

Preface

The modern world has been evolving through remarkable changes in all aspects of life. The technological advancements in the era of information and communications technology (ICT) have connected people from various regions so gracefully as if they are living together in a virtual global village. The open market economic infrastructures of the world bring healthy people mobilities, cultural infusions and improved living qualities. The consequence is the rising economic power and eradication of poverty in the Eastern nations, and the complex socio-political equations between the Eastern and Western worlds. With the advent of new technologies and economic prosperities, a large pool of middle-class people can effort many new amenities. As consequences, lifestyles have changed, and the physical activities have reduced enormously with the advents of mobile communications gadgets, easy accesses to private cars, entertainment activities, the Internet and social media.

To maintain the high living standards of the current era, the lives of people have become more busy and stressful. The lifestyle and stress-related diseases such as sleep deprivations, diabetics, blood pressures, cancers, heart attacks and strokes have emerged as the most killing factors. These lifestyle diseases were very uncommon in our previous generations because they were physically more active and less stressed. Even the children are not immune to lifestyle diseases. In recent decades, living in nuclear families and less physical activities among children have become very common due to easy access and the popularity of mobile gadgets, TVs and Internet. Therefore, sleep apnoea is very common in children too. One of the main goals of the current research was to develop wireless sleep apnoea monitoring system targeting the pediatric patients.

Prolonged sleep deprivation and sleep disorder can cause many diseases as stated above. It also affects the mental health of a person and a child severely. Therefore, sleep monitoring in an early stage is imperative to stop the high risk of these killing diseases.

Sleep monitoring is a complex exercise. To understand the cause and effect of the sleep disorder, at least 11–22 physiological parameters of a patient are needed to be measured. That is why sleep test of a patient in a sleep laboratory may cost more than a thousand dollars. The second important factor of identifying the sleep disorder is to measure these physiological parameters in a patient's natural sleeping condition. In a laboratory setting, with many wires of the monitoring devices attached to the patient in the bed of a sleep laboratory, a patient cannot provide the natural sleep pattern. Even this is more serious for paediatric patients due to the fear factors of tangling with many wires and electronic gadgets attached to the body. The best solution is to develop a wireless sleep monitoring system that is easy to retrofit with the garment. The patient can take it home and sleep in his/her bed. The solution is also cheap as it will not involve any laboratory setting and presence of nurses and doctors. With the cloud computing interface, the doctor and nurse can download the data at ease and interpret the results. The current book has augmented the vision of telemedicine by developing a microwave wireless sleep monitoring system that is easily mountable to the patient's body without any wire. A local base station gathers the physiological data from the patients during his/her regular sleep in his/her own bed, and transmits the data via the WiFi and/or mobile phone communications networks to the doctor and nurse. The doctor and nurse can download the sleep monitoring data for further processing.

The book has two main hypotheses: (i) developing a wireless microwave frequency dot, also called wireless microwave frequency transducer that collects the heart rates in term of electrocardiogram (ECG) data, muscular activities in term mechanomyogram (MMG) and brain activities in term of electroencephalogram (EEG), and (ii) advanced-level signal processing called virtual multiple input multiple output (MIMO) algorithm to enhance efficacy of the system by reducing noise and interferences in the on-body wireless propagation channel. This book covers four major areas so that a general reader who is not expert in the fields of microwave engineering, antenna technologies, signal processing and even medicine, can be benefited. The book includes the general background of wireless monitoring technology and MIMO in wireless body area network (WBAN), microwave hardware designs, virtual MIMO in WBAN, hardware system-level implementation and field trials.

Australian Research Council (ARC) supported the project under the scheme of the prestigious nationally competitive Linkage Project Grant *LP0776796: Radio Frequency Wireless Monitoring in Sleep Apnoea (Particularly for Paediatric Patients)*. The project was partially sponsored by Regni Health and Sciences Pty. Ltd, Melbourne, Australia. Completion of two PhD-level research projects exemplifies the significance of the research outcomes of the ARC Linkage project. The research outcomes are: (i) the state-of-the-art 2.4/5.8 GHz wireless microwave frequency transducer design from scratch for ECG/MMG/EEG signal capturing, (ii) propagation modelling of 2.4/5.8 GHz around the patient's body, (iii) spatial

diversity test of MIMO antennas using Alamuti coding, and finally, (iv) virtual MIMO cooperative network for energy efficient transmission/reception of wireless body area network (WBAN) signal. We conducted a successful demonstration of the wireless monitoring system in front of the industry sponsor in June 2013. We believe that the microwave engineers, antenna technologists, signal processing experts, biomedical engineering professionals and students, and the doctors and nurses of the sleep apnoea laboratories will accept the book very well.

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