DEVELOPMENT OF A PLANAR SENSOR FOR MONITORING ORTHOPAEDIC HEALTH

Antony Christen Varun Miranda, N.Arun Palanikumar, G.M.Jagan
Under the guidance of Dr.S.Esther Florence, Associate Professor, Dept. of ECE
SSN College of Engineering

ABSTRACT

The work presented in this paper deals with the design and development of a microstrip patch sensor for orthopaedic treatment. Here, the reflected EM waves obtained by application of microwaves in bones were analyzed and the cracks had been detected if present. The sensor was optimized for resonance at a frequency of 2.45GHz, with a reasonable return loss. This method involved illuminating the targeted bones with propagating electromagnetic waves using a patch sensor and then we synthetically analyzed the reflections from the target using a network analyzer. As a result, we measured the shift in the return loss of the radiating sensor and utilized it to monitor the changes in the bone and its orientation.

PUBLICATIONS

This paper has been presented at the National Conference on Science Engineering and Management (NC-SEM) and has been selected as the best paper in the conference held at Chennai on 20th March 2016. This paper is also accepted for the publication in the IRF Journal.

CONTACT

Antony Christen Varun Miranda
9176014005 | varun.miranda@gmail.com
N.Arun Palanikumar
8903454031 | arun230195@gmail.com
G.M.Jagan
9566303961 | gmjagan128@gmail.com

INTRODUCTION

Osteoporosis is a condition where there is a reduction in the density of the bone. Lack of consumption of Vitamin D, mainly Calcium brings about the brittleness in the bones which eventually leads to these fragile bones cracking under their own weight. In order to effectively detect osteoporosis we use a microstrip patch sensor which uses a scattered microwave radiation. By operating it in a microwave frequency range, this allows us to decrease the size of the antenna in order to enable us to use it in wearable and line of sight technology. Wearable antennas extend the applications of textile materials in the field of wireless bodycentric sensing systems. The excellent performance of these materials at microwave frequencies, flexible nature, durability makes them highly preferable as a substrate for the wearable sensors.

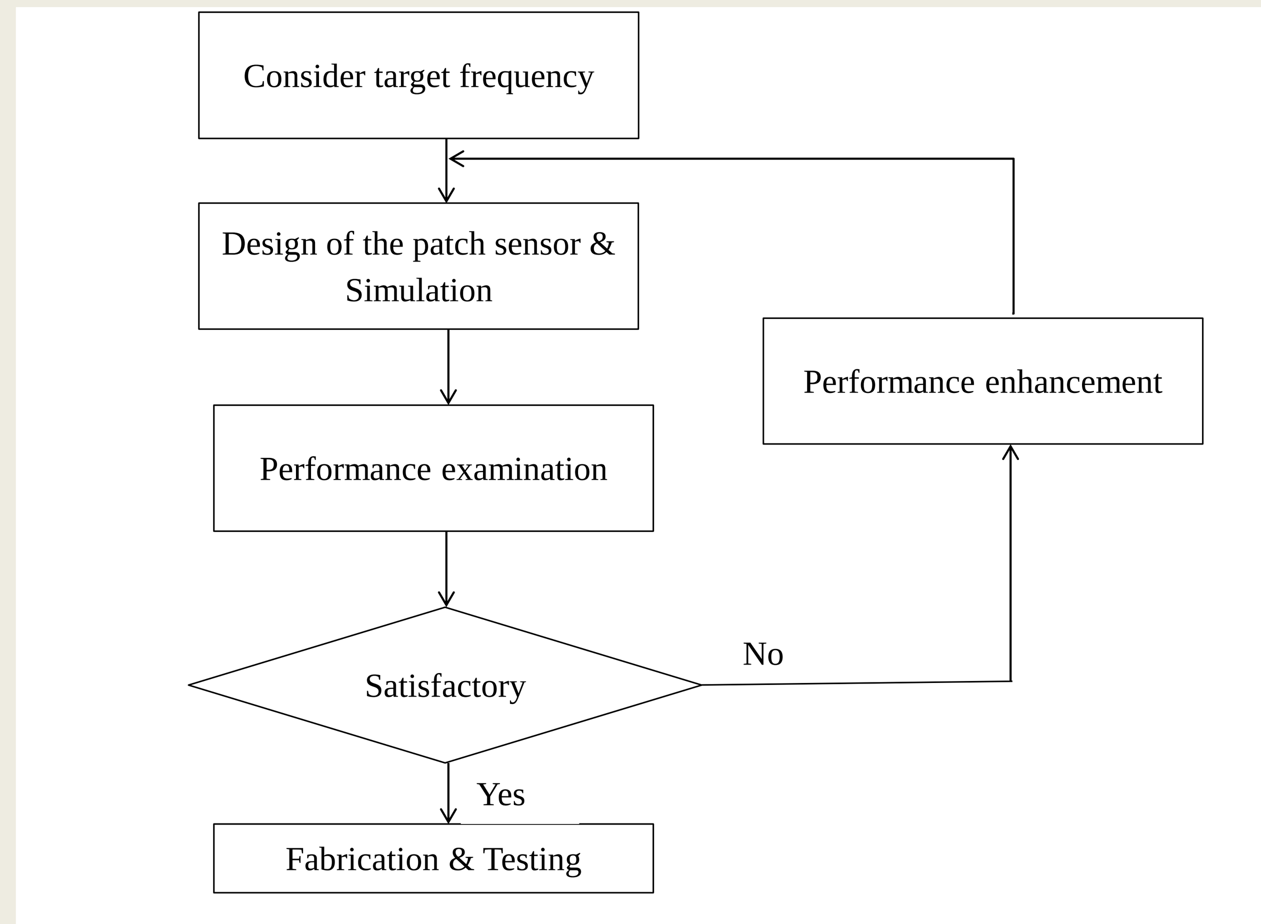
MOTIVATION

1. Osteoporosis are noticeable after 30% to 40% of bone mass loss leading to severe fractures in the bones especially among women of above 40 years of age.
2. Sometimes, X-ray will be unable to detect wrist fractures, hip fractures (in older people) and stress fractures.
3. X-ray imaging, CT scan, MRI scan etc. is not a wise thought in the case of osteoporosis as it delivers high doses of radiations and its unhandy in nature.
4. Hence, it is recommended to adopt an alternative to diagnose bone defects, thereby improving the efficiency and eliminating the disadvantages of traditional methods.

OBJECTIVE

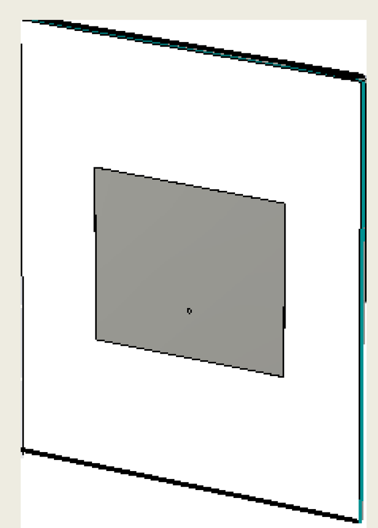
1. The developed prototype of a planar sensor has to detect imperfections in the bones and to diagnose osteoporosis.
2. To fabricate the developed prototype using wearable technology and to make it applicable for orthopaedic treatments.

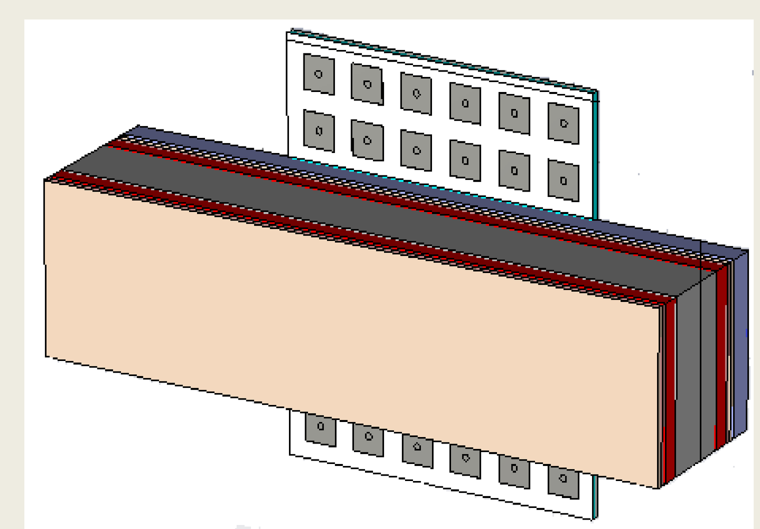
FLOW CHART



DESIGN OF SENSING ELEMENT

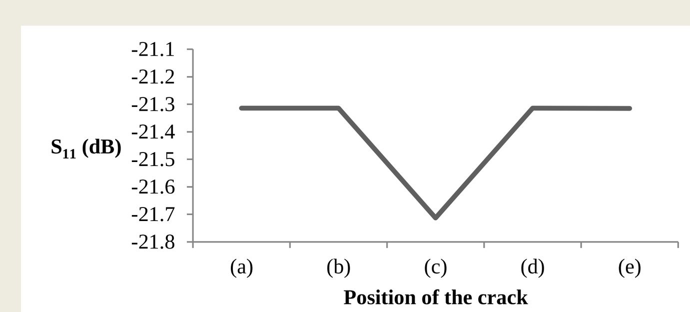
The sensor is designed to operate in the frequency of 2.45GHz. The designed sensor is shown in figure below and then the sensor is optimized using the EBG structure and the truncated arm is then placed in front of the optimized sensor.

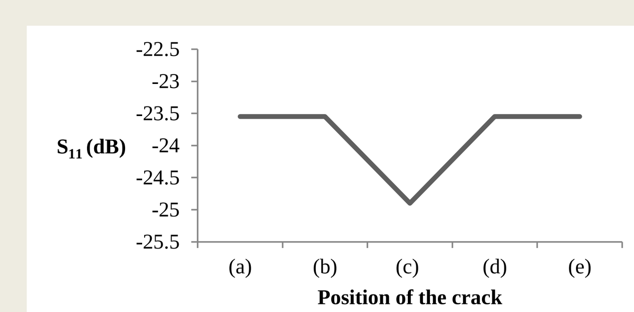




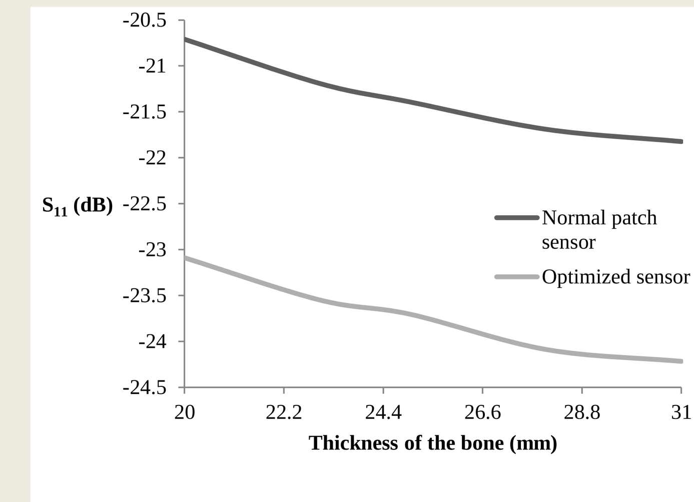
RESULTS AND INFERENCE

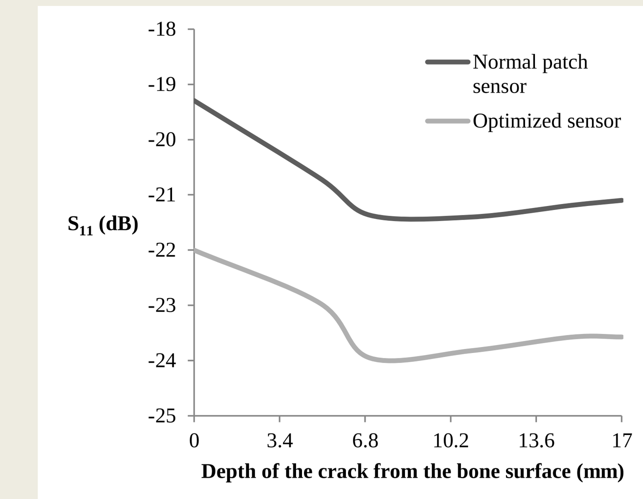
The sensor with bone model in front of it is excited and database is created in different scenarios.

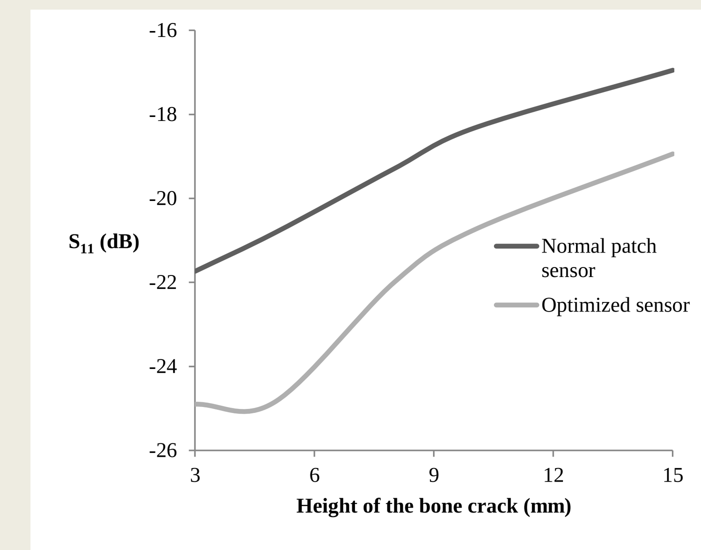


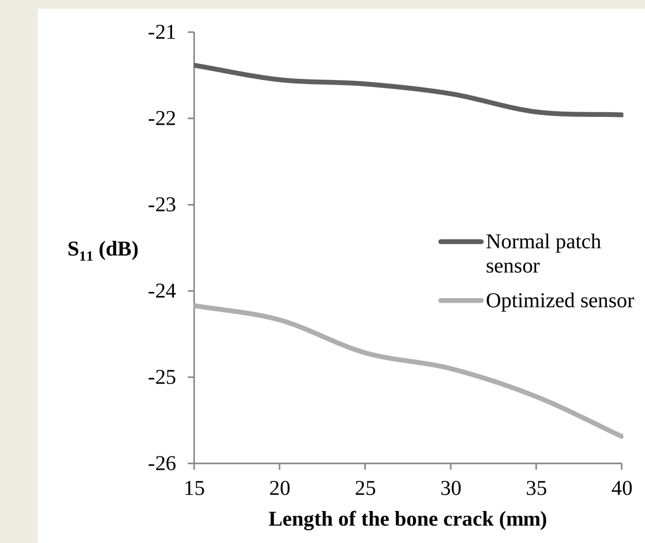


Plot between position of the crack and S_{11} (dB) for the normal and optimized patch sensor respectively









These experimentations demonstrate that the return loss are shifted with respect to the different thicknesses of the bone or with respect to different depths, height, length of the bone crack.

CONCLUSION & FUTURE WORK

The patch sensor can therefore detect the presence of a sub-millimeter crack with high resolution. This work will allow us to develop a microwave imaging system which will allow to localize the cracks inside the bones remotely using the antenna scanning system. It is validated that the patch antenna sensor have great potential to serve as wireless crack detecting sensor in orthopaedic treatments. This method of using the planar sensor for detecting bone cracks can also be extended in detection of tumours, characterization of bone tissues, etc.

REFERENCES

[1] Geetha Chakaravarthi and Kavitha Arunachalam, "A Compact Microwave Patch Applicator For Hyperthermia Treatment of Cancer, " IEEE Transactions on Microwave Applications, pp.5320-5322.
[2] Tata U, Huang H, Carter R L and Chiao J C, Exploiting a patch antenna for strain measurements, *Meas. Sci.Technol.*, vol. 20, (Jan.) 2009, pp 1-7.
[3] Mabao Liu, Binbin Li and Hao Li, "A Crack Monitoring Method Based on Microstrip Patch Antenna," IEEE Transactions on Antenna and Propagation, April 2015.
[4] Peter S.Hall, Yang Hao, "Antennas and Propagation for Body-Centric Wireless Communications," Artech House Inc, 2006.