ABSTRACT

In most of the healthcare sectors, such as monitoring of elderly, disease prevention and rehabilitation, an engineering approach provides numerous advantages. This study aims to make contributions to the advancement in the wireless and MEMS technology for the chronic patients, sports persons and common people. There are many existing medical monitoring systems using specialized equipment which could send data using either standard telephone lines or specially designed network for medical applications. However, these systems are not location independent and in most cases, they are clumsy in nature due to the use of wired sensors. The Wireless Body Area Network (WBAN) is a key technology which supports this field effectively. The sensor node is either wearable or implanted inside the human body and the critical issue is energy efficiency.

The main objectives of the study are to design an energy efficient communication protocol to transmit and receive the medical datum in an efficient way, to propose a low power architecture for the implantable medical devices in the MICS Band and to test the algorithms in a real hardware for evaluating the energy efficiency, latency, and mobility requirements which revolutionize healthcare system. The design of

communication protocol includes both the medium access and routing protocols. Here, the medium access should be performed in an energy efficient manner and the routing protocol must be capable of routing the medical information to the internet. In order to increase the comfort level, the algorithms should support mobility.

In this research work, different modules are proposed to effectively transmit the health information about human being. At first a modification in the IEEE 802.15.4 superframe structure is performed in order to make it compatible for Wireless Body Area Network. As most of the data is sent only in the guaranteed time slots, it has the inherent advantage of saving power. The modification in the response time accounts for lower end to end delay. The existing on demand routing protocol, namely the Dynamic Source Routing (DSR) has been modified to support the power and delay requirement and the performance is analyzed with the proposed Medium Access Control (MAC) protocol. From the results, it is concluded that the cross layer design of networking layers proves as the most promising alternative to inefficient traditional layered protocol architectures.

A Medium Access Control (MAC) protocol decides when competing nodes access the radio channel and tries to ensure that no two nodes are interfering with each other’s transmissions. In the second module,

the development of an energy efficient MAC protocol is done exclusively for WBAN by modifying the existing low duty cycle XMAC. The results show that for an optimum value of announcement size, the percentage of radio usage decreases by 7% confirming the reduction in power consumption. The work has been implemented in real time using TelosB motes with biological sensors after careful analysis.

The sensed data are transmitted wirelessly through the route defined by the routing protocol which supports Internet Of Things (IOT). The IETF's work group of routing over low power and lossy network develops the Routing Protocol for Low power and lossy networks (RPL) based on IPv6. RPL forms paths towards roots based on one or more metrics. From the analysis, it is shown that RPL is a suitable protocol for WBAN in terms of throughput, power, and packet loss.

The challenges faced when dealing with mobility are increased power consumption and frequent change in the coverage range. This phenomenon causes the sensor nodes to disconnect. These issues are resolved by optimizing the RPL and MAC parameters using Cooja simulator in Contiki OS. The parameters should be jointly optimized to support mobility. For modelling the human mobility in the hospital environment, the RPGM mobility model has been used. The performance of RPL is analysed using the performance metrics packet delivery ratio and

energy consumption by varying the RPL parameters like DIO_Interval_ Doubling, DIO_Interval_Min together with the MAC parameter channel check rate and the CCA. The designed parameters provide twice the packet delivery ratio compared to the default protocol parameters.

The final contribution of this study is for the implantable medical transceivers. The RF front-end transmitter and receiver suitable for implantable medical applications has been implemented using Cadence tool with 0.18 µm CMOS process technology at 1 V supply voltage. The techniques such as a current reuse principle, folded approach, and resistive source degeneration are incorporated to achieve low power consumption and better linearity performance. The transmitter consumes 900 µW with good linearity and the receiver consumes 485 µW of power. Overall, these technologies aid the pervasive health monitoring.