Omantel Supported Projects

Project Title: Mobile Healthcare System for Monitoring and Diagnosis in Oman

Project Code: *EG/SQU-OT/18/01*

PI: L. Khriji (College of Engineering), Collaboration with CIRC, College of Medicine, SQU Hospital

Source of Funding: Omantel

Years: 2018-2019

Summary:

The idea of providing medical information and health care services to a remote patient has made telemedicine emerge as a fast and rapidly expanding area of research. The adoption of wireless technology has made possible new applications in health care provision, such as remote routine check-ups, emergency and rescue situations, and sports science physiological measurements. The technology should allow medical services to be delivered to any location within the coverage of a cellular network. A patient from a rural area can be given a routine check via a cellular network without having to commute regularly to a hospital. Routine inspections and monitoring could be done while the patient is at home, travelling, at work or at leisure, thereby relieving resources for more demanding hospital cases.

As technology advances in short-range wireless and biotechnology, the adoption of wireless medical sensors integrated with a networking capability has been gradually introduced into *mobile healthcare applications*. The use of intelligent sensors with wireless connectivity can now produce a Wireless Body Area Network (WBAN) to acquire physiological signals from various body parts. The short-range wireless protocols implemented ranging from RF transceivers to Bluetooth and Zigbee and the newly introduced 6LowPAN protocols. In view of its growing role in wireless sensors application, the ZigBee and 6LowPAN protocol will be adopted in this research.

Telecommunication capability is also highlighted as one of the major issues in current and future challenges of smart wearable health systems. The link between sensors and the link between a smart wearable system and a healthcare provider involves short and long-range wireless and mobile communications. The non-invasive medical sensors to be developed in this research should therefore contribute to a basis and proof of concept of current and future development in wearable systems. With the increase of an ageing population and chronic diseases, society becomes more health conscious and patients become "health consumers" looking for better health management. People's perception is shifting towards patient-centered, rather than the classical, hospital–centered health services. It is expected that mobile telemedicine systems integrated with wireless medical sensors have great potential in transforming the current way of healthcare delivery and in leading towards the provision of personalized next-generation medical applications.

Project Title: Internet of Things (IoT) Security and Privacy Aspects Related to Architecture, Connectivity and Collected Data

Project Code: *EG/SQU-OT/18/02*

PI: M. Sarrab (CIRC), Collaboration with College of Engineering, College of Science

Source of Funding: Omantel

Years: 2018-2019

Summary:

This is two years' project in the field of internet of things (IoT) security and privacy aspects related to architecture, connectivity, and collected data. The research on this project focused mainly on exploring the privacy concerns in IoT technology to provide a complete scenario of IoT phases especially in healthcare with privacy concerns in each phase. This project detailed state-of-art review analysis of different IoT architectures considering security and privacy starting from the initial IoT architecture, which was proposed 2008 until 2018. Besides, it analyzed privacy policies of different IoT medical apps. Studied issues related to security and privacy in IoT healthcare will help in mitigating the risks that can threaten patient's data collected by IoT medical devices. The studies in this project open the doors for future research specifically in IoT healthcare. The research in this project covered the following topics:

- Exploring IoT definition, components, and IoT phases.
- Exploring the evolution of the IoT term (IoT History).
- Discussing IoT trends and supporting technologies.
- Discussing IoT contribution in our life (benefits and usage).
- Reviewing and analyzing IoT data flow across Architecture's layers.
- Analyzing of the theoretical background of IoT security and privacy.
- Analysis of IoT-based healthcare data types.
- Discussing IoT-based healthcare data flow.
- Exploring the actual data collection practices of IoT medical apps.
- Investigating to what extent the privacy policies of IoT medical apps provide sufficient information about their data collection practices.

Project Title: Smart Urban Water Management

Project Code: *EG/SQU-OT/19/03*

PI: S. Zekri (College of Agriculture and Marine Sciences), Collaboration with College of Science, CIRC

Source of Funding: Omantel

Years: 2019-2020

Summary:

The project aims to optimize the use of urban water via an integrated supply-demand approach utilizing novel ICT technologies, including Internet of Things (IoT). The approach will ultimately contribute to meeting the Oman 2020 targets on Climate and Energy, namely achieving a sustainable, low-carbon society by reducing the use of desalinated water, thus energy. The project will develop by researching, demonstrating, and evaluating a fully integrated ICT-based system that will enable households to monitor their water demand and consumption and motivate them to minimize water wastage. The approach will also enable suppliers to understand water consumption, estimate water needs, and test different pricing schemes to improve water use efficiency.

In order to achieve the expected goals of the project, we will be collaborating with several stakeholders, including the Public Authority for Electricity and Water (PAEW), water users, ICT developers, experts in the field of water management, and experts in information and system analysis. Along with these stakeholders, we will be bringing clear understanding of current water consumption practices, state-of–the-art on hardware and software technologies used in urban water metering as well as potential use of recent advances in data analytics and artificial intelligence to monitor water demand and give appropriate feedbacks to the supplier and users. As a proof of concept, we will be developing our solution based on water consumption inputs from SQU households. We are also planning to obtain inputs from the broader water industry through the PAEW. Our project will ultimately be contributing to the SQU smart campus vision, which is aligned with the national strategies and initiatives.

Project Title: STREAMS: Spatio-Temporal Renewable-Energy-Aware Management and Scheduling of Green Cloud Computing Systems

Project Code: *EG/SQU-OT/19/04*

PI: A. Ammari (College of Engineering), Collaboration with CIRC

Source of Funding: Omantel

Years: 2019-2020

Summary:

Green computing that maximizes the use of renewable energy becomes a critically important issue world-wide in order to sustain the economic development in a heathy way. This project intends to propose STREAMS: Spatio-Temporal Renewable-Energy-Aware Management and Scheduling of Green Cloud Computing Systems (GDC) to promote green computing. It focuses on delay-bounded applications in (GDCs), and proposes the architecture of distributed GDCs, which supports cost and energy-efficient scheduling of delay-bounded tasks of multiple heterogeneous applications by considering spatial and temporal variations of multiple factors. The existing studies usually adopt queueing theory to model each GDC, and only average delay bound of all arriving tasks can be met. The long delays of real tasks makes the delay performance of some tasks is not secured. Different from the existing studies, the proposed STREAMS can guarantee that tasks of multiple applications are finished within their specified bounds. In comparison to existing methods for task scheduling in GDCs, STREAMS proposes to maximize the use of renewable energy sources from different geographical sources, and significantly reduce the energy cost and environmental impact by considering the spatial and temporal variations in such factors as a smart grid's power price and stability, solar irradiance, and wind speed. Moreover, STREAMS innovates intelligent optimization algorithms to offer real-time near-optimal solutions. As a result, the successful execution of this project can help promote the development and use of renewable energy facilities in Oman for green computing and networking. The completion of this research project will help create digital economy at the sultanate and strengthen its information technology sector. It will help cultivate highly talented professionals who can contribute to the industrial sectors of green computing, e-commerce, and renewable energy.

Project Title: A Vision-Based Navigation System using Deep Learning for a Guide Mobile Robot in the National Museum of Oman

Project Code: EG/SQU-OT/19/05

PI: A. Saleem (College of Engineering), Collaboration with CIRC

Source of Funding: Omantel

Years: 2019-2020

Summary:

Tourism in Oman is expected to be one of the main sources of revenue for the national economy in the near future. Therefore, equipping Omani museums with the latest state-of-the art technologies will enable them to effectively handle large number of visitors. Robot guide is one of the most recent technologies introduced to museums. Due to the very dynamic nature of museums' environments, robot guides are required to be equipped with intelligence that enable them to navigate effectively and to interact seamlessly with the guests.

Despite an impressive development in the field of autonomous robotics in the last two decades, robot navigation is still an area of active research due to the uncertainties associated with dynamic environments. Most existing navigation systems rely on geometric models to construct local cost-maps. This process does not require using active perception processes. These navigation systems depend on maps built from complex artificial features obtained from fusing multi-sensor data. To develop an efficient navigation system for unstructured dynamic environments, however, a number of challenges need to be overcome. These challenges are mostly associated with real-time perception and intelligent control.

With advance of fast computing, deep learning is fastly gaining popularity in an increasing number of applications and has so far achieved impressive results in areas such as speech processing, image and text recognition, medical diagnosis, autonomous vehicles, and human-machine interface. Due to its self-learning ability, deep learning is anticipated to overcome most challenges related to real-time navigation in dynamic and unstructured environments.

The main goal of this project is to develop a vision-based navigation system using deep learning to endow a mobile robot with real-time navigation ability in a dynamic unstructured environment. The Omani National Museum will be used as a case study.

Project Title: Design of coordinated strategy control of multi air-drones for parcels delivery in .urban environment

Project Code: EG/SQU-OT/20/01

PI: J. Ghommam (College of Engineering), Collaboration with CIRC

Source of Funding: Omantel

Years: 2020-2021

Summary:

This project aims to address several scientific and technological challenges towards the future of delivery service in urban environments using drones. As there are severe autonomy constraints to the endurance and travel distance of drones, this project will explicitly consider those limitations and use drone relays to enable effective parcel delivery to destinations that go beyond the flight range and autonomy of a single drone. Interestingly enough, this raises other scientific challenges in terms of planning of optimal and efficient trajectories for a team of drones deployed throughout a city, for the cooperative control of several drones for parcel transportation and relay maneuvers, as well as for estimation of vehicles and parcel location during transportation and relay maneuvers. The research plan will start by addressing single vehicle control and estimation strategies, and progressively evolve into cooperative control, estimation and planning for coordinated relay transportation.

Project Title: Artificial Neural Networks for Early Identification of Heart Rate Variability Changes in Offspring of Individuals with Genetic Predisposition to Hypertension in Oman

Project Code: EG/SQU-OT/20/02

PI: A. Hossen (CIRC), Collaboration with College of Medicine, SQU Hospital, College of Engineering

Source of Funding: Omantel

Years: 2020-2021

Summary:

To enhance the diagnostic process in hospital daily routine and avoid misdiagnosis, artificial intelligence methods (especially computer aided diagnosis and artificial neural networks) can be employed. These adaptive learning algorithms which vary from simple perceptron to complex deep learning algorithms can handle diverse types of medical data and integrate them into categorized outputs.

In this project, comparison of heart rate variability in offspring of hypertensive and normotensive parents is to be performed on data from large homogeneous Omani Arab families. The purpose is to early detect hypertension in those offspring of individuals with genetic predisposition to hypertension. The early detection will help in treatment of those young people. The project studies the relation between hypertension and the changes in HRV under different conditions The study will concentrate on implementing neural techniques for early detection and selection of features that may indicate the predisposition of offspring to hypertension.

Various neural networks from simple perceptron to Feed-Forward Back-Propagation to Deep learning neural network will be employed in this project. Different frequency-domain and time-domain features will be extracted from the data and from the morphology of the signal and/or its spectrum.

Neural networks will help also in identification using short length segments of data (minute by minute identification).

In addition, by using Deep Learning networks, the classification algorithm may anticipate early stages of hypertension in young Omaies,which can help greatly in preventative care for patients at risk of hypertension. The developed approach consists of two parts: a deep neural network learning-based training model and prediction model for the estimation of risk of hypertension in offsprings with genetic predisposition to hypertension in Oman.

Project Title: Design and Implementation of a mobile application for monitoring and intervention of patients with cardiovascular disease during physical activity

Project Code: *EG/SQU-OT/21/01*

PI: K. Al Rassadi (MRC), Collaboration with CIRC, College of Medicine, SQU Hospital, College of Engineering

Source of Funding: Omantel

Years: 2021-2022

Summary:

Physical activity (PA). Plethora of studies have suggested the IHD tends to have negative repercussions in terms of the integrity of biopsychosocial functioning. A potential to achieve a better physical active lifestyle can be discovered through the day-to-day displacements that people make, especially in the form of the travel modes they use for trips. The decade of studies has led to more precision estimation of what constitutes PA. Walking for transportation is considered in the range of moderate intensity PA, and bicycling in the range of moderate to high intensity PA. This study aims to measure the actual travel behaviour and travel-related PA of cardiac patients by monitoring them using a proposed professional smartphone application to be designed and implemented allowing for deeper insights into daily travel behaviour and contextual factors influencing their travel patterns. The study also aims to optimize the travel-related PA by generating personalized, semiautomatic feedback with specific advice and suggestions to replace some trips into more active travel modes. Next, the impact of this intervention (feedback) will be evaluated. The study include also following of heart rate variability (HRV) of patients before the start of a 12 weeks PA program and after 3 weeks of the program and at the end of the program. Concurrently, the psychosocial outcome will be also an integral part of the present study. One of the unique features of the present study is to utilize an artificial intelligence (AI) based expert system to evaluate the effect of PA on the patient's status.

Project Title: Artificial Intelligence in Education System at Sultan Qaboos University

Implementation Plan and Challenges

Project Code: *EG/SQU-OT/21/02*

PI: Z. Nadir (College of Engineering), Collaboration with CIRC

Source of Funding: Omantel

Years: 2020-2021

Summary:

Artificial Intelligence (AI) is simply defined as developing software or hardware techniques to simulate human intelligence. It could also be defined as computer systems that have the ability to solve problems that can be only solved by human. AI has an unimaginable capabilities. Within the next couple of years, it will revolutionize every area of our life, including education. AI systems can enable education process as they have the potential to improve education and enhance traditional teaching and learning methods. AI in education can enhance: teaching and learning methods, personalized and adaptive learning, advising system, student assessment, analysis of learning systems, and academic life.

In this project a comprehensive study is to be done on what AI tools can be applied at SQU education system and how those tools can be applied and at which specializations and levels. A road map of buiding an AI-based education system is to be designed and implemenation stages are to be pointed and challenges and difficulties are to be indicated.

In this study, a face-to-face interviews about AI-based education system with SQU's experts are to be done. Experiences of international universities in AI in education are to be studied.

AI in education tools are to be reviewed and an implementation of a case study on selected tools is to be done. E-learning arised as most important education system during Covid-19 pandemic. AI applications in E-learning are also to be included in this study.

Project Title: Mobile Network Coverage Assessment using Unmanned Aerial Vehicle and Artificial Intelligence

Project Code: *EG/SQU-OT/21/03*

PI: N. Tarhuni (College of Engineering), Collaboration with CIRC

Source of Funding: Omantel

Years: 2021-2022

Summary:

Cellular network operators and Telecommunication regularity authorities are working hard to increase the network coverage to unserved or underserved areas. Cellular networks coverage is normally conducted by the use of mathematical models of the propagation environment or by actual site surveys using drive tests. However, drive tests are not visible for hard to reach areas such as mountainous regions and high-rise buildings. In this research, we propose to investigate the potential of Unmanned Aerial Vehicles (UAVs) as a tool for monitoring and assessing mobile network coverages. The end product will be using a deep learning algorithm to provide a simple and affordable solution for network operators to assess the coverage at remote and/or hard to access locations.