Research interest

Currently involved with the following research projects:

1. Smart Home based on Wireless Sensors Network for Elder Care

Research on wireless sensors and sensor networks, especially for in-home monitoring of elderly people, are under consideration. The requirements of the sensor for making a smart sensor network are investigated. The aim of this research is to give develop a smart home for elderly people who need to be constantly monitored for health and safety reasons. Many elderly people dread the idea of being forced to live with their adult children, or in a rest home or in other sheltered living arrangement. They want to live independently and keep control of their own lives. Yet at the same time they know there is a high risk of injury or even death because of a fall or stroke. With the population aging in most developing countries, there will be more and more elderly people living alone in future. Such people need to be monitored continuously and provided with immediate medical help and attention when required. The cost of hospitalization is ever increasing, so is the cost of rehabilitation after a major illness or surgery. Hospitals are looking at sending people back as soon as possible to recoup at home. During this recovery period several physiological parameters need to be continuously measured. Hence telemedicine and remote monitoring of patients at home are gaining added importance and urgency. There are a lot of design issues involved which are currently under investigation.

2. Zigbee Based Wireless Physiological Monitoring System

As a part of the smart home a wearable device has been developed to monitor physiological parameters (such as temperature, heart rate, fall) of a human subject. The system consists of an electronic device which is worn on the wrist and finger, by an elderly or at-risk person. The system can be used by normal person as well for the monitoring of physiological parameters. Using several sensors to measure different vital signs, the person is wirelessly monitored within his own home for a smart home. An accelerometer has been used to detect falls. The device can monitor the stressed condition of the person and sends an alarm to a receiver unit that is connected to a computer. This sets off an alarm, allowing help to be provided to the person. Since no vision sensors (camera or infra-red) are used, the system is non-invasive, respects privacy and will find wide acceptance. The system can be used in combination of the bed sensor (part of the home monitoring system) to monitor the person during the night.


A novel planar interdigital sensor based sensing system has been developed for detection of dangerous marine biotoxins in seafood. Our main objective is to sense the presence of dangerous contaminated acid in mussels and other seafoods. Initial studies were conducted with three peptide derivatives namely Sarcosin, Proline and Hydroxylproline. These three chemicals are structurally closely related to our target molecule. The proline molecule is arguably the most important amino acid in peptide conformation, contains the basic structural similarity to the domoic acid. Three novel interdigital sensors have been designed and fabricated. The initial results show that
sensors respond very well to the chemicals and it is possible to discriminate the different chemicals from the output of the sensor. The outcomes from the experiments provide chances of opportunity for further research in developing a low cost miniature type of sensors for reliable sensing system for commercial use.

4. Sensing System based Pathogen detection in meat

Sensing system is planned to be developed to detect different dangerous pathogens in meat. The system will provide first hand information report of the existence of pathogen so that rigorous testing can be carried out in laboratory.

5. New planar electromagnetic sensor for detection of nitrates in natural water sources

A novel sensor based on the combination of meander and interdigital planar electromagnetic sensors has been developed for monitoring the level of contamination in water sources. Sensor modelling has been accomplished using COMSOL. A series of experiments was conducted to determine the sensors characteristics. Two nitrates forms namely, sodium nitrates and ammonium nitrates of different concentration between 5 mg and 20 mg dissolved in 1 liter of distilled water were use to observe the sensor response. Initial results show that the sensor can acceptably detect the presence of nitrate in any samples as shown from the calculation of complex relative permittivity. Furthermore, the sensor response seems to be independent of pH in the pH range of 2 and 9. Water samples taken from various sources and locations have been tested with the sensor and the results was compared with the results obtained using nuclear magnetic resonance (NMR) show a good correlation of the interdigital output with the total amount of organic materials where the ionic strength of the water sample was also estimated. The work and improvement are under consideration.

6. Wireless sensors based smart weather station

A wireless platform based on zigbee communication protocol is under development which will collate data from different wireless nodes located in distributed environment. One of the application is to develop a smart weather station where the sensors provide different weather related parameters such as temperature, humidity, pressure, rain-fall, wind-flow and so on.

7. Novel Sensing Technologies and Instrumentation in Environmental Climate Change Monitoring

The proposed project represents a synergy of the expertise of five Higher Education Institutes from four different countries building on their complementary expertise to improve the knowledge, awareness and skills of students undertaking Engineering programmes at undergraduate (Bachelors and Postgraduate Masters) level. The agreed, specific aim is to Introduce new educational programmes and enhancing current practice by emphasizing innovative teaching methods to address topical issues, underpinning better sensors and instrumentation for Climate Change, preparing students to contribute strongly to the international debate and on-going activity. The need for monitoring parameters of climate change has never been greater - driving
research in accurate, robust and reliable sensors and associated instrumentation to achieve reliable measurement of these parameters. Key examples include temperature (e.g. water, atmospheric), gas concentration (CO₂, NO₂, NO SO₂, etc) and water quality (e.g. poisoning by algal blooms). Sensors and instrumentation is core to today's Engineering curricula, being strongly cross-disciplinary and an ideal subject for today's environmentally-aware students, to bring up-to-date knowledge of applications, technology and solutions. This emphasises the need for teaching activities to be fully underpinned by the contribution that the internationally recognised research teams involved in this proposal are making.

8. GMR needle sensor for flux-density estimation inside human body

Cancer is the most deadly disease in the world today. There is a variety of different treatment methods for cancer, including radiotherapy and chemotherapy with anti-cancer drugs that have been in use over a long period of time. Hyperthermia is one of the cancer treatment methods which utilises the property that cancer cells are more sensitive to temperature than normal cells. The control of temperature is an important task in achieving success using this treatment method. This seminar reports the development of a novel needle-type nano-sensor based on the spin-valve giant magneto-resistive (SV-GMR) technique to measure the magnetic flux-density inside the body via pricking the needle. The sensor has been fabricated. The modelling and experimental results of flux-density measurement have been reported. From the information of flux-density the temperature rise can be estimated to permit the delivery of controlled heating to precisely defined locations in controlled hyperthermia cancer treatment.

9. Sensors for non-invasive fat estimation in meat

Planar electromagnetic sensors are able to detect the presence of cracks, discontinuities, mechanical fatigue and many other imperfections without material damage. Planar electromagnetic sensors based approach of quality testing of pork belly cuts in a non-invasive and non-destructive way has been proposed. The sensor is of planar interdigital type. The response of the sensor indicates a good possibility of using this type of sensor for estimation of fat content in pork belly in a non-invasive way. The experimental results are reported. A new type of sensor with improved performance has been fabricated and developed.

10. Quality Improvement of Leather Tanning Process Using a Novel Sensor

Design of a novel sensing system to measure the dielectric properties of sheep skin and thereby alter the tanning process to produce better quality leather will be presented in the talk. Tanning process cannot be reversed so it is important to know the suitable tanning process required to produce better quality leather. Using a non-invasive and non-destructive sensing method based on an interdigital sensor, it was attempted to correlate the dielectric property measured by the sensor with looseness values which is a quality attribute in finished leather. The sensing system is reliable, fast and cost efficient along with a low cost data acquisition system. The objective of the reported work is to develop a non-destructive low-cost system to identify the skin
types and modify the process to maximize the profit and improve the quality of the finished skin.

**Other research activities**

11. **Integrated Modeling of Switched Reluctance Generator for Wind Energy Application**

Switched Reluctance Machine has gained interest from researches due to its geometry simplicity and other advantages such as robust, ability to operate at wide speed range and absence of permanent magnet and windings on rotor. The machine has a good prospect for variable speed applications. Its operation in motoring mode and high speed generating has made steady progress, however its low speed generating is still under study. Limitations of experimental work due to repetitive testing and redesign of prototype, increases time, costs and material before the correct specification is achieved. Hence with the advent of high speed computing, simulation is made possible by first obtaining machine characteristics. The advantage of simulation is that it enables verification of analytical design and also minimizes trial and error approach by developing prototype. In this research we are studying the performance of the machine operating in generating mode. The model was built using MATLAB/SIMULINK and the machine was modelled using COMSOL FEM based numerical field computation program. An integrated approach taking into account the machine configuration, converter and control are analysed. The developed SR generator will be applied in extracting energy from wind.

12. **Control of Water Quality**

Research is being conducted to develop novel water quality control techniques and monitoring the quality of water by which it is expected waste water can be purified. The emphasis of this research is to develop novel sensors to determine quality such as contamination of acid, bacteria and measurement of different parameters. Also the quality of control is achieved by using different filtration technique. The parameters are transmitted over remote wireless control keeping the system under water.

13. **Thermal model of induction motors:**

A novel hybrid thermal model of induction motor based on hybrid and distributed thermal parameters has been developed. The model can be used to predict the steady-state and transient thermal conditions of inductions motors throughout the periphery. The model can be used to predict the temperature rise under abnormal operating conditions such as unbalanced supply system, distorted supply systems as well to derate the motor due to abnormal situations.

14. **Hybrid Magnetic bearing**

A prototype hybrid magnetic bearing has been fabricated. This bearing uses a novel arrangement of permanent magnets for the levitation of the rotor and radial stability. Currently sensorless control is under consideration. This research topic encompasses
Electromagnetics, control systems, mechanics, sensing technology, microprocessor systems etc. Due to this the magnetic bearing model is employed as an integrated platform to teach many topics of engineering discipline. The design and implementation of smart and robust control is very important research topic for this unstable system.

15. High temperature superconducting fault current limiter

With the funding from Industrial Research Limited, Lower Hutt, the analysis of high temperature superconducting fault current limiter has been carried out and good results were obtained in the preliminary studies.