Industry Day Theme # 2: Sustainable Medical Technologies

Wearable UWB Technology for Biomedical Applications: Localization/Tracking/Motion Detection

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Abstract

Ultra wideband (UWB) radio is a promising technology for high precision indoor positioning where "everybody and everything" is connected by different types of communication links: human to human, human to machine, machine to human, and machine to machine. The human body is a complex medium from the radio propagation perspective and hence, is essential to understand and characterise the effect of the human body on the antenna characteristics, the radio propagation channel parameters and the overall communication.

A compact, simple and efficient UWB body centric communication system has been designed for sub centimetre 3D positioning and tracking accuracy of the human activity for healthcare applications. The focus has been to track the movements of limbs and position of the human body in an indoor environment in static and dynamic state with high accuracy and precision.

Introduction

Wireless body area networks (WBANs) has attracted significant interest in research and development related to various IOT and 5G applications in the field of healthcare domain.

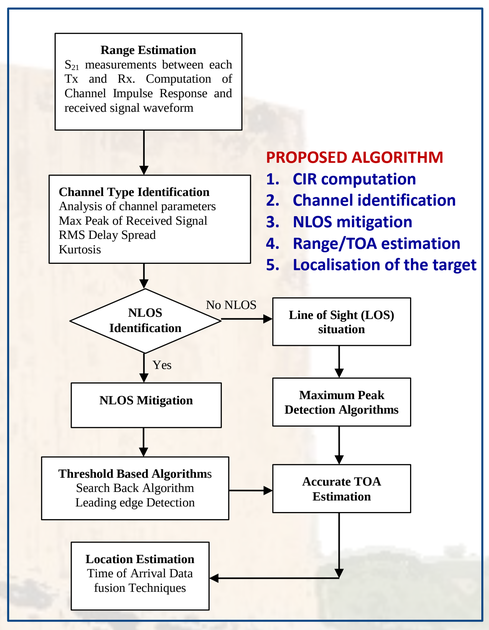
The ongoing miniaturization of wireless sensor devices, sophisticated signal processing algorithms and several technologies available, wearable devices have become a reality and are catering to various needs such as health monitoring, localisation, motion tracking, detection and smart homes.

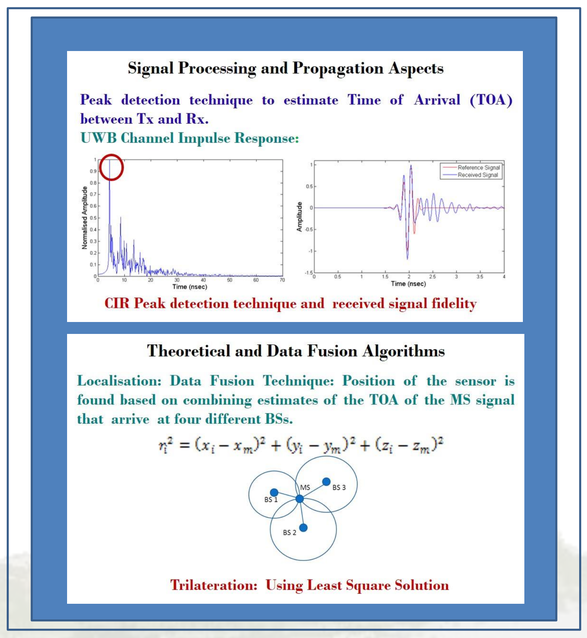
Ultra-wideband (UWB: 3.1 GHz to 10.6 GHz) communication is one promising technology for WBANs

Features:

Ultra-short pulses	Compact antenna design
Low cost/low power	Low hardware complexity
Integration with other technologies	High data rate
Fewer effects on human	Penetrating through various obstacles

Methodology





Conclusion

The work has scientific, technological, commercial, societal and strategic importance as significant contribution has been made in the field of body centric wireless communication. The proposed algorithms and system related parameters has achieved up to sub-cm localisation accuracy during indoor tracking and performing physical exercises related to health care, sports, rehabilitation, yoga and day-to-day activities.

Industrial Significance

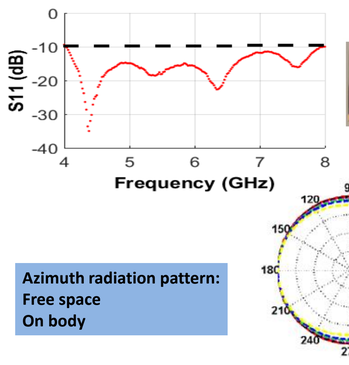
The present work carried out is of immense importance for design and development of a compact, simple, efficient, low cost, low power UWB body centric communication for sub centimetre 3D positioning and tracking accuracy of the human activity and general fitness exercises.

Technology Readiness Level

- **In depth channel characterisation of various body-centric links such as on-body, off-body, body-to-body to aid the tracking and localisation algorithms.**
- **Techniques for assessing the movements of limbs and position of the human subject and object localisation in an indoor environment in static and dynamic state with high accuracy and precision**

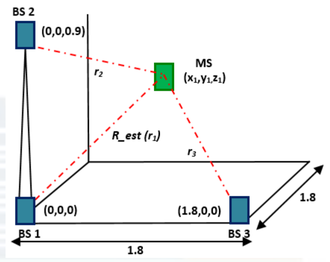
Results

Designed and fabricated miniaturised UWB antennas using GML 60 mil, 3.2 permittivity substrate.

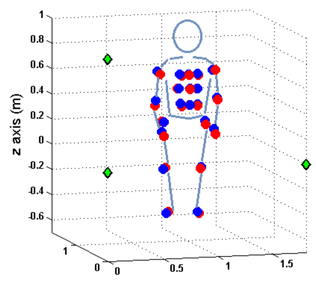


Very Compact Wearable UWB Antenna Size: 12X18 mm²

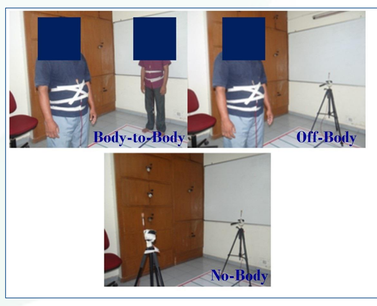
Compact L-Shape Base Station Configuration

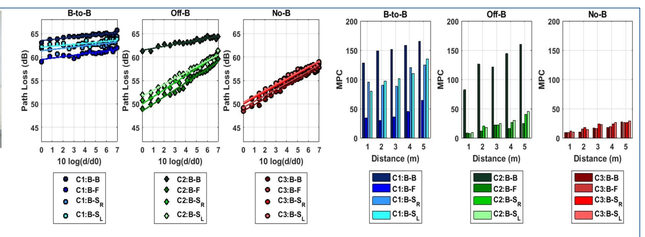


- **2D plane, 3BS configuration instead of conventional 3D plane, 4BS configuration.**
- **Decreases occupancy volume needed to achieve accurate position.**
- **Less complexity for installing the localization system.**
- **High accuracy (1-3 cm) 3D Cartesian and Directional information.**
- **Suitable for various body-centric applications.**



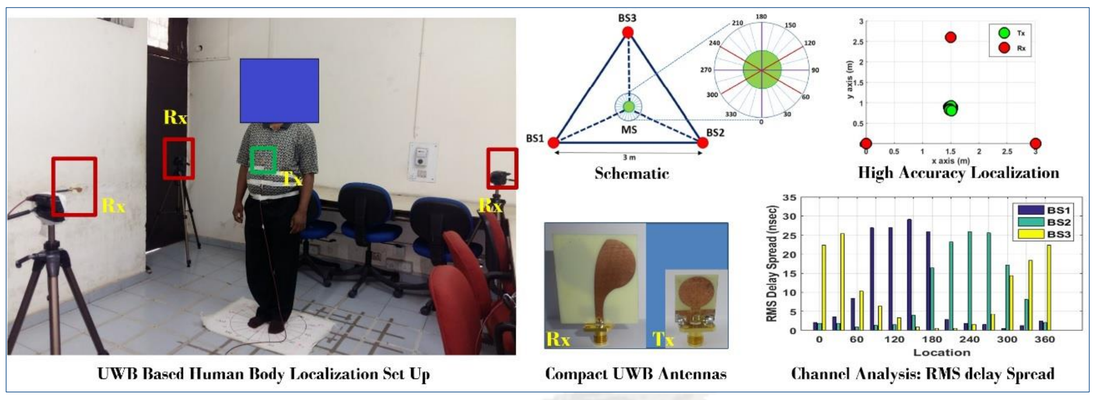
Channel Characterisation





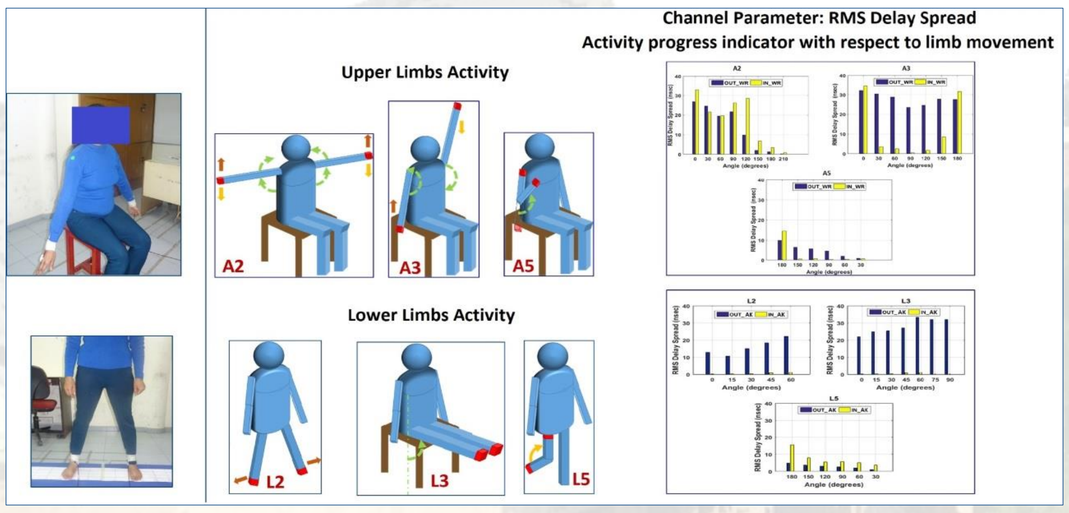
Path Loss Magnitude vs. distance and Number of Multipath Components vs. distance for various communication links. C1:body-to-body, C2:off-body and C3:no-body. Tx-Rx Body Positions: Tx:(B)-Rx:(F/B/S_R/S_L). F/B/S_R/S stands for Face/Back/Side Right/Side Left orientation.

Indoor Human Body Localization



UWB Based Human Body Localization Set Up | Compact UWB Antennas | Channel Analysis: RMS delay Spread

Physical Exercises Monitoring & Assessment



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