimental results. It is seen that ANN provides the better prediction capability with overall mean prediction error, 0.640114 and 0.321957 respectively for BPN and RBFN, while 1.300806 for regression model. Though the proposed regression model is adequate and accepted, neural network models yield better prediction.

2. The BPNN showed a slightly better performance compared to the RBFNN model i.e. the MAE for test data are 0.297188 for the BPNN and 0.574888 for RBFNN. However, the RBFNN model predicts quite faster the error goal reached in only 18 epochs while BPNN requires 478 epochs. It is important to note that for BP networks the required number of nodes in the hidden layer was found by trial and error method, whereas, the RBF networks have only one hidden layer with a growing number of neurons. The overall outcome is that the surface finish of EDMed surface can be

predicted by the above models with reasonably better accuracy.

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# MULTIBAND MPA: LOADED WITH FOUR RECTANGULAR SRR STRUCTURES, INSPIRED BY METAMATERIAL STRUCTURES

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**Abstract:** *In this paper a Micro strip Patch Antenna (MPA) design has been proposed which will be using 4 rectangular shaped SRR metamaterial structures arranged along with a separate wire to achieve metamaterial properties. The prime objective in this design proposal is to obtain the best possible gain using multiple SRR structures. The design of such antenna is simulated in HFSS-15 at a frequency range of 5-20GHz and the observations result into a slight drop of return loss and a sufficiently good enough gain and multiple resonant frequencies allowing the antenna to be a multi-band antenna with three resonant peaks visible below 10dB. The proposed antenna is designed using TLM equations that calculate the patch size for given frequency and height of the substrate.*

*The substrate material used is FR4 which is having a permittivity of 2.25 and loss tangent of 0.01. The patch size is 27mm × 28mm with the substrate height being 1.57mm. The proposed design has a combination of SRR and wire to obtain Meta material characteristics which is the primary objective. The cut wire pair structure can achieve magnetic resonance at frequency bands by appropriately designing the cut wire dimensions. The four pairs of rectangular SRR and wire combination meta material structures are placed at four corners and exhibit meta material properties resulting in improved gain BW and better return loss. The resulting antenna is a multi-band antenna which shows multiple bands below 10 db frequency i.e. three resonant peaks at: 7.88GHz, 10.12GHz and 12.22GHz respectively with bandwidth of 2.2GHz, 1GHz and 0.4932 GHz respectively and a relatively high gain of 6.94dB. The BW obtained by far denotes that the antenna is a Low Frequency Antenna but it is yet useful enough to be used as a multiband antenna in the low frequency range.*

*The outcome of this simulation gives us a wide area of opportunity for research in this particular BW and also a great scope of research particularly in metamaterial based antenna designs. The results of simulation of the proposed MPA with metamaterial structures has also been compared to that of a regular patch antenna (without metamaterial structure) and it is observed that the use of SRR structures enhances the gain and BW to be out to optimum usage.*

**Keywords:** MPA- Micro strip Patch Antenna, MTM-Metamaterial, BW-Band width, LHM-Left Handed Material, Return Loss, SRR-Split ring Resonator.

## INTRODUCTION

MPA antennas have become popular in the latest trend of antenna design formulation and use. Wireless devices have increasingly started using the MPA's and henceforth the primary requirement becomes that of being the reduction of size or the volume of the communication system as a whole. This can be and is achieved by minimizing the sizes of the antenna which should be implemented to put to practical use as well.

The MPA makes use of a patch which is generally stated to be a low gain antenna and usually has a very small return loss and hence we will have to look forward to have a design which is small in size and yet shows a high gain bandwidth performance.

Such antenna can be formulated by making use of the popular structures of metamaterial i.e. circular, rectangular etc.

To develop such an antenna of high performance and still have a low cost of design and production, we make use of a substrate material sandwiched between the patch and the ground plane. The use of substrate covering the space between a patch and a ground plane is the actual thickness of the substrate denoted by't' and is denoted by $\lambda_0/100$.

### 1.1 LEFT HANDED MATERIAL (LHM)

Left handed material or the metamaterials are artificially prepared smart materials designed such that they exhibit properties which can be well utilized for engineering purpose. LHM was founded by Victor Veselago [2] but the practical design implementation of LHM could not be achieved for the upcoming several decades until SMITH fabricated it in year 2000 [7].

Meta is a Greek word which means "to go beyond "which here signifies a material that directs something beyond, altered, changed or something advance.

Metamaterials do not exist in nature as real elements. The Metamaterials do not derive their properties from the properties of base materials but from the way they are designed and their shape, size, geometry etc when arranged in a pattern makes them capable to manipulate the EM waves ( by absorbing, bending etc.) & thereby resulting in useful structures.

Metamaterials have a structure or design that shows Negative Permeability and Negative Permittivity at the same time and since the wave propagation in a metamaterial is in backward direction in the medium, It is thus known to follow the Left handed propagation rule[5]. The metamaterial structure also helps in improving the Antenna Directivity Gain [6].

Due to negative μ and negative ξ , the refractive index of the medium is also negative and thus it is also known as Negative index material NIM [5].The following Metamaterial structures have been introduced so far:

Electromagnetic Band Gap (EBG), Split Ring Resonator (SRR), artificial magnetic conductor (AMC) ,PHOTONIC BAND GAP (PBG) etc. But of all the above, SRR's are the most popularly used structures and we have also used the same.

In our proposed design we have made use of four rectangular structures along with wire arrangements of SRR which are deployed in the ground plane. The SRR design helps to attain the negative permeability and negative dielectric constant with ease and are hence also known as Double Negative Materials (DNG) [1]. In our design SRR structures are used and are used in pairs consisting of a rectangular shaped metallic split ring along with the wire arranged in parallel and printed on the microwave dielectric circuit board.

The complimentary SRR (CSRR) structures can be obtained by replacing copper parts with substrate material and vice versa [1] and are often used for the same purpose of design and obtaining better results along with SRR.

## 1. Design of a regular MPA for comparative study

In Order to have a better analysis, a regular rectangular MPA is also designed with the help of HFSS-15 and is simulated. The Return Loss plot and the Gain BW is also provided below. These plots will be further used to compare the parameters of the proposed MPA. Operating Frequency used for the regular MPA is 20 GHz.

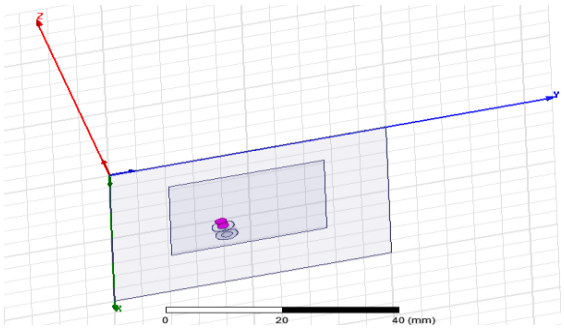


**Fig.1.** A regular Rectangular microstrip patch antenna

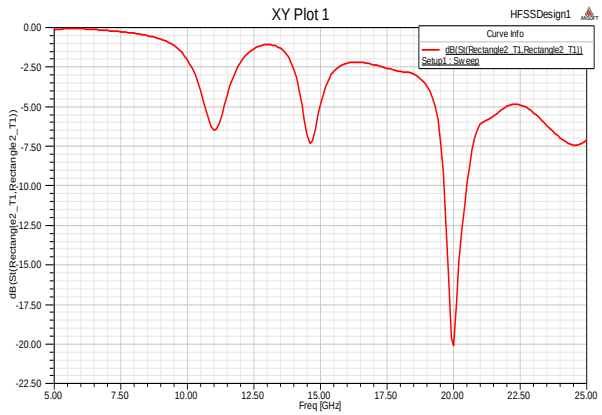


**Fig. 2.** Return loss and bandwidth of a simple rectangular MPA
BW =500MHz at 20 GHz Resonance freq
Return loss = -20Db

## 2. DESIGN SPECIFICATIONS OF PROPOSED ANTENNA

The Microstrip Antenna presented in this paper is a rectangular patch Microstrip Antenna and has the following specifications and parameters on which the simulation has been done. The material use for the purpose of Substrate is FR4.

| Parameters | Dimension | Unit |
|---|---|---|
| **Length L (Ground Plane)** | 50 | Mm |
| **Width W (Ground Plane)** | 50 | Mm |
| **Thickness (h)** | 1 | Mm |
| **Length of Patch** | 27 | Mm |
| **Width of Patch** | 28 | Mm |
| **Operating frequency** | 5-20 | GHz |
| **Die-electric constant** | 2.25 | |
| **Loss tangent (tan )** | 0.01 | |
| **Type of feed** | coaxial | |

**Tab. 1.** Specifications of Proposed MPA

The proposed Meta material structure with 4 rectangular SRR and wire structures is as shown below:

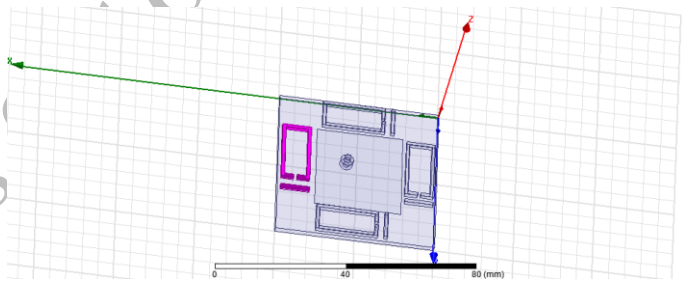


**Fig.3**. Proposed metamaterial structure.

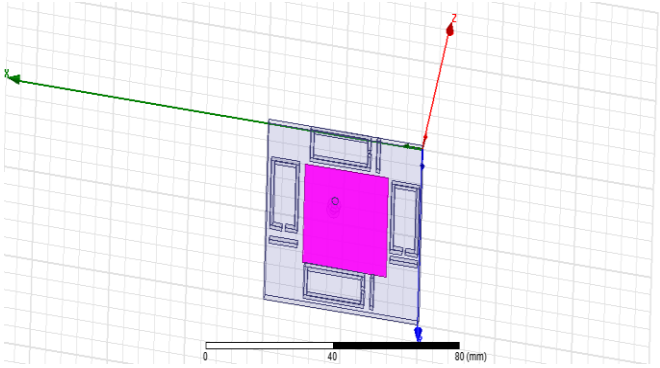


**Fig.4.** Proposed metamaterial structure showing the patch.

The above proposed design has shown better results in terms of BW and Return loss as is reflected in the plots below after simulation on HFSS-15.

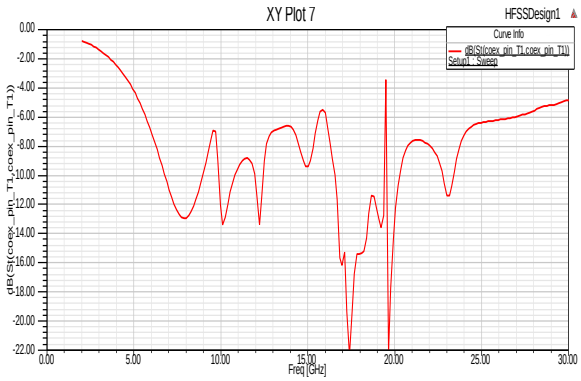


**Fig.5.** Simulation result of proposed Meta material structure

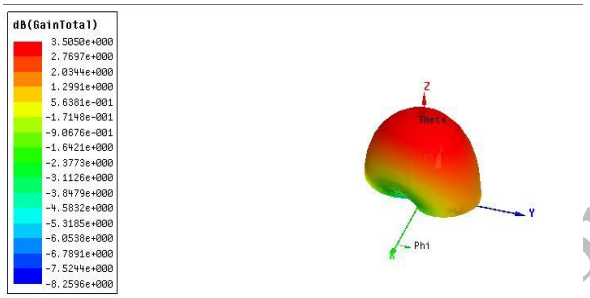


**Fig.6.** Antenna Gain of regular MPA

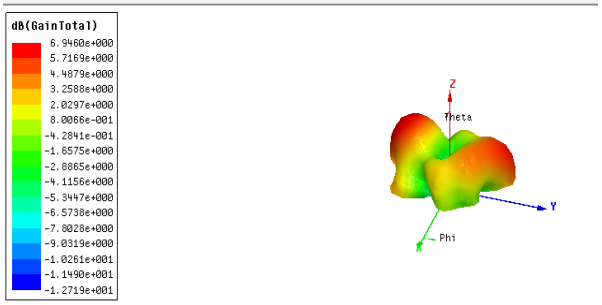


**Fig.7.** Antenna Gain of MPA with proposed metamaterial structure

The Simulation results of the proposed MPA with rectangular SRR structures are shown in Fig.7.

As we can clearly see from the return loss plot it will be touching the return loss of -22.29dB at 17.4 GHz and -22.09dB at 19.64 GHz**.** So it clearly withstands as a better result output when compared to a regular MPA (Specially in terms of Gain parameters).

The Gain of the regular MPA is 3.50dB while the gain obtained by our proposed antenna is 6.94dB. Also the return loss has slightly improved (though not much) from -20dB to -22.29dB and our proposed antenna also provides 3 resonant frequencies below 10dB and hence can be used in different bandwidths.

## 3. Results & Further Scope of improvements.

As we have seen in this paper, the proposed MPA with metamaterial structure simulated with HFSS-15 at 5-20GHz frequency provided us a low return loss and for the same reason on the contrary part it also improved the gain and the directivity of the MPA. The proposed antenna can be well utilized in the low frequency band range within 0.4GHz to 2.2 GHz as a multiple band antenna.

So it is hereby confirmed that using the metamaterial structure on a regular rectangular MPA helps in decreasing the return loss [18] and increases the BW at the same time.

Although the above results for the proposed metamaterial structure with MPA shows us a better gain but further gain has been achieved by many by making use of the "Slot cutting" technique. The Slot when cut can further increase the gain to a greater extent this technique has been widely popular in various fields including that of the Meta Materials (MTM).

### 4.1 Conclusion and application

We can analyze from the plot that though the BW which we have obtained may not be too large but since it can be used as a multi band antenna in the LOW FRQUENCY RANGE and the gain plot seems to be quite

exciting as compared to the small gain obtained in a regular patch antenna. The gain of 6.94 is sufficiently exciting and leaves a good scope for study for further improvements for increasing BW without compromising on the gain parameters that are obtained.

As the frequency range of our proposed antenna varies as 2.2GHz, 1GHz and 0.4932 GHz(VHF range) respectively, this frequency range typically lies in the L Band (1 to 2 GHz; best used for telemetry purpose in the army, GSM cell phones and GPS etc.) and S band (2-4GHz) which can be best used in monitoring the weather data as a weather radar device and also finds application as a radar in various other radar devices and also in microwave devices like ovens etc. and of course being used in mobiles and multiple other small but useful applications.

In the upcoming years Metamaterial will play a vital role in our everyday life from tip to toe including electronics to agriculture as it possesses a unique negative property and as seen the metamaterial loading effect enhances the crucial parameters of the patch antenna. It can hence be said to be a material of the future.

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# DESIGN OF ENCRYPTION DECRYPTION TECHNIQUE USING ASCII VALUES FOR SECURE NETWORK COMMUTATION

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**Abstract:** *Cryptography is used in technologically advanced applications, including areas such as the security of ATM cards, computer passwords, and electronic commerce, which all depends on cryptography thus cryptographic, is the need of the hour so day by day new research and inventions are required so this present paper gives the design and working of a new sheltered cryptographic technique.*

## 1. INTRODUCTION

The art of protecting information by *encrypting* it into an unreadable format, called cipher text [8], [9], [10], [11]. Only those who possess a secret *key* can decipher (or *decrypt*) the message into plain text. Encrypted messages can sometimes be broken by cryptanalysis, also called *code breaking*, although modern cryptography techniques are virtually unbreakable. As the Internet and other forms of electronic communication become more prevalent, electronic security is becoming increasingly important [8], [9], [10],[11]. Cryptography is used to protect e-mail messages, credit card information and corporate data. One of the most popular cryptography systems used on the Internet is *Pretty Good Privacy* because it's effective and free. Cryptography systems can be broadly classified into symmetric-key systems that use a single key that both the sender and recipient have, and *public-key* systems that use two keys, a public key known to everyone and a private key that only the recipient of messages uses. Cryptography is the practice and study of hiding information. In today's environment, cryptography is considered a branch of both mathematics and computer science, and is affiliated closely with information theory, computer security, and engineering [8], [9], [10], [11].

## 2. ENCRYPTION AND DECRYPTION PROCESS

There so many different types of cryptographic schemes [8], [9], [10], [11]. We need with just one the answer is that each scheme is optimized for some specific applications [8], [9], [10], [11]. Hash functions, for example, are well-suited for ensuring data integrity because any change made to the contents of a message will result in the receiver calculating a different hash value than the one placed in the transmission by the sender. Since it is highly unlikely that two different messages will yield the Secret key cryptography, on the other hand, is ideally same hash value, data integrity is ensured to a high degree of confidence [8], [9], [10],[11]

suited to encrypting messages, thus providing privacy and confidentiality[8], [9], [10],[11].The sender can generate a session key on a per-message basis to encrypt the message; the receiver, of course, needs the same session key to decrypt the message.

Key exchange, of course, is a key application of public-key cryptography (no pun intended). Asymmetric schemes can also be used for non-repudiation and user authentication; if the receiver can obtain the session key encrypted with the sender's private key, then only this sender could have sent the message[8], [9],[10],[11].. Public-key cryptography could, theoretically, also be used to encrypt messages although this is rarely done because secret-key cryptography operates about 1000 times faster than public key cryptography [8], [9], [10],[11].

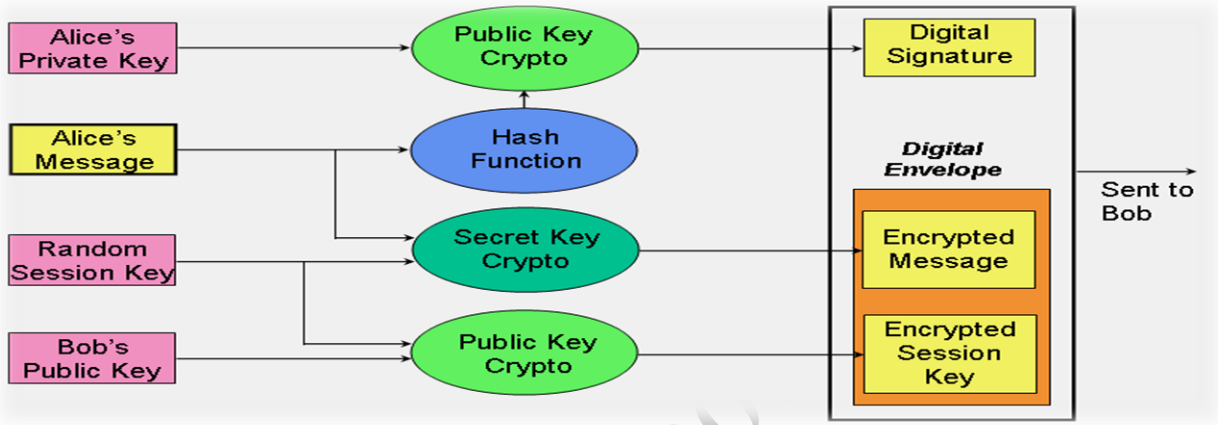


Figure 1: Three Cryptography Techniques [11]

## 3. ASCII BASED CRYPTOGRAPHY TECHNIQUE

I. Take a Plain text/string as input=s
II. Count the string length of string =s
III. Calculate the one fourth of the string length=k
IV. Add "k" to the string length
V. Through random function choose a digit between (1 to 5)=r
VI. Multiply the randomly selected word with "k"
VII. e= (k*r)
VIII. Then add the "e" in the ASCII values of plain text in the incremental way and it will produce encrypted text.

**Example:**

Plain text: s= RAM IS A BOY

| ASCII values correspondence to the plain text 32= Is the ASCII value of space | | |
|---|---|---|
| **R =82** | I=73 | =32 |
| **A=65** | S=83 | B=66 |
| **M=77** | =32 | O=79 |
| **=32** | A=65 | Y=89 |

**Table 1:** ASCII values correspondence to the plain text

1. Calculate string length ($s_l$)=24
2. One fourth of the string length ($s_l$) k=6
3. Add "k" to the string length 24+6=30, then is j=30
4. Apply random function(r) between (1 to 5) for example random function generate digit 2 randomly
5. Multiply r with j then e = r*j ,2* 30=60, e=60
6. Then add the "e" in the ASCII values of plain text in the incremental way and it will produce encrypted text.

## 4. ENCRYPTION PROCESS

| | | | | | |
|---|---|---|---|---|---|
| **R =82 + 60** | **142** | **I=73 + 64** | **137** | **=32 + 68** | **100** |
| **A=65 + 61** | 612 | S=83 + 65 | 148 | B=66 + 69 | 135 |
| **M=77 + 62** | 139 | =32 + 66 | 98 | O=79 + 70 | 149 |
| **=32 + 63** | 95 | A=65 + 67 | 132 | Y=89 + 71 | 160 |

**Table 2:** Encryption Process

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **R =82 + 60** | **142** | ÄŽŽ | **I=73 + 64** | **137** | **ë** | **=32 + 68** | **100** | **d** |
| **A=65 + 61** | 612 | ɤ | S=83 + 65 | 148 | ö | B=66 + 69 | 135 | ç |
| **M=77 + 62** | 139 | Ï | =32 + 66 | 98 | b | O=79 + 70 | 149 | ò |
| **=32 + 63** | 95 | _ | A=65 + 67 | 132 | ä | Y=89 + 71 | 160 | á |

Ž

**Table 3:** Encrypted Text

## 5. ENCRYPTED TEXT

**Ä** ɤ ï_ ë ö b ä d ç ò á

During the decryption, process adopt for encryption will work in the reverse order And decrypted text can be produce by the technique which can be easily understood by the receiver.

## 6. CONCLUSION

ASCII Based Encryption Decryption Technique is based on ASCII values. The symbols generated using ASCII values depends on string length and further steps apply by the method on it. Value of string length may be different form one plain text to other and in advance plain text length cannot be predicted by intruders. Secondly during encryption process a specific value

generated by the techniques by applying some arithmetic operation on ASCII values and that value further used to encrypt and decrypt plain text.

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# DEVELOPMENT OF ASCII VALUES BASED ENCRYPTION DECRYPTION TECHNIQUE

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## 1. INTRODUCTION

The art of cryptography is considered to be along with the art of writing. As civilizations evolved, human beings got organized in tribes, groups, and kingdoms. This led to the emergence of ideas such as power, battles, supremacy, and politics. These ideas further fueled the natural need of people to communicate secretly with selective recipient which in turn ensured the continuous evolution of cryptography as well[15].

### 1.1 Components of a Cryptosystem

The various components of a basic cryptosystem are as follows [15].

- Plaintext. It is the data to be protected during transmission. [15].
- Encryption Algorithm. It is a mathematical process that produces a cipher text for any given plaintext and encryption key. It is a cryptographic algorithm that takes [15].Plaintext and an encryption key as input and produces a cipher text [15].
- Cipher text. It is the scrambled version of the plaintext produced by the encryption algorithm using a specific the encryption key. The cipher text is not guarded. It flows on public channel. It can be intercepted or compromised by anyone who has access to the communication channel [15].
- Decryption Algorithm, It is a mathematical process, that produces a unique plaintext for any given cipher text and decryption key. It is a cryptographic algorithm that takes a cipher text and a decryption key as input, and outputs a plaintext. The decryption algorithm essentially reverses the encryption algorithm and is thus closely related to it [15].
- Encryption Key. It is a value that is known to the sender. The sender inputs the encryption key into the encryption algorithm along with the plaintext in order to compute the cipher text [15].
- Decryption Key. It is a value that is known to the receiver. The decryption key is related to the encryption key, but is not always identical to it. The receiver inputs the decryption key into the decryption algorithm along with the cipher text in order to compute the plaintext [15].
- Key space: For a given cryptosystem, a collection of all possible decryption keys is called a key space [15].
- Interceptor: An interceptor is also called attacker is an unauthorized entity who attempts to determine the plaintext. Attacker can see the cipher text and may know the decryption algorithm [15].

| ASCII values correspondence to the plain text, 32= Is the ASCII value of space | | |
|---|---|---|
| R =82 | I=73 | =32 |
| A=65 | S=83 | B=66 |
| M=77 | =32 | O=79 |
| =32 | A=65 | Y=89 |

**Table 1:** ASCII values correspondence to the plain text

## 2. ASCII BASED TECHNIQUE

I. Take a string as plain text
II. Count the string length = $s_l$
III. Apply the random function(r)
IV. Apply the value of r on string length $k=(s_l)^r$
V. Perform $nk=k-s_l$
VI. Then $e=\sqrt{nk}$
VII. Then add "e" in the ASCII values to generate encrypted text.

## 3. Example:

- Plain text: s= RAM IS A BOY
- Select a random no by applying random function between (2, 3, and 4)
- For example random function generates 2 digit then perform the following operation
- String Length Is 24
- $(24)^2$ =576
- 576-24 = 552
- $\sqrt{552} = 23$

## 4. ENCRYPTION PROCESS

| | | | | | |
|---|---|---|---|---|---|
| R =82 + 23 | 105 | I=73 + 39 | 112 | =32 + 55 | 87 |
| A=65 + 27 | 92 | S=83 + 43 | 126 | B=66 + 59 | 125 |
| M=77 + 31 | 108 | =32 + 47 | 79 | O=79 + 63 | 142 |
| =32 + 35 | 67 | A=65 + 51 | 116 | Y=89 + 67 | 156 |

**Table 2:** Encryption Process Phase-I

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| **R =82 + 23** | **105** | **I** | **I=73 + 39** | **112** | **P** | **=32 + 55** | **87** | **W** |
| **A=65 + 27** | 92 | \ | S=83 + 43 | 126 | ~ | B=66 + 59 | 125 | } |
| **M=77 + 31** | 108 | L | =32 + 47 | 79 | O | O=79 + 63 | 142 | Ä |
| **=32 + 35** | 67 | C | A=65 + 51 | 116 | T | Y=89 + 67 | 156 | £ |

**Table 3:** Encryption Process Phase-II

## 5. ENCRYPTED TEXT

**i\ l C p~ O t W} Ä£**

**Figure 1:** Encrypted Text

To decrypt the encrypted text same technique will be apply in the reverse order.

## 6. CONCLUSION

ASCII Based Encryption Decryption Technique is based on ASCII values. The encrypted symbols generated using ASCII values depends on string length, random function and some mathematic operations. Thus output of this technique is unpredictable and not depends on any specific key this is the major strength of this technique. Thus technique cannot be crack in advance by the intruder and it is a secure and robust encryption technique.

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# ASCII VALUES BASED INFORMATION ENCRYPTION DECRYPTION TECHNIQUE USING RANDOM FUNCTION FOR SECURE COMMUNICATION

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**Abstract:** Network communication Security is the emerging field as most of the communication of daily life executes through the internet or any network so network security is the major challenge. Many labs, companies and researchers continue working on it and try to improve the security standards. This paper also presents a cryptography technique which is also used to encrypt decrypt the information. It is an ASCII based technique which uses random function and some numerical calculation to perform encryption and decryption.

**Keywords:** ASCII, RC2, RC4, RC5, DES

## 1. INRODUCTION

The process of encryption and decryption of cryptography can be implemented through different algorithms which have different way to encrypt and decrypt the data by using various types of keys. On the basis of these keys cryptography algorithms can be divided in to two major categories semantic and asymmetric algorithms [1]. Algorithms use the same key for encrypt and encrypt the data is called symmetric algorithms [1]

The use of different keys for encrypt and decrypt the data comes under asymmetric cryptography algorithms like RSA, Digital Signature. Block Cipher, strem cliper, RC2, RC4, RC5, Blowfish, DES are example of the symmetric cryptography [1]. The two major task of cryptography first to perform encryption decryption second to perform information security from intruders. As every time intruders try to attack on the information to get it to destroy it through various type of attacks. These attacks can be divided in to two categories passive and active attacks. A passive attack attempts to learn or make use of information from the system but does not affect system resources. An active attack attempts to alter system resources or affect their operation [1].

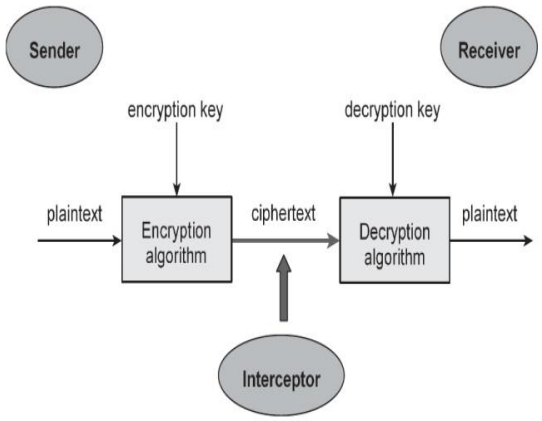


**Figure 1:** Model of a cryptosystem [15].

### 1.1 Passive Attacks

Passive attacks are in the nature of eavesdropping on, or monitoring of, transmissions. The goal of the opponent is to obtain information that is being transmitted [1]. Two types of passive attacks are the release of message contents and traffic analysis. The release of message contents is easily understood [1].A telephone conversation, an electronic mail message, and a transferred file may contain sensitive or confidential information. Cryptography

prevents an opponent from learning the contents of these transmissions [1]. A

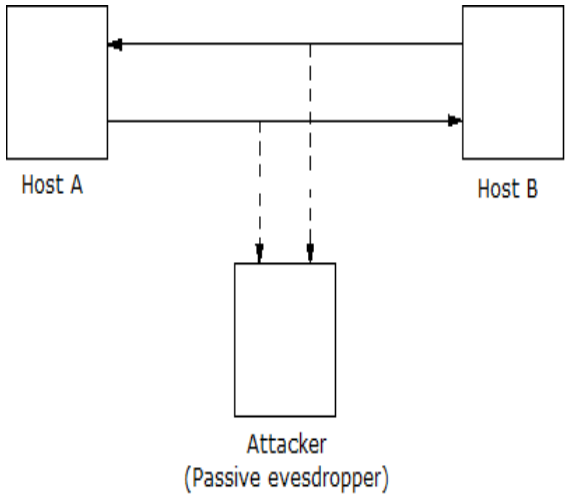


**Figure 2:** Passive attacks [15].

the other forms of active attack [1]. For example, authentication sequences can be captured and replayed after a valid authentication sequence has taken place, thus enabling an authorized entity with few Categories: masquerade, replay, modification of messages, and denial of service [1]. A Masquerade takes place when one entity pretends to be a different entity. Active attacks involve some modification of the data stream or the creation of a false stream and can be subdivided into four Technique form asking contents is encryption [1].A masquerade attack usually includes one of the privileges to obtain extra privileges by impersonating an entity that has those privileges [1]. second type of passive attack, traffic analysis, is subtler. A way of masking the contents of messages or other information traffic so that opponents, even if they captured the message, could not extract the information from the message. The common

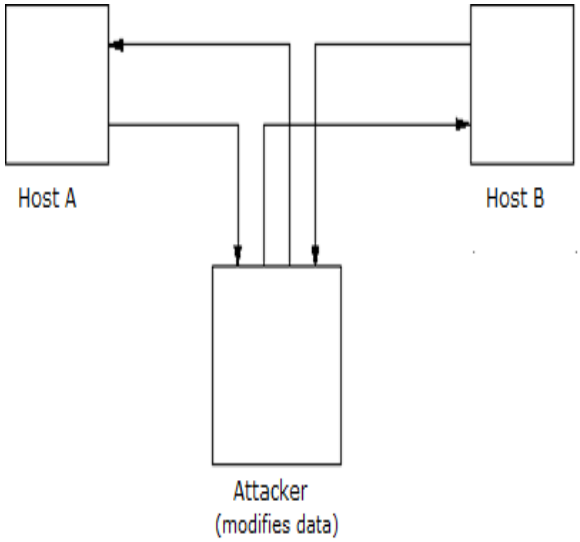


**Figure 3:** Active attacks [15].

Replay involves the passive capture of a data unit and its subsequent retransmission to produce an unauthorized effect [1].

## 2. ASCII Values Based Information Encryption Decryption Technique through Random Function for Secure Communication

**Step 1**

Take a input string/Plain Text

**Step 2**

Calculate string length $=s_l$, $s_l = 86$

**Step 3**

Apply random function (r) between (1 to 99), consider random function generates 90 then check it against the conditions.

**Here**:

$S_l$ =String length

r =Value generated by random function

ev = value used for encryption

## 3. ENCRYPTION PROCESS

For example

Plain Text: "THE QUICK BROWN FOX JUMPS OVER THE LAZY DOG".

This input string contains all alphabets.

| Characters | ASCII Values | Characters | ASCII Values | Characters | ASCII Values |
|---|---|---|---|---|---|
| T | 84 | | 32 | Y | 89 |
| H | 72 | J | 74 | | 32 |
| E | 69 | U | 85 | D | 68 |
| | 32 | M | 77 | O | 79 |
| Q | 81 | P | 80 | G | 71 |
| U | 85 | S | 83 | | |
| I | 73 | | 32 | | |
| C | 67 | O | 79 | | |
| K | 75 | V | 86 | | |
| | 32 | E | 69 | | |
| B | 66 | R | 82 | | |
| R | 82 | | 32 | | |
| O | 79 | T | 84 | | |
| W | 87 | H | 72 | | |
| N | 78 | E | 69 | | |
| | 32 | | 32 | | |
| F | 70 | L | 76 | | |
| O | 79 | A | 65 | | |
| X | 88 | Z | 90 | | |

**Table 1:** Encryption phase-1

Here $s_l$=86 and value generated by random function is 90 thus as per step 4 if $r>s_l$ then ASCII values + r used to generate the encrypted value.

| **Characters** | **ASCII Values** | **Encrypted Values(ev)** | **Encrypted Text** | **Characters** | **ASCII Values** | **Encrypted Values(ev)** | **Encrypted Text** | **Characters** | **ASCII Values** | **Encrypted Values(ev)** | **Encrypted Text** |
|---|---|---|---|---|---|---|---|---|---|---|---|
| T | 84 | 174 | « | | 32 | 122 | z | Y | 89 | 179 | │ |
| H | 72 | 162 | ó | J | 74 | 164 | ñ | | 32 | 122 | z |
| E | 69 | 159 | *ƒ* | U | 85 | 175 | » | D | 68 | 158 | Pts |
| | 32 | 122 | z | M | 77 | 167 | º | O | 79 | 169 | ⌐ |
| Q | 81 | 171 | ½ | P | 80 | 170 | ¬ | G | 71 | 161 | í |
| U | 85 | 175 | » | S | 83 | 173 | ¡ | | | | |
| I | 73 | 163 | ú | | 32 | 122 | z | | | | |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| C | 67 | 157 | ¥ | O | 79 | 169 | ⌐ | | | | |
| K | 75 | 165 | Ñ | V | 86 | 176 | ▒ | | | | |
| | 32 | 122 | z | E | 69 | 159 | ƒ | | | | |
| B | 66 | 156 | £ | R | 82 | 172 | ¼ | | | | |
| R | 82 | 172 | ¼ | | 32 | 122 | z | | | | |
| O | 79 | 169 | ⌐ | T | 84 | 174 | « | | | | |
| W | 87 | 177 | ▒ | H | 72 | 162 | ó | | | | |
| N | 78 | 168 | ¿ | E | 69 | 159 | ƒ | | | | |
| | 32 | 122 | z | | 32 | 122 | z | | | | |
| F | 70 | 160 | á | L | 76 | 166 | ª | | | | |
| O | 79 | 169 | ⌐ | A | 65 | 155 | ¢ | | | | |
| X | 88 | 178 | ▓ | Z | 90 | 180 | ┤ | | | | |

**Table 2:** Encryption phase-II

## 4. ENCRYPTED TEXT

**« ó ƒ z½ » ú¥ Ñ z£ ¼⌐ ▒¿ z á z ⌐ ▓ z ñ » º ¬ ¡ z⌐▒ ƒ¼ z«**

**ó ƒ z ª ¢┤ │ zPts⌐ í**

To decrypt the encrypted text same technique will be apply in the reverse order.

## 5. CONCLUSION

This technique is based on ASCII values. ASCII characters are used for encryption and decryption with random function followed by numerical calculations. To break this technique intruder requires much information about the plain text only single information like string length, random number, is not sufficient to break this technique. The use of random function in step 3 makes the technique more robust. Further operations apply and depend on the string length. Thus this technique is not depends on any specify key or key generation method it is the strength of the technique.

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# Design of Hybrid Adaptive Antenna and Comparison Analysis of Different Technology BPSK, QPSK and QAM

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**Abstract**: *This research paper presented the hybrid adaptive antenna for CDMA using different digital technique like BPSK, QPSK, QAM, 16 QAM, 64QAM etc. Proposed work is present in two steps. first one is to design smart antenna which consist 4 transmitter and 8 receiver and second one is to modelled basic modulation technique for example CDMA BPSK, UWB BPSK and OFDM BPSK encoding techniques. Proposed work provided array of antenna to provide much efficient and good quality of service. Simulation result shows Transmitter and receiver message and calculate Bit Error Rate (BER) and Signal-to-Noise ratio (SNR) for BPSK QPSK, QAM 16, QAM, 64 and QAM 256 modulation technique. Simulation and analysis has been done using MATLAB software for different type of modulation schemes with these systems for different parameters like BER, SNR, Constellation graph and MSE.*

**Keyword:** Modulation, BPSK, UVB, QAM, OFDM, AWGN, BER, SNR, MIMO, Transmitter

## 1. Introduction

CDMA (code division multiple access), OFDM (orthogonal frequency division multiplexing) and UWB (ultra wide band) the system which simulink with communication and Digital signal processing signal library with smart antennas for multiple transmits and receives system. Most third generation mobile communication systems are using CDMA as their modulation technique [4]. Prior to the recent industry boom, the most common UWB system implementation is impulse radio, where ultra-short baseband pulses are used with a variety of modulation schemes to transfer data [11]. Impulse radio has various advantages over OFDM, with its ability to penetrate through materials and resolve multipath with path length differences on the order of a foot or less [5].

## 2. LITERATURE REVIEW

CDMA (code division multiple access), OFDM (orthogonal frequency division multiplexing) and UWB (ultra-wide band) are the most developing technologies in modern mobile communication. OFDM is a parallel transmission scheme, where a high – rate serial data stream is broken into a number of set of low – rate sub streams, each of which is modulated on a separate subcarrier [12-13]. For this research a lot of research paper studied because there are two main problems. First one was that there is no such type of research paper found in which all of CDMA, OFDM and UWB are depicted so it's very tedious task to analyse these techniques and second problem was to design simulation blocks and especially adaptive antenna. During 1980 we have limited resources to transmit information via space with help of electromagnetic waves. Few technology are listed which are used during earlier like aloha (Aloha is of two type slotted and pure aloha and throughput of both techniques are different and slotted is superior to pure aloha), packet radio, carrier sense technology [1]. With time new research came into existent TDMA, FDMA with help of TDD and FDD concept transmission executed. Thereafter a tremendous research carried out by scientist and more advance technology came into existent. MC-CDMA could provide that qualities of service

that the other system may not able to support. UWB system suitable for indoor wireless environment and due to it a problem arises that channel suffers from frequency-selective fading [7-8]. OFDM system is not so much complex as compared with the DS-CDMA, but it also unable to resolve power problem. Because MC-CDMA does not require RAKE receiver and it is very simple as compared to DS-CDMA and its output or efficiency is better than OFDM at low signal power. The bit error rate performance of each system in downlink channel with S-V channel is analysed by computer simulation [14-15]. Indeed, the proposed techniques divide UWB channels into a set of parallel channels. UWB signals are multipath rich, we have used orthogonal frequency division multiplexing ultra wide band. OFDM gives superior resolution than the single carrier UWB. Now addition of iterative turbo decoding increases performance of the receiver [10]. Our research work is focused on the performance evaluation of UWB receivers. Thus, rake filtering is also included for optimal multipath diversity which improves the overall performance. Cognitive Radio plays a very crucial role in our cross-layer ultra wide band receiver architecture where it send and receive information with the physical layer for probable channel conditions before allocating links dynamically for its data transmission [16]. UWB technology and the WSN are come into existence for the aim of forest fire early warning system. The system consist many aspect few of them are of wireless temperature sensor (WTS), integration of wireless humidity sensor (WHS), network topology, the network communication set of rule and the node energy. It adopts the cluster-tree topology with star structure and main advantage of this network platform is easy to install and easy to use and low cost. The system greatly improves the efficiency of forest fire prevention and reduces the loss of forest and now days they are tremendously used in agriculture [3].

## 3. Methodology

In our research work our main task is to develop simulation block diagram which are backbone of this work. First of all we have to design smart antenna 4*8 which is very tedious task. Now a day's smart antenna also known as MIMO or array of antenna to boost up performances and if we increase order then complexity increase so much so we have to maintain trade off between cost and complexity.

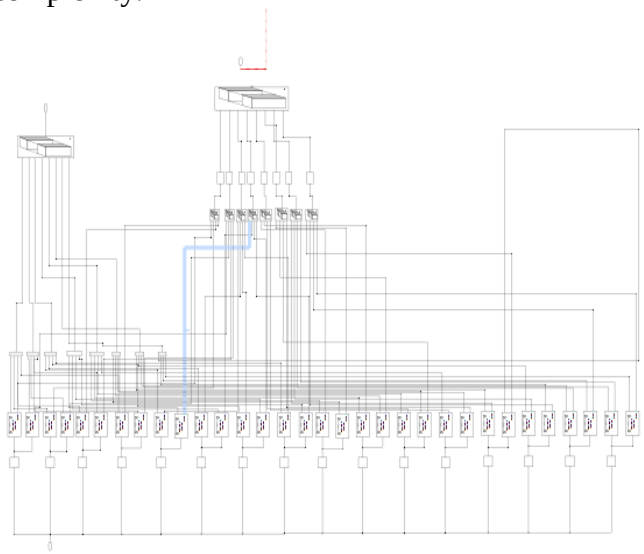

**Figure 1** Smart Antenna 4*8

### 3.1 CDMA:

In our research work we concerned with to calculate performance of a CDMA in a multipath fading and AWGN channels that is modelled by a discrete set of Rayleigh faded paths[2].

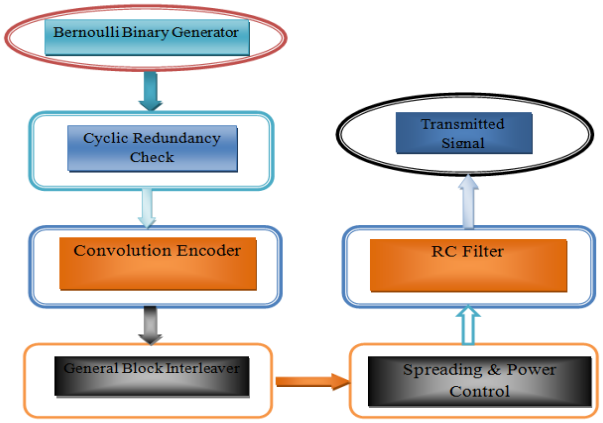


**Figure 2** CDMA Transmitter

The received signal is first filtered and then digitally converted with a sampling rate. It is

followed by a rake receiver. The rake receiver is necessary to combat multipath. After correlation, the power of all detected paths is combined and, finally, the de-mapping and FEC decoding are performed to assure the data integrity.

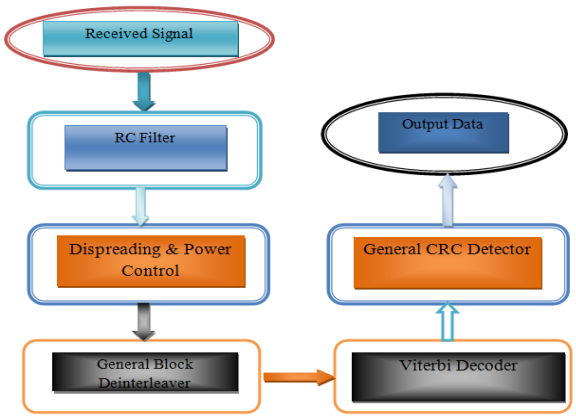


**Figure 3** CDMA Receiver

### 3.2 OFDM:

OFDM is preferably used for the uplink in a multiuser environment; low-order modulation such as QPSK with Gray mapping is preferred. However, we can also use high-order modulation can also be employed. The sub- carrier assignment can be of two types that are fixed and dynamic [6]. In order to improve the system robustness a dynamic assignment of sub-carriers for each user is preferable.

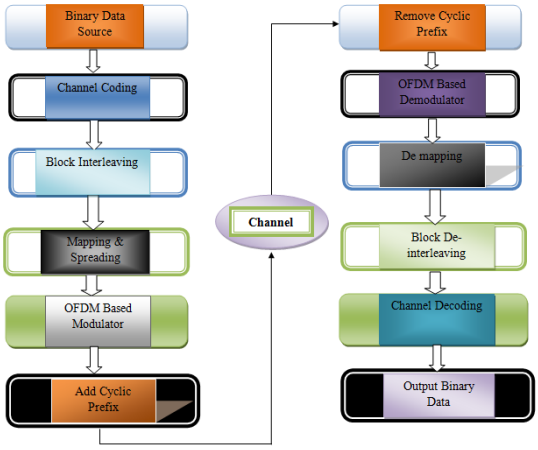


**Figure 4** System Model of OFDM System

**3.3 UVB:** The basic scenario of our simulation is represented by the UWB transmission system performing through multipath fading and AWGN transmission channel [9]. The encoder of UWB system uses CRC and RS Encoder schemes.

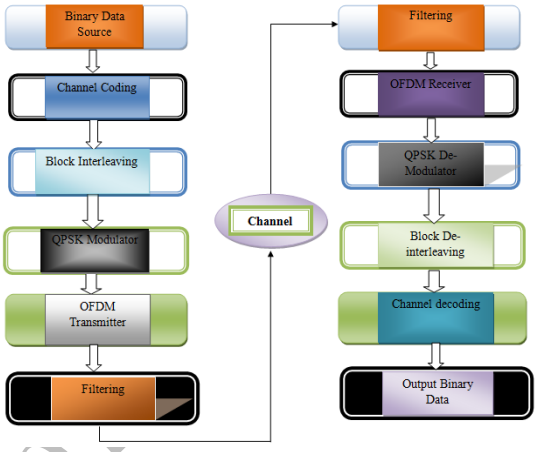


**Figure 5** System Model of UWB System

## 4. Simulation Result

Now we put simulation result of different technology and then compare their respective result and after that we reach at a conclusion out of these technologies which one is superior.

### 4.1 Simulation Block of CDMA

**Software Requirement:** MATLAB Version R2013a. It is powerful software that provides an environment for numerical computation as well as graphical display of outputs. In Matlab the data input is in the ASCII format as well as binary format. It is high-performance language for technical computing integrates computation, visualization, and programming in a simple way where problems and solutions are expressed in familiar mathematical notation. Matlab consist following important parameters for example Acquisition, Data Exploration, Analysing &Visualization, Engineering complex drawing and scientific

graphics, Analysing of algorithmic designing, Mathematical and Computational functions, Modelling and simulating problems prototyping, GUI (graphical user interface) building environment but in our research work we implemented simulation library from a lot of simulation toolboxes and main toolbox used is communication toolbox. Now we put simulation result of different technology and then compare their respective result and after that we reach at a conclusion out of these technologies which one is superior.

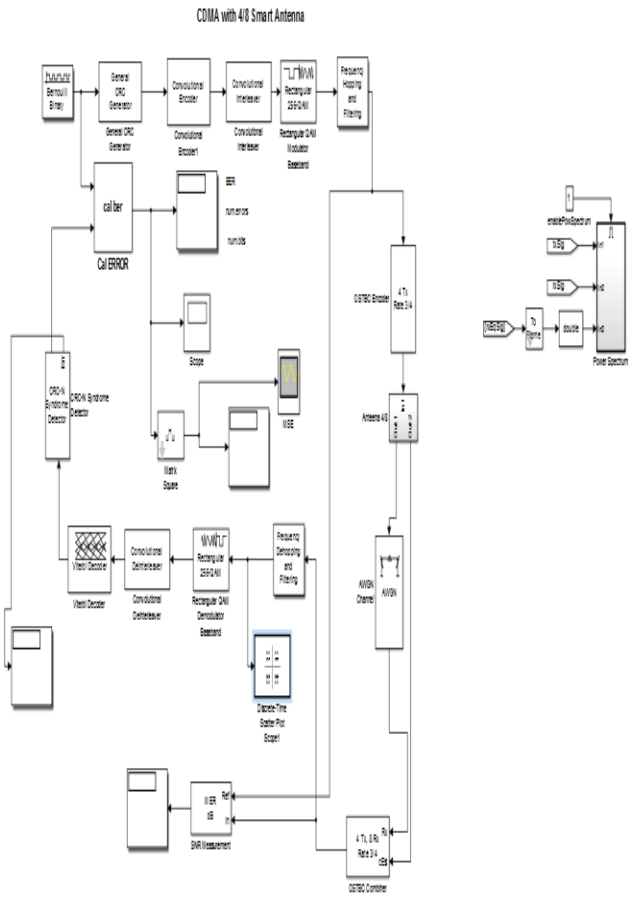


**Figure 6** Simulation block of CDMA System using QAM 256 modulation

### 4.2 Performance analysis of CDMA

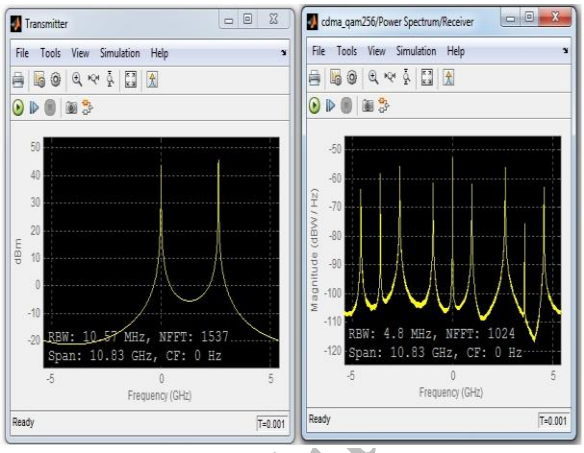


**Figure 7** CDMA Transmitted & Receiver Signal using QAM 256 Modulation

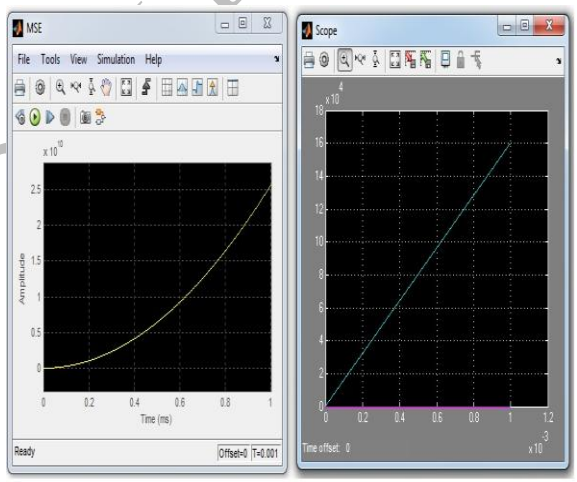


**Figure 8** CDMA Mean Square Error (MSE) left & Total Bits (Blue), number of error (Magenta) and Bit error rate (yellow) in right side using QAM 256 Modulation

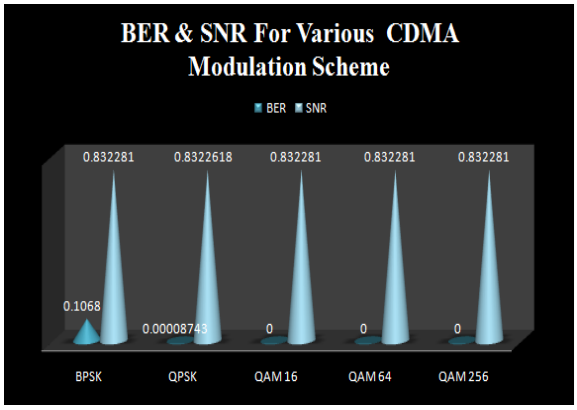


**Figure 9** BER and SNR value representation of CDMA

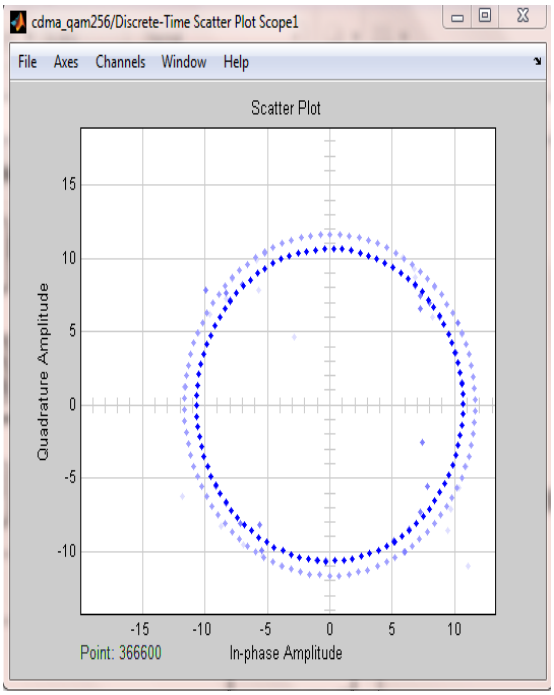


**Figure 10** CDMA QAM 256 Signal Constellations

The CDMA transmitted signal to the channel. This signal passed through the multipath fading and additive white Gaussian noise channel. After passing this signal from channel we get the CDMA received signal. The scatter plot illustrates the effect of fading on the signal constellation. For all the interleaving schemes the transmitted and received signal has same bandwidth but these schemes affect the transmission rate and bit error rate of CDMA system.

**Table I BER and SNR Modulation Schemes in CDMA System**

| Modulation Scheme | Signal to Noise Ratio | Total Bit | Error Bit | Bit Error Rate |
|---|---|---|---|---|
| BPSK | 0.832281 | 160100 | 17100 | 0.1068 |
| QPSK | 0.832262 | 160100 | 14 | 0.00008743 |
| QAM 16 | 0.832281 | 160100 | 0 | 0 |
| QAM 64 | 0.832281 | 160100 | 0 | 0 |
| QAM 256 | 0.832281 | 160100 | 0 | 0 |

**Table II BER and SNR Modulation Schemes in OFDM System**

The Bit Error Rates (BER) of these performance analysis is shown above: First, simple OFDM system is modelled then we compare different type of modulation schemes with this system and get QPSK modulation scheme is best for OFDM system on the basis of BER as above.

| Modulation Scheme | Signal to Noise Ratio | Total Bit | Error Bit | Bit Error Rate |
|---|---|---|---|---|
| BPSK | 0.67546 | 160100 | 1844 | 0.01152 |
| QPSK | 0.62661 | 160100 | 1881 | 0.01175 |
| QAM 16 | 0.71236 | 160100 | 0.00001029 | 0.6427 |
| QAM 64 | 0.71236 | 160100 | 0.00001029 | 0.6427 |
| QAM 256 | 0.71236 | 160100 | 0 | 0 |

**Table III BER and SNR Modulation Schemes in UWB System**

| Modulation Scheme | Signal to Noise Ratio | Total Bit | Error Bit | Bit Error Rate |
|---|---|---|---|---|
| BPSK | 0.40541 | 160100 | 75870 | 0.4738 |
| QPSK | 0.36024 | 160100 | 69010 | 0.4310 |
| QAM 16 | 0.37870 | 160100 | 98110 | 0.6127 |
| QAM 64 | 0.37870 | 160100 | 98110 | 0.6127 |
| QAM 256 | 0.37870 | 160100 | 0 | 0 |

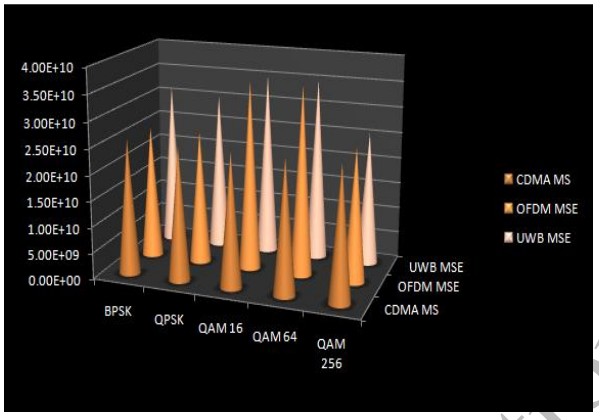


**Figure 21** MSE of Different Modulation Schemes for CDMA, OFDM and UWB System

**Table IV MSE of Different Modulation Schemes for CDMA, OFDM and UWB System**

| Modulation Scheme | CDMA MSE | OFDM MSE | UWB MSE |
|---|---|---|---|
| BPSK | 2.593e+10 | 2.564e+10 | 3.14e+10 |
| QPSK | 2.564e+10 | 2.564e+10 | 3.04+10 |
| QAM 16 | 2.564e+10 | 3.623e+10 | 3.527e+10 |
| QAM 64 | 2.564e+10 | 3.623e+10 | 3.527e+10 |
| QAM 256 | 2.564e+10 | 2.564e+10 | 2.564e+10 |

## 5. CONCLUSION

Proposed work is present in two steps. first one is to design smart antenna which consist 4 transmitter and 8 receiver and second one is to modelled basic modulation technique for example CDMA BPSK, UWB BPSK and OFDM BPSK encoding techniques and after that to design their advance configuration in MATLAB Simulink. Now our main focus is to analyse the performance of different type of modulation schemes with these systems for different parameters like BER, SNR, Constellation graph and MSE and then finally reach to a conclusion which modulation scheme is best one. QPSK modulation is best for OFDM and QAM is best for CDMA and UWB system with less BER. CDMA, OFDM and UWB are the well-known air interface technologies in modern mobile communication.

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# COMPACT UBW RECTANGULAR APERTURE ANTENNA AND BAND-NOTCHED DESIGN IDEA

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***Abstract*—A compact ultra wide band (UWB) aperture antenna with extended band-notched designs is presented in this paper. The antenna has a rectangular aperture on a PCB ground plane and a T-shaped exciting stub. The proposed planar coplanar waveguide fed antenna is easy to be integrated with radio and microwave frequency for low manufacturing cost. The antenna is successfully designed. A compact aperture area of 12* 23 mm$^2$ is obtained with promising performances with broadband matched impedance, stable radiation patterns, and constant group delay. The correlation between the mode-based field distributions and radiation patterns is given in the paper.**

***Index Terms*—Aperture antennas, band-notched UWB antennas, coplanar waveguide (CPW) fed antennas, planar antennas, printed circuit board antennas, slot antennas, (UWB) antennas.**

With a T-shaped exciting stub in this paper. T-shaped stub has some main advantages over the fork-like stub.

1)We can reduce the aperture area (more than 50%) without compromising the antenna performances.

2) The antenna can be extended to the advanced band reject design without adjusting the size of the original aperture and stub, which is very good.

3) The exciting T-stub has a simple geometry with less parameter.

An aperture area of 12 by 23 mm2 is designed[6]. The antenna performs promising characteristics on the impedance matching, radiation patterns, and group delay over the entire UWB. The measured return loss and antenna gain spectrum are shown successfully.

## 1. INTRODUCTION

In recent allocation of frequency band from 3.1 to 10.59 GHz by the Federal Communications Commission for ultra wide band (UWB) radio applications has presented challenge for antenna designers. The FCC first approved for commercial use of UWB in February 2002. Till April of that year, the FCC gave formal approval for the unlicensed use of the technology between 3.1 and 10.59 GHz. Then the feasible design of UWB system has become a competitive topic in academy and industry of telecommunications [1]. Challenges of the feasible UWB antenna design consist of ultra wide band performances of the impedance matching and radiation stability, size and the low manufacturing cost for consumer electronics applications. Among the planar UWB antenna designs the slot antenna is one of the most promising candidates and includes wide bandwidth performance and low cost in the printed circuit board process. The enhancement in the bandwidth this the main focus of this slot antenna designs and can be divide in two kinds. One is to manipulate the field distribution in the slot with a feeding scheme or with tapered shape to generate multiple resonances[2][3]. The other is widened slot (or aperture) and a fork-like stub for excitation so we can get a broad bandwidth [4,5].

The design of using fork-like stub need large aperture and contains many parameters and it is hard to modify the designed antenna for the band-rejection function, a desirable feature in the UWB system. Over the designated bandwidth of UWB systems, there are existing bands used by wireless local-area network (WLAN) and IEEE802.11a and HIPERLAN/2 which are

operating in frequency range of 5.1–5.825 GHz band. It is desirable to design the UWB antenna with a reject band at 5–6 GHz to minimize interferences [7][8][9]. We have used a coplanar waveguide (CPW)-fed rectangular aperture antenna

## II. ANTENNA DESIGN

### *A. Antenna Structure*

Fig. 1 shows the geometry of the given antenna.

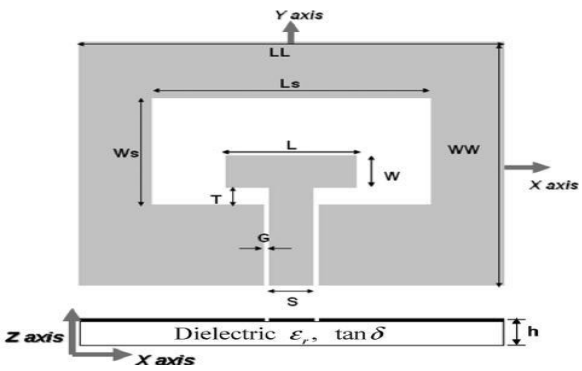



Fig.1. Geometry and configuration of the proposed antenna(length L, extrusion depth T=2mm, width W=4mm, WW=30mm, LL=34mm, Ws=12mm, Ls=23mm, G=.5mm, S=4mm).

Since the feeding structure are not implemented on the same plane with antenna. The wave port is used for the feeding and CPW transmission line is designed with 50ohm. Design of aperture is determined by reducing the aperture area while satisfying the input impedance matched especially for the lower frequencies [6,7]. The compact aperture area of 12* 23 mmis achieved, that is, the dimension is less than a quarter-wavelength for the lowest frequency (3.1 GHz). The feeding of the antenna is implemented by a simple T- stub of only 3 parameters: the length L, extrusion depth T, width W, as shown in Fig. 1.
VSWR, Reflection coefficient and other parameters are subjected to following relations:

$$\Gamma = \frac{VSWR - 1}{VSWR + 1} \qquad RL = -20\log\left[\frac{VSWR - 1}{VSWR + 1}\right] \qquad ML = -10\log\left\{1 - \left[\frac{VSWR - 1}{VSWR + 1}\right]^2\right\}$$

$$VSWR = \frac{1 + \Gamma}{1 - \Gamma} \qquad RL = -20\log(\Gamma) \qquad ML = -10\log(1 - \Gamma^2)$$

$$\Gamma = 10^{\frac{-RL}{20}} \qquad VSWR = \frac{1 + 10^{\frac{-RL}{20}}}{1 - 10^{\frac{-RL}{20}}} \qquad ML = -10\log\left[1 - \left(10^{\frac{-RL}{20}}\right)^2\right]$$

### *B. Parametric Study*

The simulation tool An soft HFSS is used in the paper for design optimization. Since the T- stub is the very important factor in the optimization process, its three parameters W, L, and T are used to show the sensitive study of the antenna. Fig. 2 shows , S parameter v/s frequency graph of the proposed antenna and stub width W mainly influences the impedance at the frequencies (4-5 GHz).Fig 2 shows the first resonance at the approximate frequency 4GHz.And resonance also can be obtained at the 7, 10 GHz but at these frequencies the S parameter and VSWR value are not sharp.

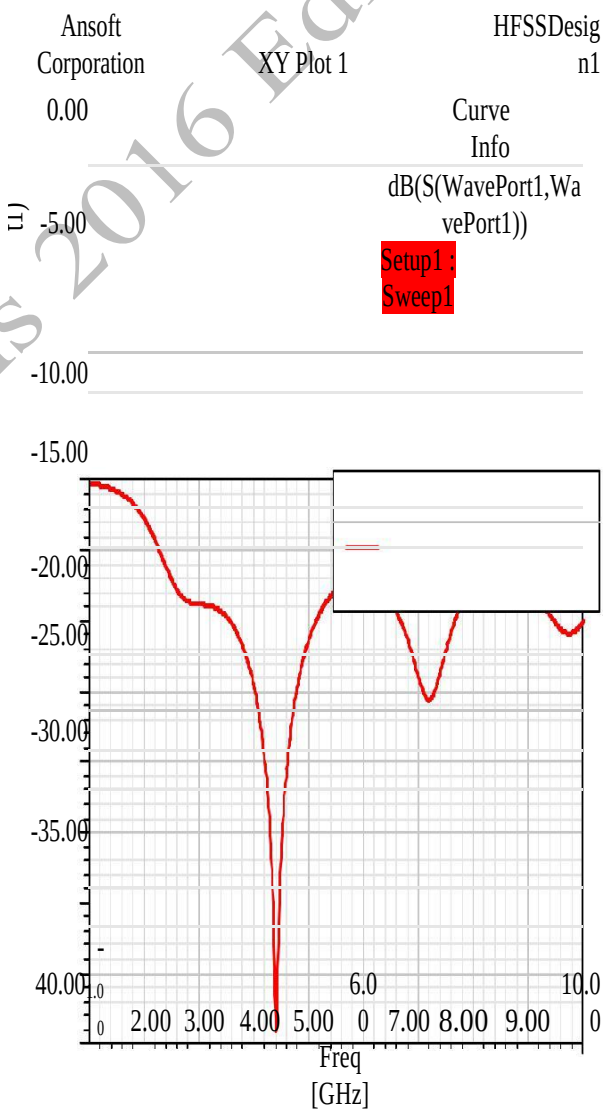
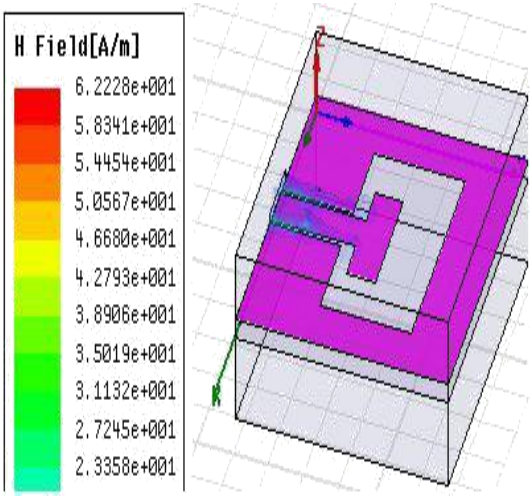



Fig.2.S parameter v/s frequency graph of the proposed antenna.




So depending on the sensitivity corresponding to the aperture parameters of the antenna the return loss performance of the antenna can be increased.

From the spectrum of S parameters and performance in Fig. 3, it can be seen that there VSWR have three resonances around the frequencies at 4, 7, and 10 GHz. which are shown as m1, m2, m3 points on the pattern These resonance cases perform the different modes of field distribution and play important roles on the explanation of the radiation pattern

The electric field distributions of these resonant modes are simulated and shown in Fig.4,and Fig.5.

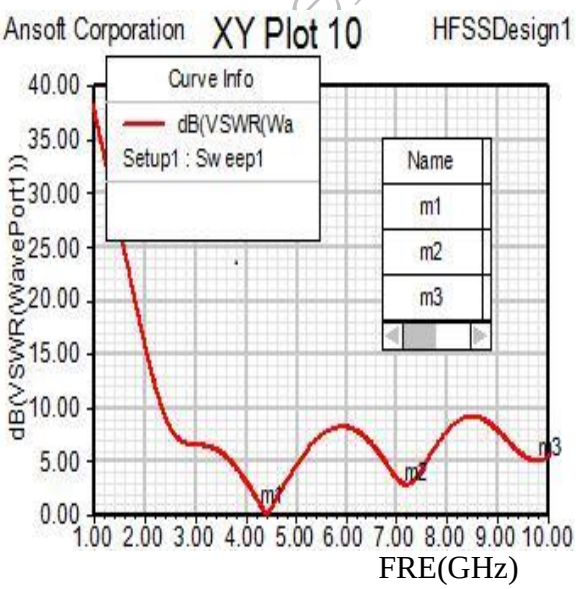



Fig. 3.VSWR v/s frequency graph of the proposed antenna

### *C. Field Distribution and Radiation Patterns*

. This set of field distribution is locally similar to fundamental mode in a rectangular waveguide, and considered as the fundamental mode of the aperture antenna.

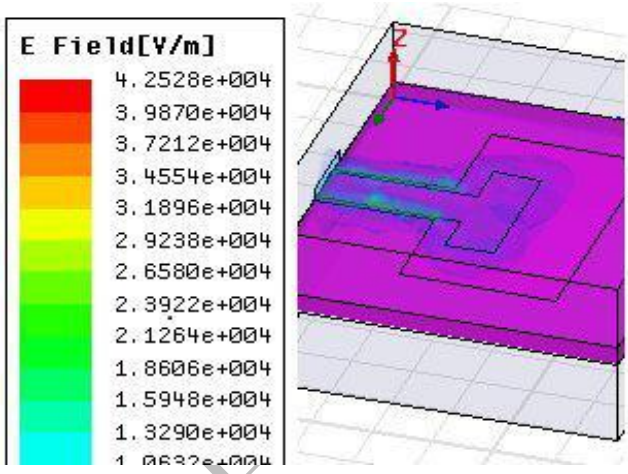



Fig. 4 Electric field pattern of the proposed antenna with anechoic chamber and field pattern of the H field is shown in the Fig.5

Both the fields looks similar but there is difference between them that in the H field , the field distribution is more at the stub but in case of the E field, field distribution is not like that it is mainly polarized in the z direction and mainly field part is in the upper side.

Fig. 5 Magnetic field pattern of the proposed antenna with anechoic chamber

Fig. 6 shows the first resonant mode at 4 GHz, where the electric fields are concentrated at the upper center part with polarization mainly in the y-axis. This set of field distribution is locally similar to that of mode in a rectangular waveguide.

The radiation pattern of this mode is like a dipole oriented in the y-axis leading to a bidirectional pattern in the E-plane and omnidirectional pattern in the H-plane. The radiation pattern for the resonant case is shown in the Fig.6

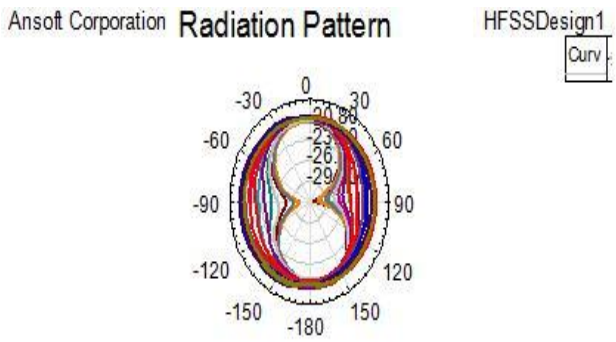



Fig. 6 Radiation pattern of the proposed antenna

## III. IMPROVEMENT

As discussed above that this design also can be advanced further for the band rejection around 5-6 GHz for which the sensitivity corresponding to the parameters (L,W,T) will be different and maximum sensitivity will be obtained from the variation in the T-stub and using the different slits structure, UWB band notched can be implemented in slot antenna design from which potential interference in the wireless local-area network (WLAN) and IEEE802.11a which are operating in frequency range of 5.1–5.825 GHz band. It is desirable to design the UWB antenna with a reject band at 5–6 GHz.

## ACKNOWLEDGEMENT

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# State of Art Emotion Recognition from Speech Features

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**Abstract.** *The focus of this paper is on emotion recognition based on the speech signal. Based on models in psychology and the requirements of automatic systems, models for emotion recognition from speech are proposed and a most appropriate one for automatic detection is chosen. The aim is to investigate the algorithm of speech emotion recognition. Firstly, five most commonly used features are selected and extracted from speech signal. After this, statistical values such as mean, variance will be derived from the features. These data along with their related emotion target will be fed to neural network tool to train and test to make up the classifier. We use feed forward back propagation neural network for classification, both for speaker dependent and speaker independent system. The research work has been done using 120 different sentences spoken by two male speakers. The performance of 90% recognition rate for speaker dependent and 75% recognition rate for speaker dependent system.*

***Keywords:*** *Speech Emotion recognition system, Classifiers, Artificial neural network.*

## 1. Introduction

Speech recognition is the process by which a computer identifies spoken word. Basically it is a process of talking with the computer & having it correctly understand what you are saying. By "understand" we means, it convert speech in the required format. In computer science & Engineering electrical speech recognition system (SR) is the conversion of spoken words into text. It is also known as "automatic speech recognition", "computer speech recognition", or "speech to text" (STT).Speech has potential of being a mode of interaction with computer. A speech signal carries information in both the time and frequency domain. In human the speech or acoustic signals are received by the ears & then transmitted to the brain for understanding and extracting the meaning out of the speech signal and then to respond to it. This system is useful for those people who do not have good keyboard skills or experience, who are slow typists, or do not have enough time or resources to develop keyboard skills. For example

I. Dyslexic people or others who have medical problems with character or word use and manipulation in a textual form.
J. Those people who have physical disabilities that affect either their data entry, or ability to read the data.

Emotion plays a very important role in Human emotion recognition system. So first we have to know about emotions in detail. In this part we discussed about emotion and what are the views of different researchers about emotions and how we recognize the emotion behavior. In order to recognize emotions, one first needs a precise idea of what they are, that is a theory of emotions. Emotion studies have a very long tradition in psychology, having produced complete models that can be used as basis for automatic emotion recognition. The one more question to deal with is where emotions can be observed. They are expressed in language, syntactic, acoustic, or semantic information, but also on other levels of human behavior as body or facial behavior. These are the channels which are at the nature of a human communication partners. Computer, however, can also utilize information obtained by measuring body signals like heart rate or perspiration to infer the emotional state of human. Having introduced these ideas, a closer look on automatic emotion recognition from speech is correct. After explaining a general system design, ranging from audio segmentation over feature extraction to the actual classification, possible features as acoustic correlates of human emotions in speech is elaborated, because the extraction of relevant features is a major part of this thesis [5]. Another topic is the creation of databases with examples of emotional expression as they are an important input to classifiers. Therefore it is important to discuss the main design questions, which are the type of the

selected emotions that is whether they are acted or natural, induced or spontaneous and the labeling of the human emotions found within the database. The latter is dependent on the inherent emotion model and on the scenario of the corpus. Humans are experts in emotions, as we experience them every minute of a day. what is an emotion? A psychologist would absolutely give a different answer than a linguist, a computer scientist or the average man on the road. Let's start with a general definition. Merriam-Webster's Online Dictionary states, among others: "a conscious mental reaction (as anger or fear) subjectively experienced as strong feeling usually directed toward a specific object and typically accompanied by physiological and behavioral changes in the body". A more detailed, psychological definition is for example to define human emotions as "episodes of massive, synchronized recruitment of mental and somatic resources allowing to adapt to or cope with a stimulus event subjectively appraised as being highly pertinent to the needs, goals, and values of the individuals" from Roesch et al. [11]. From both definitions it is undoubtedly agreed that

the word emotion describes a short-term, consciously professed, valence state, either positive or negative, like for example happy or anger, in contrast to moods which can last one or a number of days (cheerfulness/depression), preferences that explain our attitudes in relation to objects over a longer period or dispositions like nervousness or anxiousness which describe personality character [19]. The fact that emotions direct to changes in the body, and that these changes can really be observed, is certainly what makes the work described here possible. Note that the notions emotion, affect and sentiment are often used interchangeably. However, small distinctions can still be made. Affect is usually used as a general term. Damasio [4] defines "emotion as a bodily affective reaction in contrast to feeling as a mental affective reaction". Therefore, emotion refers rather to what can be observed from outside and thus is more valid in the context here while feeling refers to an internal state. Psychologists have a long tradition in study on emotions and they have proposed various models or theories for the explanation of emotions. Until the last few years the concept of basic emotions was the most accepted of these. It is encouraged by evolution theory, and already Darwin [58] supposed that there exist basic natural emotions which have a own physiological response pattern, for example contractions of the arm muscles while experiencing anger as preparation for fighting. Ekman, the most famous representative of the basic human emotion theory, classified emotions as having a unique facial expression associated that can be recognized unvaryingly across cultures [20], as illustrated by Figure 2.1. Besides physiological and facial facts, a another source of information for psychologists to identify basic emotions is to find human emotion terms that are most commonly agreed among subjects [11]. Other emotions would then be either mixtures of these basic emotions or cultural based emotions.

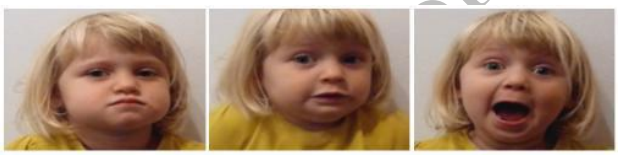

*Fig 1.1* Facial expressions of emotions that are universal according to Ekman et al. [6]. In order: anger, fear, surprise.

Nowadays Human-computer interaction has become the most popular subject, lots of researches have been put toward this area and it still has great scope. One important aspect of human-computer interaction is that to teach computer in such a way that it can differentiate human emotion correctly. So that it can give accurate response for different emotion. Many research work have been done for obtaining this goal, for instance in Fadi. A. Macht et.al develops an application of human emotion recognition to avoid traffic accident. They utilize a recognition machine to classify the voice message in phone answering machine and gives priority on the basis of their emotions. Basically, the most common way to detect the emotion from the speech is to first extract important features from the speech signal that are related to different emotion states (i.e. speech rate is a important feature to distinguish happy and sad), then feed those extracted features to the input end of a classifier and obtain detected emotions at the output. Nogueiras et al. use hidden Markov model [7] to recognize human emotions from pitch and energy. B. Schuler et al. compare their performance by using four different classification methods to a combination of acoustic features and linguistic information of speech. For classification of speech, methodologies followed are: HMM, GMM, k-NN and several others as well as their combination which put the level of each classification technique. According to Y.li and Y.Zhao, speech features that represent entire

Utterance using the average values of various features which belong to the time or to the frequency domain & for classifying the unknown speech samples vector quantization & GMM method are used.

One of researcher develop an emotion recognition system that uses the combination of both statistic and temporal features.GMM and HMM Likehoods are integrated which is then fed to a Bayesian and an MLP classifier.

According to B.Vlasenko, A variety of descriptors is calculated on frame as well as turns level. A GMM classifier is used during the frame level analysis and A SVM classifier is used during the turn on analysis. Also a sentence level emotion recognition is developed by je hun jeon in which information from subsentence segments was used for sentence level decisions. segment level classifier used to generate predictions for segments to obtain a sentence level decision.

The objective of this work is to classify recorded speech signal in for categories by extracting features from the speech signal, namely: angry, happy, nature and sad. In this work, prosodic and spectral features are extracted from the speech signal to perform emotion recognition. A total of 15 features are extracted from the speech signal. Various emotion recognition systems (ERS) are developed for different speakers and combination of speakers. This paper mainly divided into four parts which is organized as given below: firstly the overall structure of emotion recognition system from speech, secondly how to extract the feature and how to do the feature selection and in last part discussed the different classification schemes.

## A Emotion Recognition system from speech

Speech recognition is a pattern classification task. It is divided into two major part, the first is speech signal processing and the second part is speech pattern recognition. The speech processing stage consist, preprocessing of speech signal and feature extraction. The second part consists of pattern recognition system using neural network system (NN).Fig.2.1 indicates the speech processing stage.

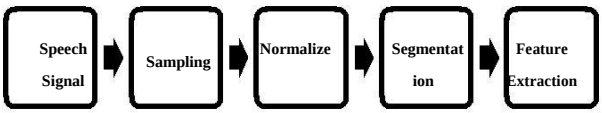


*Fig.2.1* Speech Processing System

Before extract the features from the speech signal, there are some essential steps to take to manipulate recorded speech data [1]. For emotion recognition first step is signal to convert analog signal to digital speech signal, after then normalize the signal to set the volume of each sentence is in the same range. In the final step segmentation is done to divide signal in short duration frame in such a way that speech signal can maintain its characteristic in small duration. Five features are chosen to study and extract from speech signal. Speech rate and energy is basic feature of speech but they still have significant to detect emotions like sad and angry. Pitch is commonly used feature in this area and autocorrelation is used to detect the pitch in each frame of the signal. After that statistical value of pitch such as variance, mean and max will be calculated for speech signals. Another important feature for emotion detection is a Formant for this Linear predictive coding (LPC) method is used to extract the formant. For formants statistical value are also calculated. One more important feature is Mel frequency cepstral coefficients (MFCC) which represent the short-term power spectrum in a human speech like mel scale of frequency. First three coefficients of MFCCs are select to get the statistical values means and variances. In this work total 15 features are extracted from 120 sentences and put them into an input matrix along with a target matrix, which shows the emotion state for each sentence composed the input of neural network. Pattern recognition tool of Neural Network (NN) is used to train and test the extracted feature and perform the classification. In the last section figures of mean square error and confusion matrix show how good is the performance of classifier. Preprocess mainly includes sampling, normalization and segmentation of the recorded speech signal as shown in above figure. Speech is analog signal it is required to be changed to digital signal to process it in computer.

The computer. Sampling theory provides a way to change the analog signal Y (t) into a discrete time signal Y(n) and remains the quality of original signal. According to sampling theorem, "when the sampling frequency is larger or equal to two times of the maximum of analog signal frequency, the discrete time signal is able to reconstruct the original analog signal. Sampling is done by collecting certain points from analog signal in time period defined by $T_S$. Sampling frequencies are 8KHz, 16 KHz and 44.1 KHz which are fixed in the MATLAB environment. In reality it is impossible to control the recording volume for each sentence to maintain it at the same level. Volume is an useful fact when calculating speech energy and other features. Normalization process use the signal sequence divided by maximum value of the signal amplitude to make each sentence has a comparable volume level. The formula of normalization is shown below in Eq. (1.1).

$$S`(n) = S(n)/Smax \quad , \ldots\ldots\ldots\ldots\ldots\ldots\ldots(2.1)$$
$$n=1, 2, 3 \ldots N,$$

S (n) = original sampled signal.

S`(n) = Normalized signal.

$S_{max}$ = Absolute maximum value of signal.

N = length of the sequence.

Speech is a random signal and its characteristic is changing with time, but this change is not immediate. Generally it assumes in a finite duration (10-30ms) the signal is stable. In this sense, segmentation process divides the signal sequence into number of frames with overlap Overlapping is used to avoid loss of data due to Aliasing [5]. The signal x(n) becomes $x_i(n)$ once framed, where i indicates the number of frames. After preprocess characteristics of whole voice signal could be study from statistical values.

Databases with recorded material of emotional speech are essential to statistical emotion recognition. In this thesis SAVEE database are used for emotion recognition. These data is recorded in four emotions with 128 bit/sec and at 8khz sampling frequency. There are 60 recorded sentence by a professional with 15 in each emotion (anger, happy, nature, sad).In labeling emotional databases once data has been collected, it requirements to be labeled in order for a supervised classifier to find out dependencies between acoustic data and emotions. This is a critical task, as of course, an automatic human emotion recognizer can only be as good as its primary data and the quality of the data's labels. For acted data, the classes are usually known before. The classification of emotions can in principle follow any of the models, however normally; a small set of discrete emotion labels is used. Note that this holds only for the reason of automatic classification [2]. The most common emotion classes in acted speech include anger, joy, fear, sadness, disgust, boredom and neutral. In spontaneous voice, often distinctions on the evaluation dimension are made as this is most significant in many applications. So neutral against negative, and less often against positive speech is labeled. Other common labels for spontaneous voice include anger, joy, or stress. Typically, two, three, or no more than four emotion labels are used for practical emotions.

## 3. Speech Parameters and Feature Extraction

Speech signals are produced due to the excitation in the vocal tract by the voice. Therefore features can be detected both in vocal tract as well as the excitation source signal. Those features which are extracted from the vocal tract are called spectral features [8]. The widely accepted spectral features are "Mel frequency cepstral coefficients (MFCCs), linear prediction cepstral coefficients (LPCCs) and Perceptual linear prediction coefficients (PLPCs)". Source features are those features which extracted from the excited source signal are called linear prediction and glottal volume velocity .Prosodic features are those features which are extracted from the complete sentences, word and syllables of speech .They are also known as supra-segmental features. They include the important speech properties such as rhythm, intonation, stress, volume and duration. The prosodic features are pitch, energy and their derivations. when vocal fold is tremble then pitch signal produced. The prosodic features are used to extract emotional behavior of articulators. Spectral features are useful to capture the information regarding the movement of articulators and the shape and size of vocal tract which produces different sounds.

Speech Rate: It is a representation of speaking rate of speaker. It has strong relation with emotions like happy angry and sad.

St = Tv/Nw ……3.1

Where St is speech rate, Tv is total duration of voice part and Nw is number of words. A

higher threshold level is used to detect the voice part and a good range is set between each word. In this work two thresholds were defined thr1=0.03 and thr2=0.4. The lower one sets for speech duration and the other for number of words in sentence.

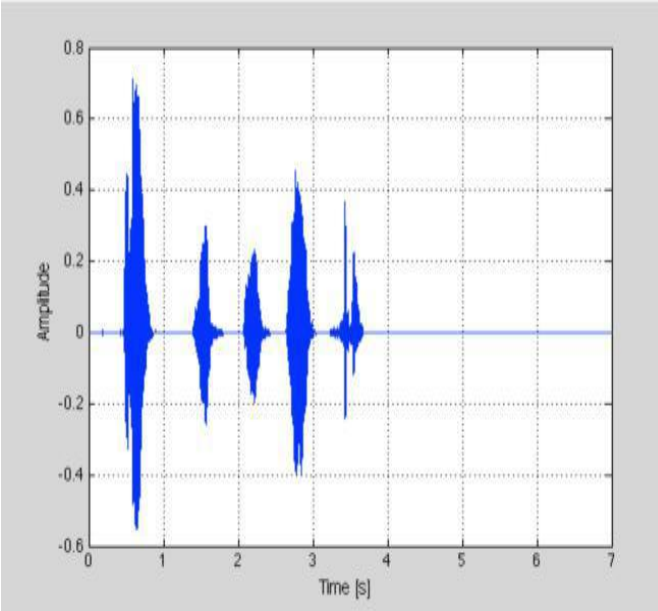


*Fig.3.1* Speech Rate

Energy: It is a basic feature in and it plays an significant role in human emotion recognition. Speech signals of angry and joy emotion have much higher energy in comparison to sad. In this work Savee database are used which are noise free so no threshold required to remove the noise during the calculate $E(n) = \sum_{i=1}^{N} x(n)^2$ ….3.2

Where En is energy and x(n) is the signal sequence after sampling, N is sequence length. Each and every sampled point will be multiplied by itself and added up for the overall signal

Pitch: It represents the vibration frequency of vocal folds at the time of speaking. It known as the perceived rising and falling of voice tone, is the perceptual form of fundamental frequency. Huang [7] states, "It's called fundamental frequency because it sets the periodic baseline for all higher-frequency harmonics contributed by the pharyngeal and oral resonance cavities above. It is the source of speech model." It is the commonly used feature for emotion recognition. There are a number of ways to extract pitch from a speech signal. In this work, autocorrelation is used for it. In this process short-term analysis is used to retain the characteristic of each frame. In this pre-process should be completely applied before extracting the pitch from signal. Since autocorrelation can decide the period of each voice signal for each frame apply the autocorrelation from Eq. 3.3

$A(k) = \sum_{i=1}^{N} x(n)x(n+k)$ ……(3.3)

Where N represent frame length, x(n) is the signal Frame, k is shift parameter and A k is autocorrelation.

Formant: It is defined as resonances in vocal tract and they determine characteristic timbre of vowel [7]. It is an important feature for emotion recognition and it i s found very useful in many emotion studies. A representation of formants is shown in figure 4.2. The peak obtained from the frequency response of LPC filter is known as formant. This method provides a way to find the formants. That is to calculate the roots of a linear prediction coding (LPC) polynomial [8]. This calculate the formant every frame level as well. The linear prediction coding as its name indicate that it predicts current sample as a linear combination of its previous samples [7].

$X'(k) = \sum_{k=1}^{p} b(k)x(n-k)$…….3.4

Where x`(n) is the predict sample, p is the number of past samples and bk is the coefficient.

Mel-Frequency Cepstrum Coefficient (MFCC): The Mel-frequency cepstrum coefficient (MFCC) is used for the correct representation of short time power spectrum of a speech signal. It imitates the reaction of human ear to sound using ear to sound using a Mel scale instead of linearly spaced frequency bands [7]. The formula for converting from frequency to Mel scale is given in equation 3.7

M(f)= 1125ln(1+f/700) ……..……..3.5

The process of extracting the MFCC from speech signal is shown below in block diagram Figure 3.11. First signal is preprocessed after then period gram of power spectrum is computed for each frame by take the complex discreet Fourier transform and square it.

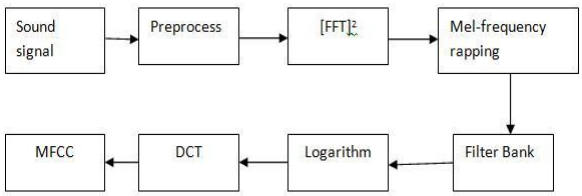


*Fig.3.2* MFCC

## 4. Classifier Models

A number of machine classifiers are used for recognition of different emotional states from speech. Artificial Neural Networks: Artificial Neural Networks (ANN) is a example of more sophisticated classifiers. They are made up of a variety of

interconnected artificial neurons, which mimic the behavior of biological neurons. A number of architectures with deferent numbers of neurons and layers can be used. A multi-layer perceptron is a feed forward neural network with two or more layers of neurons. They use non linear activation functions (like sigmoid) and are capable to classify data that is not linearly separable by a hyper plane. A challenge is to discover the best architecture of the network that will assure the finest performance for the given datasets [15].

Hidden Markov Models: Hidden Markov models can be regarded as the easiest dynamic Bayesian networks (DBN). They have a long tradition in voice recognition based on the idea that the statistics of speech are not stationary. The use of HMM and their capability to model the temporal behavior of voice as opposed to the global statistics approach has more advantages. For example it can be helpful for dealing with phenomena such as the rising pitch in interrogatory sentences which have no emotional relation. Also preprocessing does not have to wait until the entire utterance has been pronounced, providing therefore ability for real-time application HMMs are successfully used in emotion recognition from voice signals. [15].

**Gaussian Mixture Models:** Gaussian mixture models (GMM) is one the complex statistical methods. The original feature probability density function is approximated with a set of weighted Gaussians. GMMs are used in [16]. GMMs can be utilized as the state dependent probability distribution functions of HMMs. Therefore, a Gaussian mixture models is equivalent to a hidden Markov Model with just one state edges between nodes are directed and express the conditional probabilities of nodes and their parent nodes. The joint probability distribution provides a entire representation of the conditional probabilities and of the network's structure [9].

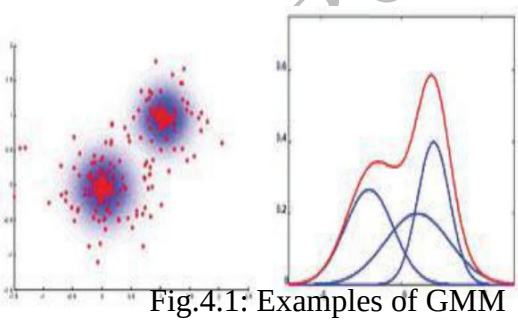

Fig.4.1: Examples of GMM

Support Vector Machines: It is one of the most accepted classifiers in speech emotion recognition, due to their high accuracy. Given the separation problem of two classes, a support vector machine will try to find a hyper plane that can completely separate these two challenged persons. In the present work many number of conclusion are observed like how

K-Means and K-Nearest-Neighbors: K-means and k-nearest-neighbors (KNN) are linear classifiers. The k-means algorithm is depends on Euclidian distance, and assigns a fresh sample to a class according to the distance between that sample and the mean of each label. K-nearest-neighbors on the other hand, labeled a new sample by a majority vote of its k nearest neighbors, so that the sample will belong to the most common class amongst its neighbors [16].

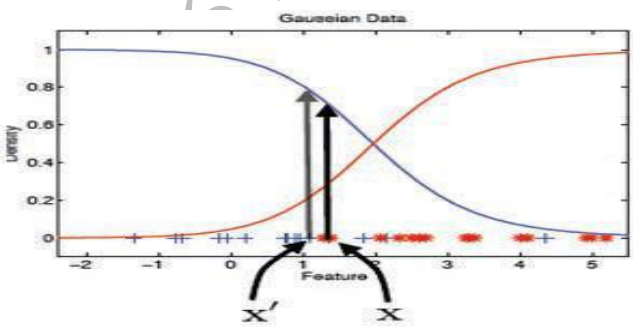


Fig.4.2. Examples of KNN

classes. Hyper plane is determined to increase the margin between the two datasets, and the samples that appear on the margin are called support vectors. The chosen hyper plane has the biggest distance to the neighboring samples from both classes. As opposite to traditional SVMs that can only construct hard decision boundaries with no probability outputs, propose using SVMs with continuous probability outputs [17].

Bayesian Networks: Bayesian networks (BN), also known as belief networks, are directed acyclic graphs. The nodes are linked to state variables from a fixed set of states.

## 5. Conclusion

The major contribution of this work is to develop an emotion recognition system from speech. This system is very helpful for medically

system respond for different speaker voice and what is the effect when extracted parameter

varied. Speaker dependent and speaker independent emotion recognition system have been evaluated for the maximum performance. For this purpose, Five main features (speech rate, energy, pitch, formant, mfcc) and there derivative are extracted
from speech and feed forward neural network is used together to form intelligent system with improved performance. The most important future scope of the work therefore is to enhance the CRR of the proposed approach in the case of speaker independent system because the CRR is minimum.

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# A Short Review
# Bacterial Resistance to Antibiotics: A Big Threat

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**Abstract**
Antibiotic resistance occurs when an antibiotic loses its ability to kill bacteria or the bacteria become "resistant" and continue to grow in the presence of an antibiotic. Resistance to antibiotic is a natural phenomenon. The misuse of antibiotics accelerates the emergence of resistant bacteria. Bacteria acquire resistance to antibiotics by wide variety of mechanisms. New resistance mechanisms can spread globally and threaten our ability to treat infectious diseases, which can even lead to death of individuals suffering from infection. Currently more than 90% of *Staph, aureus* isolates are resistant to penicillin.

**Introduction**
The word antibiotic resistance applies to bacteria and antibiotics. When a microbe develops or become more or fully resistant to antimicrobials, it is called resistance to antibiotics (1, 2).All classes of microbes develop resistance to antimicrobials such as viruses, fungi, protozoa and bacteria. A World Health Organization (WHO) report released April 2014 stated, "this serious threat is no longer a prediction for the future, it is happening right now in every region of the world and has the potential to affect anyone, of any age, in any country. The term bacterial resistance to antibiotics has been known since the first drugs were introduced for clinical use. The sulphonamide antibiotics were firstly introduced in 1935 and found to be very effective against *Neisseria gonorrhea* responsible for causing gonorrhea and 10 years later 20% of clinical isolates of *Neisseria gonorrhea* were found to be resistant. Similar facts were noted in case of penicillin antibiotic. Penicillin was firstly used in 1941, found to be effective against *Staph aureus*.

**Causes of antibiotic resistance**
1. The increase in antibiotic resistance can be attributed to a combination of microbial characteristics, the selection pressure of antibiotic use and practices that enhance the transmission of resistant organisms.
2. There is increase in use of antibiotics since 1950s. There is uncontrolled sale of antibiotics many countries.
3. Antibiotics are used even when they are not indicated or prescribed.
4. Pharma companies release large quantities of antibiotics into the environment without treatment. This increases the risk antibiotic-resistant among microorganisms.
5. In-appropriate prescribing and incomplete doses of antibiotics may lead to develop antibiotic resistance.
6. Some microorganisms are naturally resistant to antibiotics. The genes for antibiotic resistance in these organisms may be transferred to disease causing organisms developing resistance among pathogens.

**Mechanism of antibiotic resistance**
Understanding the mechanisms behind antibiotic resistance is very significant. According to studies the resistance is due to following mechanisms.
1. Antibiotic inactivation- Many antibiotics are susceptible to hydrolytic cleavage by microbial enzymes. The classic example is β-lactam antibiotics. These antibiotics posses β-lactam ring. This ring is susceptible to the action of enzymes β-lactamase enzymes secreted by microorganisms (3).
2. Antibiotic inactivation by group transfer- Transferase group of enzymes are able to inactivate antibiotics such as amino

glycosides, chloramphenicol, streptogramin by chemical substitution. The modification involves acetylation, phosphorylation, ribosylation and glycosylation.

3.Alteration of metabolic pathway- some sulfonamide-resistant bacteria do not require para-aminobenzoic acid (PABA), an important precursor of folic acid and nucleic acid synthesis in bacteria inhibited by sulfonamides(4)

4. Reduced drug accumulation: Some microorganisms possess mechanism of active efflux (pumping out) of the drugs across the cell surface. These pumps can be found within the cellular membrane of certain bacteria pump antibiotics out of the cell (3)

5. Chromosomal mutations: Resistance to some antibiotics can arise as a result of mutations in chromosomal genes because of changes in the DNA sequence (3)

6.Some bacteria possess additional circular elements of DNA which are capable of self-replicating. These extra chromosomal genetic elements are known as plasmids and code for a number of properties such as antibiotic resistance. Plasmids can be transferred within and between species and can therefore be acquired from other bacteria. This makes plasmid acquired resistance more common among bacterial population.

**The problem of antibiotic resistance**

Antibiotic resistance is becoming a serious cause and is the most common cause of treatment failure in against bacterial pathogens (5, 6). Infections with antibiotic-resistant bacteria are leading to the use of frequent and more expensive drugs which can result in increased cost for the treatment. Currently majority of the infections caused by serious pathogens can be treated by standard antibiotics available in the market. However, one should not relax and ignore the problems associated with antimicrobial chemotherapy. The ability of bacteria to transfer and acquire antibiotic resistance genes is one of the major causes of the spread of antibiotic resistance. Overuse and misuse of antibiotics can worsen this problem. Antibiotic resistance rates in the UK, which has relatively tight restrictions, are considerably lower than those in other countries, because in UK there are tight restrictions on the use of antibiotics. The president of US started a new initiative to address antibiotic resistance in 2014. US President Obama has suggested budget of than $1.2 billion to combat and prevent antibiotic resistance (7) .Antibiotic resistance is global health problem, and needs strategy to control emergence and spread of infectious organisms that become resistant to antimicrobial drugs (8). The World Health Organization has started the first World Antibiotic Awareness Week from 16–22 November 2015. The aim of this activity is to increase awareness of antibiotic resistance. It also wants to promote the correct usage of antibiotics across all fields in order to prevent further instances of antibiotic resistance

**Conclusion**

Bacterial resistance to antibiotics can threaten effective prevention and treatment of many infections caused by pathogens. The resistance is spreading all over the world very rapidly. It is a serious threat to global public health**.** Resistance to antibiotic resistance is a natural process, and bacteria are developing resistance to the action of natural antibacterial products for last many years. However, our knowledge of diversity of mechanisms involved in antibiotic resistance has expanded in last few years. People can tackle resistance by getting vaccinated properly, using antibiotics only when prescribed by the doctor, having complete dose of antibiotics and by not using left-over antibiotics. Knowing how and when resistance

occurs can help us to minimize antibiotic resistance.

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