Article I.  Design of Patch Antenna for Identification of Mal Practicing in Examination

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Abstract. Malpractice is one of the serious issues faced in examination hall. The candidates will be examined thoroughly in the entrance itself. If they are found with possessing the electronic devices, the PGD (Paper Gadget Detector) will detect it. LCD (Liquid Crystal Display) displays the values and an alarm system will be used to give a warning to them. The proposed system is to search the candidates who are carrying the hidden written paper to the exam hall. The searching of hidden written paper can be obtained from Rectangular Microstrip Patch Antenna (RMPA). Here RMPA acts as a sensor which is used to detect the hidden material. This sensor can detect the target based on the permittivity value of each material. The sensors used in this study can be adjusted according to the values of blank paper and also to identify something written in the paper with different densities. The designed antenna has been simulated using Advanced Design System (ADS). The designed antenna (single element and 4 elements) has been compared in terms of various parameters like Gain, Efficiency, Directivity and Radiation Pattern etc.

Keywords: Paper Gadget Detector, Liquid Crystal Display, Rectangular Microstrip Patch Antenna

1. Introduction
Malpractice in examination is an act of cheating, i.e illegal action by students, violating the norms of examination to get through the exams. This affects the society in various facets like discouraging the hard work of other students, results in poor performances in jobs which affects the productivity, may involve in bribery and corruption etc., Even though there are some structural methods and arrangements been done to prevent examination malpractices, at times it is difficult to find out the people involved in it. Here we propose a RMPA design to find out the hidden papers or materials so that malpractices can be avoided to a greater extent.

2. Literature Survey
Syed An Nazmus Saqueb et al., (in 2018) proposed a rail-based Synthetic Aperture Radar (SAR) imaging system. Using a motorized linear stage, slanted object is scanned across the transmitter field of view and reflection is measured in frequency domain in two waveguide bands (220-325 GHz and 500-750 GHz). [8]. Jonathan T.Richard et al., (in 2017) used Synthetic Aperture Radar (SAR) that uses either moving platform or target to reconstruct images with higher spatial resolution. SARs operate at conventional microwave frequencies because of the high powers and sufficient bandwidth available to reconstruct large scenes over long distances more than 1km with resolution below 10 m. [4]. Joseph Landon Garry et al., (in 2015) proposed Practical Implementation of Stripmap Doppler
Imaging techniques which can generate 2D images. This method seems to be compatible in spectrally congested environments but the measurements can suffer from aliasing. [5]. A. Kannegulla et al., (in 2014) demonstrated coded-aperture imaging using the Hadamard coding. In this method the coded-aperture approach limits FOV. In spite of shortcomings, researchers for large scale applications suggest that large horizontal FOV can be achieved by combining multiple coded-apertures into a single hexagonal device. [1]. David Shrekenhamer et al., (in 2013) used Single pixel terahertz (THz) imaging technique which can work at non visible wavelengths. [2]. Gregory L. Charvat et al., (in 2008) designed a X-Band Rail SAR Imaging System which has high sensitivity in comparison with single-sideband radio receivers. [3]. R. Schneider et al., (in 2003) proposed and presented a high resolution vehicle based instrumentation radar for automobile application which performs on-line acquisition and real-time visualisation of radar images. This system has high computation efficiency, but limits data acquisition speed and also requires antenna pairs which make it suitable for stationery and slow moving targets. [7].

3. Proposed System
In the proposed system we use Microstrip patch antennas (low profile antenna mounted on flat rectangular sheet) are preferred over other antennas in today’s modern wireless communication systems for their compatibility to be fit in Mobile, Aircraft, Satellites, Radars and many more applications owing to its very small size. In designing the microstrip patch antenna, selection of dielectric substrate materials and thickness are the main parameters in terms of size and compactness. Apart from compactness RMP antenna proves to be worth in terms of bandwidth, directivity and gain. Three parameters required for design are resonant frequency, dielectric constant and height of the dielectric substrate material. An inset fed of a rectangular patch antenna is designed to match the patch with a 50Ω microstrip transmission line. [6] The antenna with design dimensions is presented below in figure 1.

![Antenna Design Dimensions](image)

**Figure 1.** Antenna Design Dimensions

4. Simulation Results of RMP Antenna
The RMP Antenna Design is shown in Figure 2 and Simulation outputs are presented in this section in Figures 3 to 11 respectively.
The above figure 3 shows the current distribution of RMP antenna has maximum value at centre while current is zero at the edges.

The above figure 4 presents the S-Parameters (S11 return loss value of -18dB) of RMP antenna.
Figure 5. Gain

Figure 6. Efficiency

Figure 7. Directivity
Figure 8. Electric Far Field

Figure 9. Polarization

Figure 8 illustrates the Electric Far Field and Figures 9 and 10 presents Polarization output and Radiation Pattern respectively.
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5. **Simulation Results of 4 RMP Antenna Elements**
The 4 element RMP Antenna Design is shown in figure 12 and Simulation outputs are presented in this section in Figures 13 to 25 respectively.

![Antenna Parameters](image)

**Figure 11. Antenna Parameters Summary**

| Parameter                           | Value       |
|-------------------------------------|-------------|
| Frequency (GHz)                     | 3.50202     |
| Input power (Watts)                 | 0.00245835  |
| Radiated power (Watts)              | 0.00127667  |
| Directivity (dBi)                   | 6.66405     |
| Gain (dBi)                           | 3.81841     |
| Radiation efficiency (%)            | 51.9321     |
| Maximum intensity (Watts/Steradian) | 0.000471276 |
| Effective angle (Steradians)        | 2.70897     |
| Angle of U Max (theta, phi)         | 0 270       |
| E(\theta) max (mag, phase)          | 0.595881 -7.45764 |
| E(\phi) max (mag, phase)            | 0.00373044 29.3552 |
| E(x) max (mag, phase)               | 0.00373044 29.3552 |
| E(y) max (mag, phase)               | 0.595881 172.542 |
| E(z) max (mag, phase)               | 0 180       |

**Figure 10. Radiation Pattern**
The above figure 13 shows the current distribution of 4 RMP antennas.

The above figure 14 presents the S-Parameters of 4 RMP antennas. (S1,1 - 19.80dB, S2,2 - 19.92dB, S3,3 - 19.57dB, S4,4 - 19.12dB)
Figure 15. Gain of 4 Elements

Figure 16. Efficiency of 4 Elements

Figure 17. Directivity of 4 Elements
Figure 18. Electric Far Field of 4 Elements

Figure 19. Polarization of 4 Elements

Figure 18 illustrates the Electric Far Field of 4 elements and figures 19 and 24 presents Polarization output and Radiation Pattern of 4 elements respectively.
Figure 20. Mutual Coupling between Antenna 1 and other antennas

Figure 21. Mutual Coupling between Antenna 2 and other antennas

Figure 22. Mutual Coupling between Antenna 3 and other antennas
Figure 23. Mutual Coupling between Antenna 4 and other antennas

The Figures 20 through 23 illustrates the Mutual coupling between 4 antennas.

Figure 24. Radiation Pattern of 4 Elements
The simulated results show that Gain of single element RMP antenna is 3.81 dBi (presented in Figures 5 and 11 respectively) and Gain of 4 elements is 7.0 dBi (presented in Figures 15 and 25 respectively). Similarly Efficiency of single element RMP antenna is 51% (presented in Figures 6 and 11 respectively) and Efficiency of 4 elements is 65.2% (presented in Figures 16 and 25 respectively). Further Directivity (to measure the degree to which the radiation is emitted in a single direction) of single element RMP antenna is 6.66 dBi (presented in Figures 7 and 11 respectively) and Directivity of 4 elements is 8.89 dBi (presented in Figures 17 and 25 respectively). Mutual coupling describes the energy absorbed by one antenna’s receiver when another adjacent antenna is operating. The RMPA design with 4 elements provides mutual coupling parameters as shown in the above graphs specified. The coupling values between the antennas lie well below -10dB for all its adjacent antenna elements thereby exhibiting no interference issues by the same or the nearing antenna element. This is in turn helps antennas to work with high directive beams at the finest point to be located. Further, beamforming techniques and beam switching characteristics deployed to the antenna help in achieving precise beam points to focus on the highly required spot figuring the position of the ink identification on the paper material.

6. Conclusion and Future Scope
Initially single RMP antenna has been designed for a frequency of 3.5 GHz and the results such as Gain, Efficiency and Directivity are 3.81 dBi, 51% and 6.66 dBi respectively. To further enhance the performance of antenna, the design has been extended to 4 elements and the results such as Gain, Efficiency and Directivity are 7.0 dBi, 65.2% and 8.89 dBi respectively. This antenna can be used in the system to find hidden papers using Vector Network Analyzer. The result is determined by the rise or fall of wave found in receiver of antenna. Implementation using Antenna is Cost Efficient.
7. References

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