**RAJSHAHI UNIVERSITY OF ENGINEERING & TECHNOLOGY**
**OFFICE OF THE MEMBER SECRETARY**
**THE COMMITTEE FOR ADVANCED STUDIES & RESEARCH (CASR)**
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**Date**: 10/07/2021

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**6. Date of First Enrolment in the Programme:**

**7. Tentative Title:**
PERFORMANCE ANALYSIS OF TEXTILE ANTENNAS FOR BODY WORN APPLICATION.

**8. Background and present state of the problem**

In today's world, cell phones are carried by humans almost all the time as with this they not only can make a phone call but also can access the internet, use personal digital assistant (PDA), and take the help of Global Positioning System (GPS). This type of "always on" and "always connected" status is a step in the direction of extensive computing. Because of its widespread availability, the 2.45 GHz ISM unlicensed band is used for the development of wearable antennas. To be used as wearable antenna, it should be compact, lightweight, bendable without changing shape, and radiate away from human body. For the easiness of the user, wearable antennas need to be hidden, flexible, and of low profile. This necessitates a possible integration of these antenna elements within regular apparel. Because it can be made conformal for integration into clothes, the microstrip patch is a good contender for any wearable application. Material choices of the antenna can be specified depending on criteria such as the application (indoors or outdoors), frequency, and seamless integration into the user's attires. As antennas require a low-loss dielectric and highly conductive materials for effective EM radiation reception and transmission, highly conductive materials such as copper, conductive fabrics are being used and Substrates made of flexible polymers like Kapton, PET, PEN, PANI, liquid crystal polymer, organic material, ferrite magnetic materials, textiles, and paper, on the contrary, are ideal choices because of their flexibility [2]. A wearable patch antenna differs from a traditional patch antenna in that the substrate is composed of textile fabric with a low dielectric constant or relative permittivity, which reduces surface wave loss and enhances impedance bandwidth. When compared with traditional MPAs, a wearable microstrip patch antenna that is easily integrated in cloths [1] with a metallic ground plane positioned between human bodies and radiating elements can considerably minimize EM energy absorbed by a human body. A certain amount of research works has been presented in the literature. For the development of wearable antenna, by using the microstrip patch radiator concept and resonance method, the accurate value of the dielectric constant of the fabric material was determined in paper [3]. Substrate thickness and dielectric constant play an important role to improve the efficiency and bandwidth. S. Sankaralingam [4] studied the development of a coaxial probe feed rectangular microstrip patch antenna (RMPA) using textile substrate and IE3D software at 2.45GHz frequency for on-body wireless communication. The bandwidth achieved by those antennas was greater than the ISM (Industrial, Scientific, and Medical) bandwidth of 85MHz. In [5], performance analysis and comparison between fixed and flexible dielectric substrate materials have been presented and from the study, it was found that flexible substrate materials provided a better gain and return loss to be used in ISM band application. The authors in [6] presented an aperture coupled patch antenna made out of textile flexible material which was integrable into wearable textile systems for body and personal area networks operating in the 2.45-GHz ISM band. Using Keysight Advanced Design System (ADS) software, an edge feeding rectangular MPA was simulated where ShieldIt Super and jeans fabric was used as conductive layer and substrate respectively in [7]. The researcher(s) found a good antenna radiation performance and impedance matching. [8], represented simulation of line feed and coaxial feed RMPA that used wash cotton, curtain cotton, polycot, and polyester as substrate using HFSS and demonstrated that the RPMAs with polyester substrate provided better return loss, gain, and directivity compared to others. The paper [9] highlights the bending performance of wearable RMPA whose substrate was made from denim textile, and the conducting layers were made from a copper and nickel-plated polyester fabric. When compared to a flat antenna structure, the analysis indicated that the bending curvature had a substantial impact on gain and overall radiation pattern.

**9. Justification of the study**

Predominantly, flexible and wearable technologies are being integrated into regular activities to broaden the quality of life. Several approaches (such as changing antenna shapes and sizes, substrates material and thickness, feeding techniques etc.) have been taken by the researcher so far to improve the antenna parameters (e.g., return loss, VSWR, directivity, gain, bandwidth, radiation efficiency). A good number of progresses has been achieved in wearable antennas so far but there is still ample of scopes to develop them more by further study and better characterization of MPAs.

In this proposed work, microstrip patch antennas will be designed as the developed wearable antennas mostly are planar, they mostly radiate perpendicularly to the planar structure and their ground plane efficiently protects the human body. Wearable MPAs with different shapes (such as rectangular, elliptical, circular, seljuk star, eight-point star etc.) and textile substrates (wash cotton, curtain cotton, polycot, and polyester) will be designed and simulated in flat and bend condition using CST MWS to ensure better results than the previous works done so far using these mentioned substrates. For safety consideration of human health, the specific absorption rate (SAR) will be measured also.

**10. Objectives with specific aims**

The prime objectives and aims of the proposed work are__

- To design and simulate different shaped flat and bended textile MPAs at 2.45 GHz using four types of fabric substrate materials (wash cotton, polycot, curtain cotton, and polyster) for on body wireless communication.
- To improve several antenna parameters by optimizing the size of antennas.

- To estimate the utmost SAR in human body from the wearable MPAs.

## 11. Outline of Methodology

Theoretical and systematic analysis of approaches used in a proposed study is termed as methodology.

- Study of textile antenna for body wearable application.
- Study on antenna requirements and operating frequency.
- Study literatures of MPAs and existing wearable antennas.
- Study on MPA design process using CST Microwave Studio.

## 12. Design Procedure:

- To begin, single element rectangular MPAs will be developed to function in the 2.45 GHz band using the fundamental equations for designing MPAs, a practice called as equation-based antenna design.
- The design will be stored and simulated; if the antenna matches the criteria, the result will be recorded.
- Optimization (such as size reduction, shapes) of the MPAs will be done for better performance (e.g., return loss, VSWR, directivity, gain, and efficiency).
- The optimized structures will be saved for further simulation to get improved antenna parameters.
- Specific Absorption Rate (SAR) of the antenna at 2.45GHz will be analyzed too.
- Lastly, a comparison among the antennas of different shapes and substrates will be done to conclude which MPA(s) give better outcome in terms of antenna parameters.

## 13. Expected outcome

- The return loss and Voltage Standing Wave Ratio (VSWR) improvement will be ensured for better impedance matching with the transmission line than those of the existing MPAs.
- A better directivity, gain, radiation efficiency, and bandwidth will be obtained by the proposed shapes of the antennas and their optimization to use them for the desired application.
- The SAR will be in the prescribed value to ensure human health safety

## 14. References


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