Chapter 2 Literature Review

(1) Research Paper [1].

A stacked microstrip patch antenna having dual band is experimentally studied. In this paper stacked MPA has been investigated and optimised for the resonance frequency as it is optimised for dual frequency, return loss and VSWR is measured in network analyser.

(2) Research Paper [2].

A stacking phenomenon is applied to get wide band frequency response. U shaped top layer is staked with two other patches on different layer is proposed. The 33% input impedance bandwidth achieved from this proposed model.

Its frequency range is from 4.75 to 6.62 GHz. It can be utilised for wireless LAN. Its dimensions (ground size 25 x 30 mm) are best suited for compact transceivers.

(3) Research Paper [3].

This paper describes the novel approach to improve the performance of microstrip patch antenna. The performance improvement is possible by implementing stacked phenomena.

The proposed structure has wide impedance bandwidth as compared to conventionally feed antennas. Result claims to achieve wide impedance bandwidth nearly 88 % for voltage standing wave ratio less than 2.

The other proposed models in this paper are: Diamond shape patch excited by the F probe and diamond shape patch with stacked patch along its slant edge. The structure of F probe is it has one vertical probe and in parallel with vertical probe two triangular semicircle plates are connected. The proposed design result shows that it has very wide bandwidth of about 88 %.

(4) Research Paper [4].

A two E shaped stacked microstrip patch antennas for ultra wide band applications is presented in this paper. As E shaped patch antenna has 34 % impedance bandwidth now
adding another E shaped patch on the first E shaped patch, a 54 % bandwidth has been achieved.

Optimisation has been carried out to improve the wide band operation and also aimed to stable the radiation pattern over the proposed band. Also it is studied in time domain and observes the distorting nature of antenna. The effect of ground plane is observed on impedance bandwidth and radiation pattern.

(5) Research Paper [5].

In this paper a novel E shaped stacked patch antenna is presented. As standard E shaped patch antenna having 33 % impedance bandwidth, the proposed stacked E shaped patch antenna having 38.4 % bandwidth.

The radiation pattern from this geometry is relatively constant for entire wide bandwidth. The numerical and experimental measurement result is also carried out in this paper.

(6) Research Paper [7].

A printed MPA having low cross polarization, high gain for entire bandwidth is presented. A slotted broadband patch antenna is used to achieve high gain without disturbing the broadband nature of stacked patch antenna.

The dimensions of antenna are 42 x 55 x 4.8 mm having substrate dielectric constant 4.2 and a VSWR bandwidth of 34.9 % is projected in this paper. It has the 8.07 dBi gain and front to back ratio is good and it is observed constant throughout the entire band.

The simulated and experimental results are also carried out for with and without stacking also various optimized results are presented in this paper.

(7) Research Paper [8].
To enhance the bandwidth a stacked C type feed microstrip patch antenna is designed. The different analysis for various parameters has been investigated like rotation of feed with respect to centre, different dielectric constant, and feed distance from the centre.

This paper proposed 5 different cases; some of the proposed model had good results. The simulated results are carried out in IE3D software and it is based on methods of moments. In model analysis purpose infinite ground plane is considered.

(8) Research Paper [9].

In this paper with the help of circuit concept a theoretical investigation of gap coupled stacked microstrip patch antenna is projected. From the simulated results, antenna resonates for two different frequencies 4.76 and 6.79 GHz.

The dual frequency operation is achieved by adding V shaped element around the radiating edges of the excited patch and stacking above the rectangular shaped patch. The radiation pattern graph shows the shift in for lower frequency and 120 degree for upper frequency.

(9) Research Paper [10].

This paper describes the technique to improve the gain of microstrip patch antenna. The microstrip patch antenna is excited by slot. This proposed design is used to generate circular polarization at 31 GHz.

The gain improvement is possible by implementing conical horn antenna, with this technique 12 dB gain is achieved. The authors has reviewed the literatures on this hybrid technology and proposed model results claims to achieve 6 dB improvements over standard circular patch antenna. This antenna is used for millimeter wave imagining and near field communication.

This letter presents the work on hybrid antenna which is a combination of microstrip patch antenna and horn antenna. This antenna can be a good candidate of security
applications where millimeter wave imaging systems implemented or it is also suitable for the high data rate trans-receiving sensor system.

The proposed antenna design model offers small size, light in weight and high gain as compared to conventional antenna. The investigation of proposed model is carried out by measurement and simulation.


The disadvantages of microstrip patch antenna are overcome by the stacked fundamental. This paper presents the various techniques to determine the input impedance and the radiation patterns of proposed antenna structure.

The second part of the paper presents the different models of stacked patch antennas for rectangular and triangular shape patch. The experimental approach is carried out for dissimilar dielectric constants, unequal patch size. The observation is also done for radomes on the stacked microstrip patch antennas. At last designs and simulations are carried out for stacked triangular patch antenna.

(11) Research Paper [12].

This paper explains the stack patch antenna and its numerical calculation. Stacked geometry is analyzed by full wave method. The results are based on the complex image theory and it's very accurate. The whole structure is analyzed by numerical calculation and results are also presented.

The technique described in this letter is much faster than the numerical integration method. Feeding mechanism of proposed model is improved in terms of impedance matching, this paper claims to achieve 22% of bandwidth from stacked patch antenna.

The optimization of various parameters is done to improve the radiation pattern and impedance bandwidth. At last matching network is implemented to further enhance the bandwidth nearly 25%.
(12) Research Paper [13].

This paper presents the technique to improve the bandwidth of stacked microstrip patch antenna. The simulations and analysis is carried out in microwave office package.

The bandwidth is improved with the stacked configuration. It also throw lights on various parameters like effect of patch rotation on frequency, size of upper patch and distance from centre, it is observed with respect to VSWR.

This stacked geometry resonates in S band having height of substrate is 1 cm, and dielectric constant 2.6 is chosen for design.

(13) Research Paper [14].

This paper projects the design of dual band circular polarised (CP) microstrip patch antenna. It also represents the size reduction of circularly polarised antenna with conventional CP microstrip patch antenna.

Proposed geometry consist of stacked structure of rectangular ring patch one above another. Results show the axial ratio and impedance bandwidth is very wide and radiation also proves the CP quality in it. It has more than 9 dBi gain. It can be used for GPS purpose.

(14) Research Paper [15].

This paper describes the cavity backed microstrip patch antenna which provides the wideband and can be applied for personal communication system or the device which works on 2.4 GHz frequency.

Here microstrip patch antenna is excited by the coaxial cable and one parasitic patch is place to increase the bandwidth. This paper compares the patch antenna which is backed by cavity and without backed by cavity.

By comparing the results of cavity backed and without cavity backed, cavity backed microstrip patch antenna structure provides wider bandwidth up to about 43% and also
provide high gain. Proposed structure operates from 1.5 GHz to 2.7 GHz which covers most of modern communication system requirements.

Here parasitic patch is used to further enhance the bandwidth of cavity backed patch antenna. The proposed structure is simulated using numerical calculation which is based on finite integration method.

To validate the design and simulation, fabrication and measurement is carried out. The test result and simulated results were quite similar. The proposed structure resonates on desired bandwidth, radiation pattern and front to back ratio proves the performance of it.

Generally when microstrip patch antenna is used in practical applications, it is always used with finite ground plane, which is one of the source of degradation like increment in cross polarization and spurious radiation from back side of antenna, which leads to reduction in gain parameter.

To overcome the practical limitation of microstrip patch antenna, many literatures presents the design of cavity backed patch antenna, although this structure provide narrow bandwidth, which restricts its practical applications in communication systems. For this purpose this proposed structure is presented.

(15) Research Paper [16].

This paper presents a work on microstrip patch antenna which is excited by electromagnetic coupling method, this work is also extends for antenna arrays.

In initial phase various models are presented to analyse the coupling techniques like broad side coupled lines, transmission line methods as it is easy to analyse and implementation is less complex.

Fabrication is also done to verify the simulated results. This concept of patch is then used for array purpose which improves the gain parameter and overall performance.

(16) Research Paper [17].
This paper investigates a method to obtain circular polarisation in microstrip patch antenna. The proposed model uses C type feed location to excite the circular polarisation from stacked microstrip geometry. To achieve the circular polarisation a systematic process is involved.

In design steps optimisation is done for axial ratio bandwidth. The higher amount of gain is achieved by the optimization process like distance between two patch geometry, from centre, separation between them.

The axial ratio bandwidth from this proposed model is 14 % and ellipticity which is obtained from this model is 0.07 dB at centre frequency. This proposed method is very helpful to design circularly polarised MPA and also has high gain and wide bandwidth.

(17) Research Paper [18].

This report presents the work on array and effect of stack parasitic elements on to the patch antenna. From the array structure wide bandwidth and high gain is achieved. The basic understanding is gained by study the basic behaviour of patch as well as stack patch antenna.

Generally stack fundamental is used to improve the gain parameter of the antenna, as it is easy method to implement and less costly as it uses less space for construction. This paper represents the experimental model to improve the gain by 2 x 2 microstrip array at 20.5 GHz.

The effective isotropic radiated power and radiation pattern results are presented in this paper. It is also plotted the above mention graph with respect to the spacing between parasitic element and driven antenna layers.

(18) Research Paper [19].

A microstrip patch antenna is designed for 16 element array on Ferro material to operate in W band region. When patch is implemented on Ferro substrate, it increases the bandwidth.
The design of stacked configuration is done on EM simulators. To validate the design fabrication is also done, the array structure is also integrate with WR-10 for measurement purpose.

The S parameters measurement is carried out in Network analyser and radiation pattern measurement is in anechoic chamber. The dimensions of array are 9.3 x 9.3 x 0.4 mm, provides very high gain around 14.2 dBi at 84 GHz. It also provides 23 % bandwidth (3 dB down). The overall efficiency of the array is 48 %.

(19) Research Paper [20].

This paper presents the co axial feed V slot patch antenna which provides the 36 % bandwidth. Now, adding another resonator which work as stacked patch antenna, antenna bandwidth improves up to 47 %. The different parameters are also discussed and presented in the paper.

(20) Research Paper [21].

In this paper bandwidth of MPA is improved by stacked square ring resonator. Because of the printed loop and patch combined together, the overall size of antenna is reduced and it depends on the ring width.

The simulated results show that the impedance bandwidth is small as compared to conventional patch antenna having same size. Frequency deviation is possible by changing the length and width of square patch.

Generally stacking improves the impedance bandwidth, this paper deals with the stacked square ring. In this paper proposed design geometry and simulation are carried out in Ensemble 4.02. The fabrication and measurement is also done to validate the design.

(21) Research Paper [22].

In this paper a novel approach is established for small size; high gain multiple shapes for the microstrip patch antenna. The basic geometry is based on staked patch antenna having inverted multiple slot feed by coaxial cable. As this proposed geometry offers good advantages in gain, impedance bandwidth and radiation pattern.
In this paper, a planar array patch antenna is constructed to generate the high gain. It is also possible by adding and arranging the parasitic elements in the direction of radiation.

It has also been observed that the bandwidth parameter of the patch can be improved by placing the parasitic element in the direction of radiation. This paper describes the array of microstrip patch antenna compose of three elements radiating patch, parasitic patch (matching element) and another parasitic element (director).

This letter presents the improvement of microstrip patch antennas radiation characteristic by implementing the small size antenna. It also presents the study on different slots in circularly polarized circular shape patch antenna.

The microstrip patch antenna has mainly two drawback first is lower gain and second narrow bandwidth. Now to improve these drawback various techniques has been implemented.

The authors have reviewed many literatures on different types of cross slots which are implemented on circular patch for improvement of bandwidth of circular polarized wave. The proposed investigation is based on the integration of microstrip patch antenna and square size surface mount small size horn antenna.

In this paper, patch antennas gain has been improved by square shape small size horn antenna it also provides circular polarization. Result shows the gain is 10 dB, axial ratio achieved by proposed model is 0.1 dB and axial ratio bandwidth is 2.22 %. To generate circular polarization crossed rectangular slot is implemented on patch antenna geometry.

These results are obtained by etching circular shape dumbbell crossed slots on patch antenna geometry which is having low dielectric constant substrate. The overall size of the antenna is nearly 12.58 mm.
The microstrip patch antenna which is excited by single feed is proved to be most useful in the application of designing smart antenna and array structures. Applications like satellite communication and terrestrial communication circular polarization is desirable and this proposed structure is useful in it.

(24) Research Paper [25].

This paper reports the technique to improve the bandwidth of MPA. Here L shape probe fed technique is used to excite the patch and improvement in bandwidth is observed.

The results are indicating that the 35% bandwidth is improved, the effect of stack patch is also observed. By optimising the distance between stack patch and probe fed patch the impedance bandwidth is obtain up to 46%.

(25) Research Paper [26].

This paper describes the H shaped microstrip antenna with improved bandwidth. It is first studied with the help of model of transmission line and it is analysed by moment of method. Also stack patch configuration is implemented to improve the bandwidth and other radiation parameter.

(26) Research Paper [27].

This paper investigates the stacked configuration for MPA and it also works on dual band and provides circular polarisation.

To obtain the dual band operation, stacking of two layers in microstrip patch antenna is constructed. Theses layers are fed by dual probes. In construction features, the upper patch is excited by redundant via hole through lower patch antenna. This proposed model is fabricated and tested for results.

(27) Research Paper [28].

The microstrip patch antenna is widely used in different communication systems as it is compact in nature. The main drawback of these antennas is limited in bandwidth as well as in gain. Now to improve the radiation characteristics of patch antenna a aperture coupled microstrip patch antenna is integrate with surface mount horn antenna.
The result shows the gain of the proposed model is achieved by 4.2 dB. The proposed geometry possesses 12.4 % bandwidth. As this model is integrated with the short horn, all the advantage of horn antenna is retained. So it help to reduce back side radiation in other words it improves the front to back ratio. The proposed geometry is designed for Ku band.

(28) Research Paper [29].

This paper presents the stacked patch geometry backed by cavity. To analyse the stacked configuration for MPA which is fed by coaxial and backed by circular cavity, a Full Wave Moment Method is used.

The optimisation is done for the parasitic patch elements effect on bandwidth. The cavity effect on microstrip patch is also observed. The simulated results, radiation characteristics are presented for proposed model.

(29) Research Paper [30].

This paper theoretically investigates the geometry of reconfigurable stacked configuration of MPA for many applications. This proposed antenna works on 2 to 5 GHz of frequency range. The construction of proposed model is, it is formed by two layers, the lower patch antenna having two slots and it can be controlled by switches.

By applying the changes in status of switches, the resonant frequency can be changed, so frequency re configurability is achieved. Now the stacked patch is introduced to increases the bandwidth of patch. The parameters are optimised for separation of dielectric layer.

(30) Research Paper [31].

To design wideband microstrip patch antenna, two techniques studied in this paper, stacked patch antenna and co planar parasitic patch.

There are many models are proposed and from the simulated results, impedance bandwidth is improved from 8 % to 36 % with the help of above methods. In these techniques probe fed excitation is used.
The fabrication is done to validate the design and measurements are performed to compare with the simulated results. The measurement results show the good matching with the proposed design geometry even though it is slightly drift in frequency.

(31) Research Paper [32].

This paper projects the U slot lower MPA with E shaped stacked patch antenna, to improve the bandwidth around 60%. The optimisations are performed for various parameters to obtain the desired results.

The parametric results are also showed in to paper. The electric field distribution on patch as well as radiation pattern is presented.

(32) Research Paper [33].

In this paper, microstrip patch antenna with co axial fed excitation is used and also two dimensional arrays are used to improve the bandwidth and gain. The analysis of 4 x 4 arrays is performed in to ADS as well as HFSS software.

The proposed model is fabricated to validate the design measurement is also carried out for experimental results.

(33) Research Paper [34].

This letter describes the work on improvement of bandwidth of microstrip patch antenna by implementing Psi shape patch antenna. The paper presents the design, simulation and performance analysis of proposed antenna structure.

The bandwidth of patch antenna is improved by this model by adjusting the patch antenna shape, actually two square shapes and one rectangular shape patch antenna to gather confirm the Psi shape.

So two square shapes patch resonates to nearer frequency by adjusting the separation from center rectangular shape patch, broader impedance bandwidth is achieved. The radiation pattern from this proposed model is acceptable in wide band characteristic.
Here to construct microstrip patch antenna, foam material is taken which is easily available and model is fabricated to validate the design. The microstrip patch antenna having Psi shape is excited by coaxial cable and it is adjusted to match the impedance.

The measurement of proposed model is carried out to confirm the performance of the model. The simulated and measurement results are compared which confirms the design. The measured voltage standing wave ratio 54 % and simulated was 55 % which is in acceptable range.

The radiation pattern is too measured and which is similar with simulated one. The front to back ratio of proposed model is 20 dB throughout the bandwidth of model.

(34) Research Paper [35].

This report presents the work on improvement of axial ratio bandwidth of circular microstrip patch antenna. The bandwidth is improved by stacking phenomena and high gain is obtained by surface mount short horn.

The proposed antennas bandwidth is 14 % by adjusting the feeding position and other parameter. The circular polarized stacked microstrip patch antenna is excited by C type single feed. The results of proposed geometry claims to increase gain by 4.5 dB as compared to conventional antennas at same range of frequency.

The high gain which is achieved from this model is without compromising the 10 dB return loss bandwidth. The results show exact gain which is achieved from this model is 11.5 dB, 15 % of 3 dB axial ratio bandwidth. This proposed technique is still even simplified for wideband operation of microstrip patch antenna.

The first approach of authors is to design single feed stacked microstrip patch antenna which generates circular polarization, the other goal is to improve the axial ratio bandwidth of proposed model.
They design C type feed to excite microstrip patch antenna. In next step designing of small size short horn in done and integrated with proposed design. The impedance match is done by varying the position of feed element and separation between excited patch and parasitic patch.

The various parameters have been studied and optimized like short horn for achieving higher gain and C type feed rotation and separation between active patch and parasitic patch for wider bandwidth.

(35) Research Paper [36].

This paper proposed a structure which provides a high gain for microstrip patch antenna, this proposed model also generates circular polarization. The microstrip patch antenna is excited by proximity feed.

This paper improves the gain of patch antenna by implementing short on to the patch geometry. Results claims to achieve 4.46 dB higher gain as compare to conventional circular patch antenna, it also shows overall gain is 9 dB, the axial ratio bandwidth is 1.31 % improved.

The main purpose of implementing horn antenna is to improve the overall gain of the geometry without affecting the axial ratio bandwidth of proposed geometry.

The other aim of this paper is to reduce the overall size of proposed antenna, the authors claim that 12 % reduction is possible as compared to conventional circular patch antenna. The overall thickness of the patch is only 13 mm.

(36) Research Paper [37].

This paper presents a thorough investigation on cavity back patch antenna, the performance analysis is also carried out. The microstrip patch is excited by meander probe. The various parameters have been optimized for achieving desired gain at resonant frequency.
The parameters like size of ground plane, height of cavity and dimensions of slot are analyzed. The size of ground plane is affects significantly on the wideband characteristic of the proposed antenna structure.

Optimization is done for the feed position with respect to patch antenna to obtain perfect impedance matching. This proposed model generates directive beam at bore sight which is useful for many airborne applications. The cavity backing fundamental is useful for generating directive beam and it also enhances front side radiation by eliminating rear side radiation.

In this paper meandering probe is used to excite microstrip patch antenna mode which is backed by cavity, this meandering probe provides wide bandwidth on return loss. It also gives good radiation pattern and gain over a wideband.

Here wideband characteristic is more dependent on ground plane dimensions. The cavity dimensions and gap between feed and ground plane affects the wideband nature of proposed antenna structure. This paper analyzed the effects of various parameters on impedance bandwidth and radiation pattern of the proposed antenna.

(37) Research Paper [38].

This paper describes the dual polarized horn antenna excited by microstrip patch antenna. The proposed antenna structure resonates at 14.9 GHz. The microstrip patch antenna is excited by small gaps between the edges.

The patch antenna generates two orthogonal polarizations. The proposed structure is designed, fabricated and tested for 14.9 GHz. Results show the reflection coefficient is less than 10dB for wide range, the isolation between two ports is greater than 20 dB and gain is 12.34 dB.

Here high gain is achieved because horn antenna is implemented on microstrip patch antenna. This paper proposes a square patch antenna which is excited by two orthogonal edges coupled from small gap between microstrip line and patch antenna.
Proposed structure is comprised of dual polarized horn antenna and microstrip line gap fed patch antenna. The structure in this paper has narrow bandwidth as this model is based on microstrip patch. So this model is best suited for narrow band applications.

The proposed antenna structure is fabricated and measured results were compared with analyzed results. The measured results are quite similar with simulated results.

(38) Research Paper [39].

The microstrip patch antennas radiation properties can be improved by various techniques like stacking phenomena, implementing surface mount short horn or using cavity backing fundamental.

These techniques help to improve different parameters of patch antenna like gain, impedance bandwidth, front to back ratio, directivity, dual polarization and port isolations. This letter presents the work on cavity backed microstrip patch antenna.

The authors has reviewed many literatures for the same, they proposes a model which improves the front to back ratio of microstrip patch antenna. Results also claim that high gain is achieved along with good front to back radiation.

With reference to conventional microstrip patch antenna this proposed antenna structure has more than 12 % increment of gain is possible and also 10 % increment in front to back ratio in principal radiation pattern.

(39) Research Paper [40].

This paper represents the cavity backed stacked microstrip patch antenna which is excited by proximity feed. For improvement of bandwidth stacked geometry is useful. In this paper two stacked patches resonance behavior is interacts and based on these two resonances nature is generated.

Here the lower patch antenna and cavity makes the coupled resonance. The overall proposed model produces multiple resonances and because of that wider impedance bandwidth is achieved.
The comparisons of simulated and measured results are given in this paper. The investigation is also carried for good radiation characteristic over a wide range. Here gain is improved by cavity backed structure and broadband characteristic is achieved by stacking phenomena.

To validate the design fabrication is carried out along with it measurement is done. Finally comparison table is provided for various parameters of antenna.

(40) Research Paper [41].

This paper describes the technique to improve bandwidth as well as gain. The wideband characteristic can be achieved by stacked phenomena, by increasing dielectric constant of dielectric constant or by exciting patch antenna by multilayer dielectric medium with the help of aperture coupling technique.

Authors present the work on improving bandwidth of patch antenna by aperture coupling technique simultaneously they implement the dielectric cavity for increment in gain parameter. The gain parameter is increase because cavity prevents the back side radiation from aperture and also eliminates the parallel plane waves between upper surface and below surface of ground plane.

The antenna is excited by stripline which is best suitable for resonant feed line and the coaxial connector. Here cavity does two tasks simultaneously, first it improves the broadband characteristic by mutual resonance between aperture and patch antenna and second it increases front to back ratio of gain by eliminating radiation from rear direction of slot. A 40 % of bandwidth is achieved at 10 dB down level, cross polarization of E field and H field is also less than – 40 dB. The application of the proposed model is in RF module and also in controlling elements.

This letter proposed a structure which is a combination of aperture coupled and cavity backed patch antenna. Implementation of this method also covers one more advantage, it reduces the spurious radiation from back side of structure and it eliminates the surface wave radiation.
The antenna radiates in vertical direction which can be useful for microwave signal. The formation of cavity is such that it uses the two dielectric layers with metal at outer layer. The fabrication of this cavity is easier than the conventional cavity which is made up of metal also this proposed cavity is lighter.

Here design suggests that the formation of cavity doesn’t require ground plate, the whole structure can be supported easily. Various optimizations are done for cavity to generate resonance in desired band of operation.

It is also necessary to use appreciate size of cavity to excite patch through aperture coupling. Results shows that two resonances are generated which can improve the broadband characteristic effectively, it also shows that radiation pattern achieved from proposed model is good for whole bandwidth. The authors have reviewed the literatures on this same model and claims that with this proposed model they achieve better results.

(41) Research Paper [42].

This paper explains the method to design cavity backed stacked patch antenna, which improves the bandwidth criteria and also increment in gain is possible. With this method the efficiency of microstrip patch antenna is improved.

Authors also show the theoretical and exponential approach about the cavity which is filled by dielectric medium and it is less pattern scalping than a conventional edge fed patch antenna. It is possible because of two reasons: 1) the surface wave propagation is reduces by cavity backing and 2) the spurious radiation from a feeing structure is reduces as thin dielectric medium is used to etch the feeding network which allows thinner track width for realization of 50 Ω impedance.

The proposed structure is based on two phenomena one cavity backing and second stacking. The result shows the edge fed patch antenna achieves 3 dB more gain as compared to conventional patch antenna and structure reduces the back side radiation.
This proposed structure is best suited for large planar arrays. The parameters of the antenna are adjusted according to frequency requirement.

With slight variation in cavity backing procedure this structure can be applicable for Monolithic Microwave ICs and Optical electrical integrated circuit. The new proposed geometry overcomes the trade-offs between patch based array structure at thin dielectric medium with high dielectric medium.

The investigation is carried out to simplify the fabrication process of proposed geometry. Here cavity depth improves the impedance bandwidth of patch antenna and simulated result also proves the same thing.

The bandwidth which is improved from this method is twice that of the conventional patch antenna. Cavity is used to house the whole antenna structure and combined with Microwave ICs or Opto electronic ICs.

The bandwidth criteria are also improved by implementing Hi and low dielectric constant for stacked geometry. Authors also conclude that still improvement is possible in this proposed model.

(42) Research Paper [43].

The gain of microstrip patch antenna is low in general, to improve the gain of patch antenna various researches has been publish and implemented. One of the very simple methods to improve the gain of patch antenna is to forming array of patch.

The various kind of feeding networks is also available. In this paper patch antenna array structure is proposed and this structure is backed by cavity for improving radiation pattern. Here multiple beam is generating from patch array structure.

The main advantage to implement this structure is the feeding structure is less bulky and hence small in size as compared to the conventional antennas which uses several feeds. Cavity backing structure improves the front side radiation of patch antenna array and it reduces parallel plate radiation from the same structure.
Here beamwidths of patch antenna array structure can be controlled by adjusting the spacing between the adjacent elements. The simulated results are presented and discussed, results shows that the proposed structure is suitable for multiple beam applications.

(43) Research Paper [44].

Cavity backed patch antenna is useful for the case of airborne vehicle, surface mounted antennas and flush mount antenna. Generally cavity backing phenomena improves the front to back side radiation, it also reduces the spurious radiation from back side of antennas or feeding structure. In this paper authors has reviewed different cavity design for their model, they also study the literature on quarter wave microstrip patch antenna.

The model proposed in paper is light in weight, cheap, it operates on dual band also necessary for the covering of transmit and receive band simultaneously. The main advantage gain from this proposed structure is, it provides almost isotropic radiation in upper hemisphere. For this purpose a quarter wave microstrip patch antenna is best suitable for the design which radiates nearly in all directions and it is also easy to fabricate.

The main drawback of conventional microstrip patch antenna is it provides narrow bandwidth and reduced power level because of loss when it is implemented in horizontal surface which represents the vehicle roof. Here when this proposed model is implemented in flush mount with conducting surface, its radiation characteristic is greatly improved.

To improve the bandwidth of microstrip patch antenna, reduction in dielectric constant is necessary or by increases the height of dielectric substrate.

Although these techniques alone do not work for the improvement of bandwidth, the antenna design is one of the main constraints for the same and suitable matching network is also required for the same. The simulated results are explained in this paper which shows the proposed antenna structure is operates in dual band.
This letter presents the work on stacked microstrip patch antenna which is backed by
circular cavity. The proposed circular microstrip patch antenna is excited by probe and it
is fully analyzed by moment method. Authors proposes a two models, conventional patch
antenna backed by circular cavity and stacked patch antenna backed by circular cavity.

The simulation result shows the effect of parasitic patch on antenna impedance
bandwidth. Comparison is given in this paper for two proposed models. The radiation
characteristic is also presented in this communication.

With reference to single patch antenna and stacked patch antenna fed by cylindrical
cavity gives the broad idea about the various criteria such as impedance bandwidth, gain,
directivity, front to back ratio and axial ratio. The axial ratio graph shows the proposed
structure generates the circular polarization.

In many applications circular polarization is required, at that time this proposed structure
is best suited.

The main advantage of microstrip patch antenna is it is low profile antenna. For
applications like wireless communication systems, mobile communication etc. requires
antenna which is small in size.

Sometimes it is also required that the antenna resonates at two frequencies. In situation
like this, paper proposed a structure which resonates on dual frequency and compact in
nature. The dual band operation is achieved by stacked patch antenna. Thin stacked patch
antenna is resonating at 1800 MHz.

Results show that bandwidth achieved from proposed antenna structure is almost 10 %.
These rang of bandwidth operation is best suited for GSM 1800 and GSM 1900 systems.
The radiation pattern generated from this proposed antenna is suitable for mobile
communication antenna.
The authors have reviewed many literatures on dual band operation of stacked microstrip patch antenna. In this paper shorted stacked patch geometry is reported.

The main virtue of proposed structure is its compact in nature as compared to conventional microstrip patch antenna. As the size of antenna is very small it is very easily fit inside the mobile phone.

The bandwidth which is provided from this structure is sufficient enough for many communication devices. The proposed structure is uses short circuit element for grounding both patch element and this proposed design is relatively simple to design.

Here by using this antenna geometry, there is no requirement of shorting posts or tuning, which makes it easier for fabrication. The thickness of the proposed model is one fifth of the conventional microstrip patch antenna which uses shorting of stacked microstrip patch antenna.

(46) Research Paper [47].

This paper presents the novel way of improving the bandwidth of microstrip patch antenna. The proposed structure is based on the stacking phenomena which also uses E shaped parasitic geometry.

The proposed structure provides impedance bandwidth about 38.4 % which is better than the conventional E shaped stacked patch antenna, which reports bandwidth about 33%. This paper also gives one more model to improve the bandwidth, it can be achieve by implementing washer on the stacked patch antenna, and from this method input impedance bandwidth is improved up to 45 %.

The results claimed that the radiation pattern is almost constant throughout the operating bandwidth. Comparison of this proposed antenna is also presented briefly in this letter.

Up to these days various techniques have been investigated in different literature to increase the bandwidth of patch antennas, including the embedding of parasitic element
either in horizontal direction or in vertical direction, increases the thickness of substrate and cutting of slots in patch geometry.

This paper presents the work on microstrip patch antenna which uses stacked phenomena with E shaped parasitic element. With the help of E shaped stacked patch antenna improvement of bandwidth is up to 33%.

Authors also introduce second patch above the E shaped patch antenna for further improvement in bandwidth. Perfect impedance is matched by adjusting the probe location in patch antenna. Investigation is also carried out for observing the effect of patch separation by implementing washer, with this washer the E and H plane cross polarization is less.

(47) Research Paper [48].

This paper presents the novel way to improve the gain of microstrip patch antenna by implementing square ring with small size conical horn antenna. The metallic patch is capacitive coupled with surrounding rectangular ring.

The proposed antenna structure is generating zero order resonance by using right and left handed structure. The radiation characteristic and simulation is observed by three dimensional field solver.

Further improvement of gain is possible by implementing small size horn antenna on microstrip patch antenna geometry; obtained gain is 3.5 dBi higher than the conventional microstrip patch antenna.

Result shows that antenna structure achieves the 11dB gain without affecting on bandwidth parameter, bandwidth is 745 MHz, efficiency is 96% from this configuration and front to back ratio is nearly 20 dB.

The total height of proposed antenna is 3 mm. The presented antenna can be suitable conformal arrays or in planar arrays. The antenna geometry is designed for 12.68 GHz and 10dB impedance bandwidth is about 6%.
This paper describes the technique to reduce the size of cavity backed antenna structure, which helps for easy manufacturing and integration with slot antennas on substrate. Various researchers have proposed different structure to optimize the cavity backed slot antenna structure.

This paper provides the novel technique to reduce the size of slot antenna structure which is backed by cavity. It can be possible by removing the solid metal around the slot antenna and instead of it place a metallic pattern which can be viewed as a series of parallel strip lines around the slot antenna structure.

To reduce the size of slot antenna metallic pattern is placed in first step then this metallic pattern is modified in a fashion that it would look like parallel strips and finally obtained the compact size cavity backed slot antenna.

It is shown in this paper that a simple slot antenna structure can be reduced by about 66% without affecting the overall radiation pattern of antenna.

The overall volume occupied by the structure can be modified for slot antenna which is backed by cavity. Many literatures have been presented on cavity backed slot antenna structure which is designed, manufactured and tested.

The reduced size slot antenna structure provides the low input voltage standing wave ratio, cross polarization is low and gain is high. Though the size of ground plane is less, still it provides the front to back ratio about 6-8dB.

In this paper authors have investigated the reduction of slot dimensions by applying meandered structure. The antenna structure is analyzed by putting rectangular cavity on back side of it. Here in this technique slot structure is replaced by miniaturized finite width metallic strip which is closely separated by distance and its physical and electrical length is same as ground plane. The performance of this structure is analyzed by three dimensional simulator.
The cavity structure is replaced by series of small size transmission line. The improvement of gain is possible by adjusting the dimensions of cavity and resonance is adjust by patch dimension. The overall radiation pattern works on the desired resonant frequency.

(49) Research Paper [50].

This letter describes the size reduction technique of cavity back slot radiator. The reduction method is as follow: first the metallic ground plane around the slot antenna is replaced by the series of very small strip lines and designs them in miniaturized fashion; second the slot structure is replaced by the small parallel wires, which is meandered for further reduction of antenna dimension.

So by using this technique the antenna size is reducing about 66 % from the conventional antenna. The proposed structure is designed and fabricated and to validate the same structure measurement is carried out.

The result shows that the proposed antenna structure is having low voltage standing wave ratio, cross polarization level is low and front to back ratio is 6 to 7 dB. This paper presents the work on the size reduction of slot antenna by implementing metallic strip and meandered structure of short circuit micorstrip lines.

The result shows the proposed structure is resonating at desired frequency. To validate the design measurement is carried out. The comparison of simulated and measured result is presented in this communication report.

With the help of cavity backing structure gain is improved and this response is not affect the bandwidth response of antenna structure.

(50) Research Paper [51].

Paper describes the U slotted patch antenna for dual band, the stacking phenomena is used for improvement of bandwidth. The proposed structure is made up of two stacked patches and both having U slots in it.
Authors present the two different models for dual band operation and results comparison is given. The two models are based on the excitation method, first probe feeding and second co-planar waveguide.

The results claimed that the co-planar waveguide feed structure provides the best results in improvement of bandwidth as compared to probe excitation, though the disadvantage of co-planar waveguide feed structure is it has low gain.

Here bandwidth is also further improved by H shaped stacked microstrip patch antenna which is excited by U slot co-planar waveguide feed microstrip patch antenna.

Literatures have been proposed for bandwidth improvement by using U slot patch for driven element as well as for parasitic element but in that case bandwidth is not improved a lot.

The dimensions of antenna are optimized for getting good results for desired band of operation also feeding mechanism is also optimized for proposer impedance matching.

(51) Research Paper [52].

Bandwidth of microstrip patch antenna is improved by stacking fundamental. E shaped microstrip patch antenna is excited by the probe and stacked patch antenna with different size is investigated.

From the proposed antenna structure 44% bandwidth is improved without washer and this result is better than the square shape stacked patch antenna which is presented in literature.

For achieving an ultra-wide band the optimization of proposed structure is done and the position of coaxial probe is also adjusted for the same purpose.

In this paper E shaped stacked microstrip patch antenna is presented, here rectangular shape stacked antenna is used as a parasitic element.
The ultra-wide band operation is achieved by this proposed model and result shows that the impedance matching is best as compare to the other literatures presented and discussed before. The excitation of proposed structure is done by SMA connector and it is moved along the axis and it is adjusted for impedance bandwidth.

(52) Research Paper [53].

This paper describes the numerical study on the cavity backed narrow slot. Here cavity structure is taken as a rectangular and simulation design and performance analysis is carried out on three dimension software which is based on method of moment.

The basic motive to do this research is in electronic system RF excitation because of high power. The rectangular cavity is excited by the thin wire coaxial connector.

Now a day in electronic devices because of intentional or un-intentional electromagnetic sources interference is occurred and that is the main criteria to look after.

As cavity is implemented in to antenna structure, it reduces the interference to other circuit or because of cavity electromagnetic coupling to other RF devices is less possible.

In design consideration authors first investigate the effect of finite conductivity in to the cavity body. The problem analysis and simulation is done on software which is based on method of moment.

Authors have reviewed many literatures on RF shielding and electromagnetic excitation. In electronic devices it is necessary that its shielding should be proper. An antenna design point of view spurious radiation from feed should be eliminated at any cost otherwise it could excite the other circuit very easily. Here proposed structure is simulated by considering narrow slot as a aperture and radiation is calculated by applying boundary conditions.
The calculation of electric field is important at the surface of cavity as electromagnetic field could be penetrated through the slot. This problem is defined under the category of scattering and thus it is important to calculate the field distribution.

Generally electronic devices excite the circuit by high power RF. As this high power RF sources easily alter the chip logic or circuit disruption by near field electromagnetic coupling.

So it is necessary to design antenna such that it could not generate the interference to other circuitry. At this time cavity backed slot antenna is best suitable. Cavity back slot also gives high radiation in intended direction.

Results of this paper shows that the proposed structure resonates at desired band and its radiation pattern is good.

(53) Research Paper [54].

The advantages of microstrip patch antenna are low profile, ease of excitation and conformability. Cavity backed slot radiator offers advantages of high gain, improved impedance bandwidth and high front to back ratio.

Combined the microstrip patch antenna and cavity, all the advantages which discussed above are achieved. The disadvantage of the cavity backed microstrip patch antenna is it provides narrow band of operation. Now to overcome the drawback multiple slot resonators should be implemented.

One of the literatures that authors have reviewed use this technique, in that driven slot resonator is coupled to second slot resonator through an aperture. This paper describes the theoretical approach of aperture coupled slot resonator.

To confirm the performance of proposed antenna structure fabrication and measurement is carried out. The parameters like cavity height, diameter of cavity and aperture dimensions are optimized to achieve wider impedance bandwidth, high gain and good front to back ratio.
It is also necessary that fringing field which is co related with radiating edges of microstrip patch antenna is adjusted in theoretical analysis.

The effective length of coupling aperture is defined. In the result of smith chart of impedance is observed that only one loop is occurred and the desired resonant frequency passed through unit circle and it also shows the coupling between aperture and resonators.

Cavity provides high Q and which results improved gain. The measured and simulated data is compared in this paper.

(54) Research Paper [55].

This paper describes the multilayer structures and aperture coupling to enhance the couple power from feed line to patch antenna. It overcomes the difficulty of radiating geometries on high permittivity substrates.

The researchers are attracting towards microstrip patch antenna because of their application in phased array where active phase shifters and other component integrated on same dielectric medium. Some time it is difficult to implementing the structure on high dielectric constant.

Authors have gone through the literature review and according to them slot coupled microstrip antennas have narrow band characteristic and it can be overcome by proposed model. The proposed models in this paper claims to achieve good results by implementing stacked geometries.

It presents the design of stacked microstrip patch antenna coupled by slot which is having wide bandwidth. The future work of this paper can be extending for the phased array geometries.

(55) Research Paper [56].

This letter presents the technique to minimize the mutual coupling of adjacent patch element. The proposed model generates broadband circular polarization by stack patch
geometry it also present work on planar array of 4 elements. Structure resonates at 10 GHz and achieves good efficiencies.

As single patch antenna element has low gain but when it combines to form array structure, it provides high gain and which is useful for many applications. The proposed structure shows the high illumination efficiency which shows the proposed model is perfectly designed.

Result shows the low axial ratio by array, the overall radiation efficiency is greater than 75 %, the possible bandwidths achieved by various models are greater than 20 %. The result proves the proposed model resonates at desired frequency and provides high radiation efficiencies.

The mutual coupling of adjacent patch element is adjust so that the cumulative radiation is in desired direction. By varying the patch separation return loss is observed to be -25 dB.

(56) Research Paper [57].

To generate circular polarization in microstrip antennas there are many techniques are available. In microstrip patch antenna we can generate circular polarization by dual feed or single diagonally feed mechanism.

If we want to generate circular polarization in single feed mechanism the shape and size of patch antenna are different like: circular shape, square, corner chopped square, circular patch with notch etc. The main drawback of these antennas is small axial ratio bandwidth.

If we compare the single feed microstrip patch antenna to the dual feed, the excitation provides to square or circular patch antenna by two orthogonal points with same magnitude and 90 degree phase apart we achieve wider axial ratio bandwidth but still voltage standing wave ratio bandwidth is small.
This letter presents several stacked patch antenna configurations using circular or square patches which are proposed to increase axial ratio bandwidth as well as voltage standing wave ratio bandwidth with improved directivity.

The lower patch antenna is excited by two orthogonal feed points with same magnitude and 90 degree phase apart and another parasitic element circular or square patch is stacked to enhance bandwidth of whole proposed model. The results show that the proposed structure is having wider bandwidth and also generates the circular polarization.

(57) Research Paper [58].

This paper presents some designs of equilateral triangular microstrip patch antenna which generate circularly polarized wave. As compared to square or circular shape patch antenna the proposed equilateral triangular microstrip patch antenna has smaller size and still generates circular polarization.

To generate circular polarization there are different techniques are available which is presented in this paper like: cross slot implementation of unequal lengths , inserting narrow slit, proposed antenna with truncated tip or implementing tuning stub at center of the triangular patch.

These varieties of techniques are presented with results. This design also confirms the dual band operation which includes the GPS range of frequencies. Results show the gain is above 1 dB and input impedance is stable over the desired range of frequencies.

In this paper authors present the technique to improve the circular polarization in equilateral triangular microstrip patch geometry. This structure resonates on dual frequencies. The design also confirms the compactness of patch is maintained.