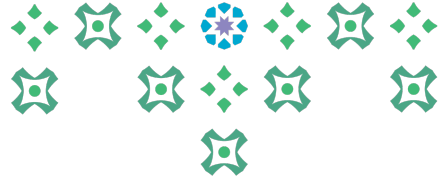


Princess Nourah Bint
Abdulrahman University
College of Engineering



EmpowerHer
Engineering
Expo2023

Capstone Design Project Showcase College of Engineering 2023



جامعة الأميرة نورة بنت عبدالرحمن
Princess Nourah bint Abdulrahman University



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College of Engineering



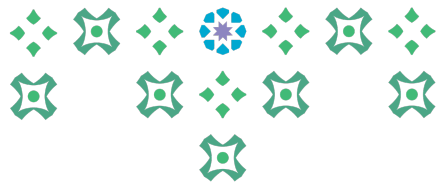
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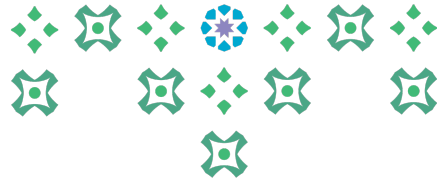
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| About the Expo

The College of Engineering at PNU holds a graduation projects exhibition (EmpowerHer Engineering Expo) of the first batch for the year 2023, where the expo included 15 graduation projects from the departments of the Industrial and Systems Engineering and the Electrical Engineering in its two programs (Electronics Engineering - Communications Engineering) - varied between experiences, engineering studies and innovative solutions that contribute effectively to economic development in the Kingdom of Saudi Arabia.



Message from CEN Dean

It is our pleasure to present to you the first catalog of projects of the College of Engineering students at Princess Nourah bint Abdulrahman University. These projects reflect the hard work, creativity and dedication of our students under the supervision of elite faculty members in order to find solutions to realistic engineering challenges from the labor market.

These projects varied in their solutions and included contemporary technologies such as industrial solutions, electronics prototypes and research in the fields of communications. Projects have adopted advanced technologies such as digital twinning to simulate real systems, enabling monitoring and improved real-time performance. Electronics and communications prototypes also employ contemporary technologies such as the Internet of Things and artificial intelligence to build innovative solutions for applications in different fields.

Through these projects, our students have demonstrated their technical expertise, design skills, critical thinking, and many soft skills such as communication and teamwork. We are confident that these projects will not only inspire specialists in engineering journals, but also contribute to the advancement of technologies used in different engineering sectors.

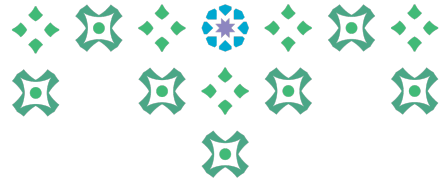
Finally, we would like to express our appreciation to all the faculty, mentors, and industry partners who supported these projects and guided our engineers to achieve the desired goals. We hope that these projects will serve as inspiration for those striving for excellence.

Dr. Areej Abbas Malibari
Dean of College of Engineering



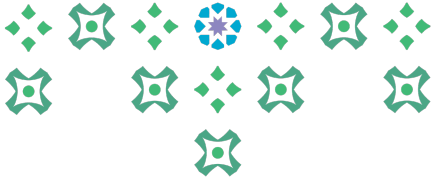
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Industrial and Systems Engineering Capstone Design Project



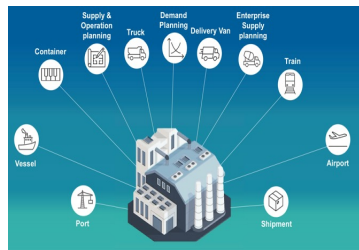
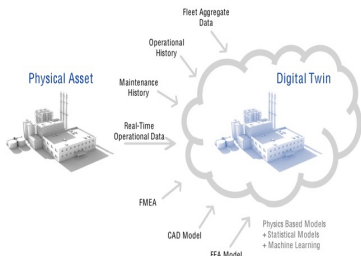


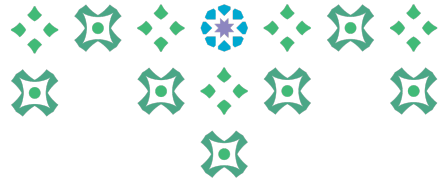
The Implementation of a Digital Supply Chain Twinning on the Enterprise

Fai Al Juhaiman, Hadeel Mudhish, Lina Almukhim, Norah Abuabah,
Sara Alyaesh
Supervisor: Dr. Samia Elattar

Digital twinning technology is one of industry 4.0 tools. Supply chain digital twinning is to create a virtual replica of the physical supply chain, which can be used to simulate and optimize various scenarios in order to identify opportunities for improvement and reduce risk. Using advanced analytics and machine learning algorithms to model and simulate various scenarios and evaluate their potential impact on the supply chain and identifying opportunities for improvement. In this project the supply chain digital twinning will be implemented on Saudi Arabia's largest corporation in the procurement, logistics, and supply chain management of pharmaceuticals, medical devices, and supplies for governmental hospitals (NUPCO) is facing multiple gaps in running its supply chain operations namely overstocking, slow supplying operations, and integration and connectivity of its suppliers.

The implementation of digital supply chain twinning on NUPCO has resulted in significant improvements as delivery time was minimized and customer satisfaction was enhanced by 45.157% on average. Improvements were achieved through integration, visibility, agility, and connectivity by applying the digital twin framework. In addition, accurate forecasting and reduced overstocking were accomplished using real-time data and advanced machine learning algorithms. This has proven to be a valuable solution for NUPCO, enhancing their supply chain capabilities.





Designed Solution for Airline Company: Crew Pairing Optimization.

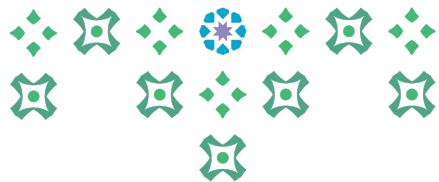
Saja Alsultan, Deema Alfhidi, Mona Alhussein, Najla Alsaif ,
Samar Almackenzly
Supervisor: Dr. Kaouther Ghachem

Airline Crew Pairing constitutes a crucial aspect of airline operations and poses an intriguing challenge for the application of Operations Research. The cost associated with crew operations ranks as the second largest component of an airline's total operating expenses. Even marginal cost reductions can lead to substantial annual savings amounting to millions of dollars. Consequently, it is imperative to establish an optimal scheduling policy that minimizes these costs, serving as a fundamental requirement in airline planning and operations.

Numerous solution methodologies have been developed, however, many objectives and constraints are handled in an approximate manner, necessitating ongoing research. This report provides an overview of the crew pairing problem and consolidates the previously published optimization methods. Additionally, it presents a novel mathematical model as the initial phase of the capstone project for the Crew Pairing Problem (CPP), considering operational and legal constraints specific to Flynas.

The process of generating pairings will be carried out utilizing Aims software, initially restricting flights to two or four sectors, which implies that the crew will always return to the base. However, this incurs higher costs such as deadhead travel and increases the number of required crew members. The optimized solution will involve permitting three sectors, allowing for situations where the crew does not necessarily have to return to the base.





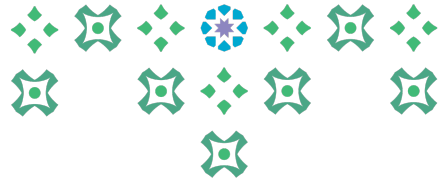
Design and Develop a Decision-Making Tool for Optimal Production Plan: Case Study in Poultry Sector.

Amal Almutairi, Duna Altwaijri, Moodhi Aldawood, Raghad Alkhamis,

Sara Alkuait

Supervisor: Dr. Imen Safra

One of Saudi Arabia's 2030 vision targets is to increase self-sufficiency in the poultry sector, ARASCO's ENTAJ company increased its production capacity to 60 million birds annually and ranked one of the fastest-growing chicken producers in the Kingdom. Due to high demand, it became a must to develop a tool for an optimal decision to meet daily customer demands during the cutting and packaging stage and before distribution arises. The project follows PDCA methodology to comprehend, analyze, and solve the problem, by applying data analytics and operational research methodologies to build a decision-making tool that reduces uncertainty and accelerates an optimal decision to reduce waste. The project's findings are a decision-making tool to reduce uncertainty and make the optimal decision. The proposed solution also showed its effectiveness, which led to an increase in the percentage of the demand covered by 5%, and a reduction in the number of downsizing operations by approximately 20%. A dashboard was built to measure key performance indicators to measure waste, losses, and the percentage of demand covered to rationalize workers in decision-making.

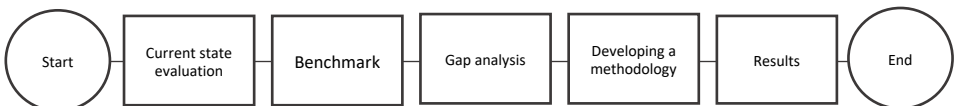


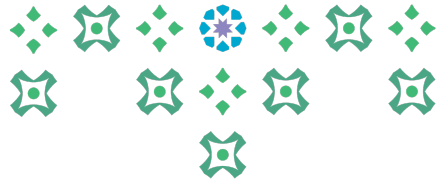
Developing a Methodology for Waste Management at PNU

Maha Alharbi, Layan Alabdulwahab, Maram Alshalawi, Deemah zaman, Noura Algurayer

Supervisor : Prof. Shabbab Alhammadi

Waste handling is a concern due to the continuous increase of waste production, proper waste management is a must to reduce the environmental consequences and regulate expenses. Princess Nourah University is one of the largest universities in the Kingdom of Saudi Arabia with massive amounts of waste produced. Therefore, it is crucial to evaluate the current situation of this educational institution in terms of whether there are any issues with improper waste handling, storage, and transportation within the university facilities. Resource reuse or recycling is an efficient way for contributing into the transformation from a linear economy to a circular economy to be aligned with the 2030 vision that focuses on enhancing and protecting the environment and economical sustainability. The project aims to develop a waste management methodology at Princess Nourah University that uses an integrated system to collect data that can assist decisionmakers in creating sustainability strategies that utilize environmentally friendly treatment and disposal technologies for waste. The PNU Waste Management System also helps in predicting the profit that can be generated from waste, which can be used to support the university's sustainability efforts. Additionally, this project aims to contribute to the sustainability movement at Princess Nourah University and serve as a starting point for future research concerned with developing the waste management system to preserve the environment.



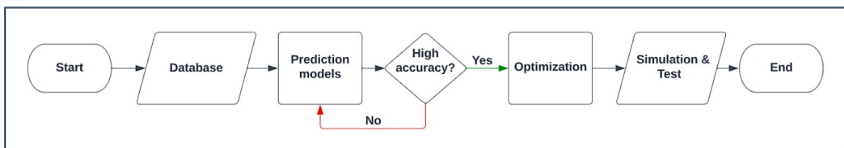


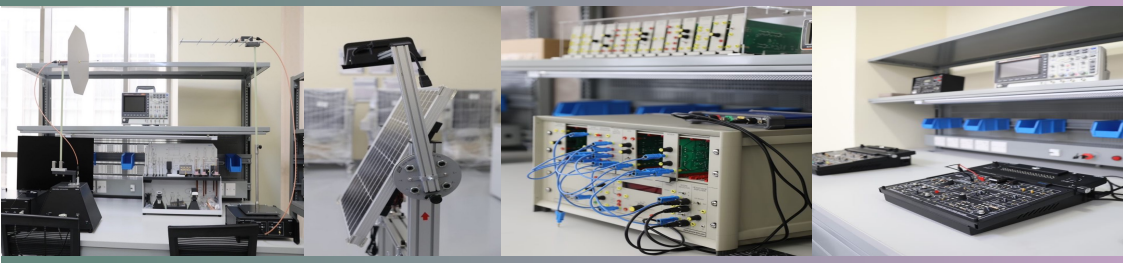
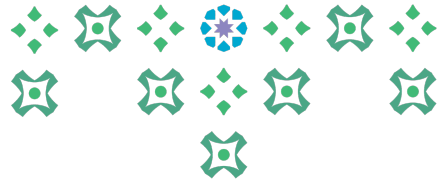
Smart Distribution of Flights to Maximize Runways Efficiency and Minimize the Number of Delayed Flights

Jinan Alhudaithi, Joud Alotaibi, Nuha Aloud, Reem Alrumaih, Wiam Alkhozim

Dr. FAIZA BEN-ABDALLAH

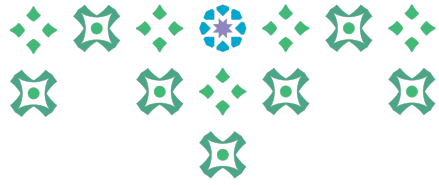
Aviation industry is enduring from the flights delay which cost billions to both business providers and consumers per year, in addition to its noxious impact on environment and bad customer services experience. This project has investigated the time performance influencers of all stakeholders' practices and its delays causes, to result a focus on the gate capacity delay which proved to be inefficient in King Khalid International Airport. Hence, the accumulated delayed flights will be minimized by applying machine learning and deep learning tools to forecast delays to build a high-accuracy optimization model to reschedule the affected flight and test the validity by applying the Arena simulation software, and thus the efficiency of gates will increase by increasing its utilization percentage. This will lead to reducing costs resulting from flight delays, preserving the environment from carbon dioxide emissions, and increasing customer satisfaction. Taking in advance international safety standards in the aviation industry, and General Authority of Civil Aviation laws and regulations. Although the delay cannot be entirely avoided, it can be reduced by consuming time wisely.





Electrical Engineering Capstone Design Project - Electronics Engineering -



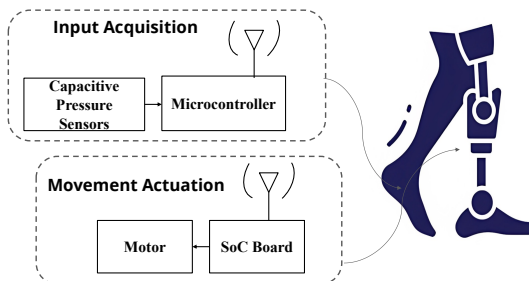


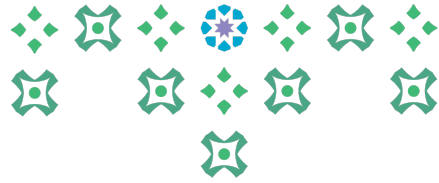
Sanad: Above-knee Adaptive Prosthesis

Lama Alhammad, Bushra Alalmi, Maha Alsulaim, Sarah Alomran
Dr. Shaeen Kalathil

Above-knee amputation is a condition where a person's leg is surgically cut up to thigh area due to some diseases or accidents. Therefore, the mobility of amputees is greatly compromised, and they face major lifestyle changes.

Consequently, prostheses have become essential for amputees. The performance of the prosthetic leg determines the walking quality of the above-knee amputee. This project proposes a non-invasive, capacitive input based, wireless, adaptive above-knee prosthesis. The prosthesis will utilize a novel System on Chip (SoC) architecture. The input will be acquired from the capacitive sensors fitted to the shoe insole of the healthy foot. This input signal will be transferred wirelessly to the other end of the system where the SoC will process the signal and actuate the movement of the prosthesis accordingly. Therefore, ensuring the highest level of synchronization with the healthy leg.





Air Pollution Based Traffic Light Congestion Control System

Amjad Alhumid, Jumanah Alshehri, Reem Albarrak, Reema Almansour
Supervisor: Dr. Shabana Urooj

Traffic lights are a major cause of congestion in many modern cities worldwide. Even though traffic lights are known as the best method for controlling traffic flow, accidents reported at traffic junctions are very common. Moreover, with high congestion at a certain traffic light junction, it will increase the emissions of greenhouse gases such as carbon dioxide (CO₂) and carbon monoxide (CO) etc., which leads to increased Traffic Related Air Pollution (TRAP). Controlling the traffic lights based on the surrounding environment will help with the traffic flow and minimize the TRAP.

This work proposes a control system that can detect gases, motion, humidity, and temperature. Delicate sensors may be employed which can manage the traffic light indications and the time needed at the signals. All these control strategies will be based on the number of vehicles. This process will help to reduce the traffic light congestion and the TRAP in a great deal.

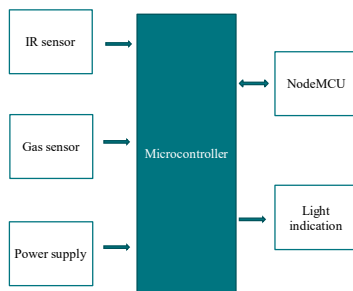


Figure 1: Controller block diagram for proposed work

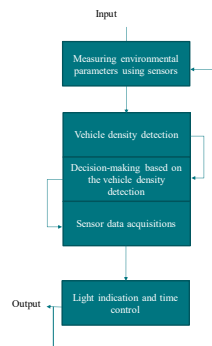
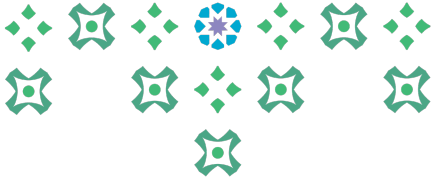


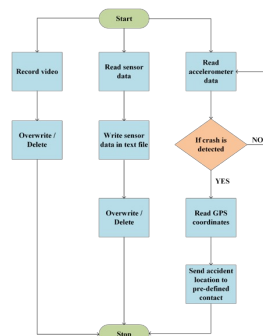
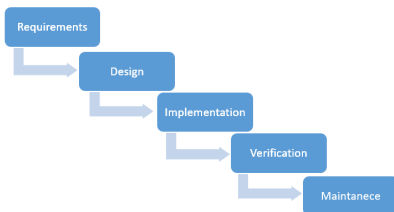
Figure 2: Controller block diagram for proposed work

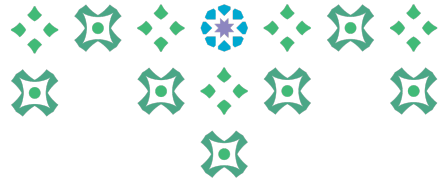


Design and Implementation of Vehicle Black Box System for Accident Detection and Retrieval

Layal Al-khathlan, Raghad Aljumah, Leen Alhazmi, Leena Ghannam
 Supervisor: Dr. Shima Ali. Alebiary

Driving a vehicle on the road is a complex activity that requires adherence to a set of policies and laws to ensure safety. Neglecting to do so exposes drivers to significant risks that can result in serious injury or death in some cases. To mitigate these risks, the Kingdom of Saudi Arabia launched the National Transformation Program as part of Vision 2030, aiming to reduce the death rate caused by road traffic accidents. This project proposes the design of a smart black box system that utilizes a combination of sensors and components to capture and transmit real-time data. The project methodology used in this research is the Waterfall method, in which the process is divided linearly into different stages, where the output of one stage is an input to the following. The proposed system is equipped with sensors that gather information such as temperature, impact, and location, and immediately transmit this information to concerned parties, such as emergency services. The aim of the project is to provide crucial information that can aid in the investigation of accidents to improve road safety. The system is intended to help reduce the human, economic, and social costs associated with road traffic accidents by providing essential data for insurance claims and emergency response efforts. The results of this project have the potential to inform the development of similar systems for vehicles around the world, improving road safety and protecting lives.

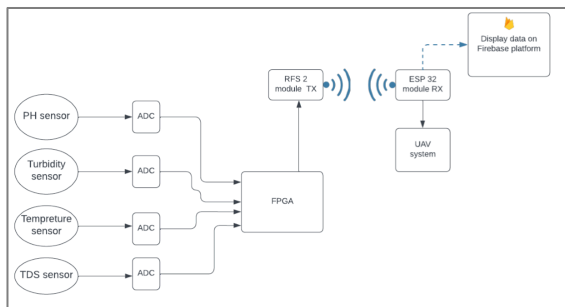


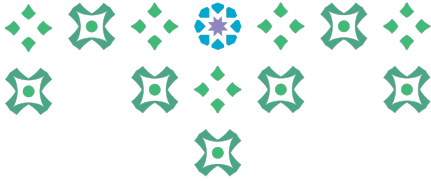


IoT Based Multi-Sensor SoC FPGA with UAV for Smart Water Quality Monitoring System

Sumayyah Alshehri, Reema Suwaidan, Yara Alghamdi
Supervisor: Dr. Shaeen Kalathil
Supervisor (out of CEN): Prof. Nazek Elatab

Water pollution is on the rise globally, so implementing water quality monitoring systems is mandatory in an Internet of Things (IoT) environment with the development of SoC FPGA technology. The main parameters used to measure water quality are the PH level sensor, turbidity sensor, TDS/salinity sensor, and temperature sensor. With the aim of developing an effective smart water quality monitoring system, the project presents a reconfigurable system with multi-sensors interfaced with an SoC FPGA for measuring water parameters with an unmanned aerial vehicle using IoT communication. The project also aims to develop a database and a web interface to store and visualize the data collected. The developed system will enable efficient and reliable water quality monitoring, which can be used to detect and monitor water pollution.



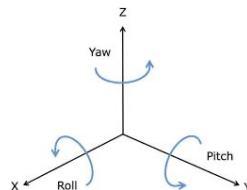
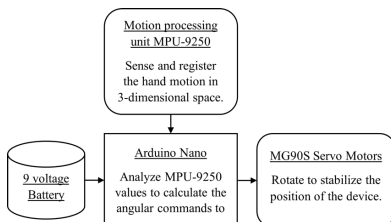


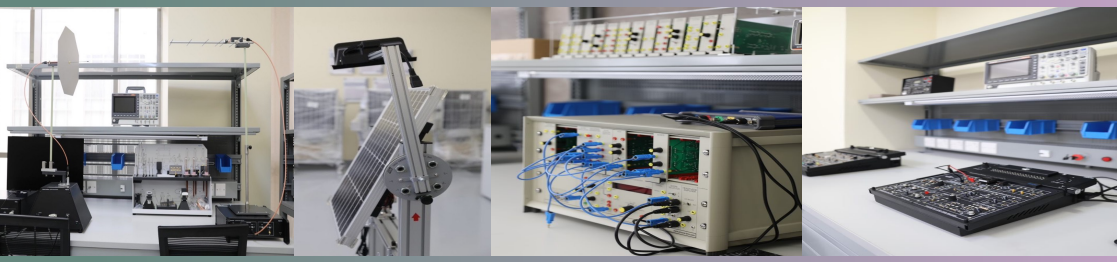
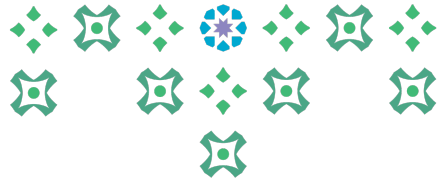
Multi-Purpose Self-Stabilization Device for People and Overall Tremor Detector

Hessah Falah Alqahtani, Lujain Abdullah Aljarid, Shahad Abdulaziz
Almuharfi, Shoug Nasser Almajed, Ruyuf Ibrahim Alaqil
Dr. Shekaina Justin Thambi

Tremor is a neurological condition characterized by shaking movements in one or more areas of the body, most frequently the hands. Tremor is not a life-threatening condition. However, it can be difficult and even crippling, making it challenging or impossible for people to perform work and daily life activities such as writing, eating, painting, and tooth brushing independently. People with tremors can use wearable or hand-held devices to assist them in doing daily activities thanks to advancements in technology. However, the available solutions in the market have some limitations, such as wearable devices being inconvenient and not portable, and hand-held devices having low sensitivity, and being limited to a single use of a spoon.

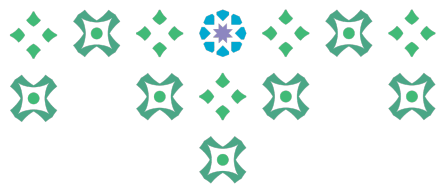
This paper discusses the design of a hand holding self-stabilization device with multiple attachments that can be utilized for a variety of purposes. The implementation of the Tremor self-stabilization device uses MPU-9250 a 9-degrees motion processing unit that contains a 3-axis of each MEMS (gyroscope, accelerometer, and magnetometer) to sense the hand movement, an Arduino Nano to process the sensed motion, and 2 MG90S servo motors to establish a system of 2-degrees of freedom. We anticipate that this design will stabilize hand movement and enable people with tremors in doing daily living activities independently.





Electrical Engineering Capstone Design Project - Communication Engineering -

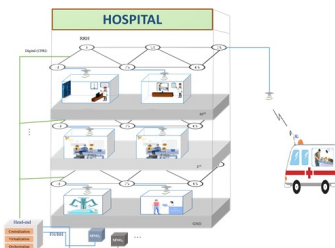


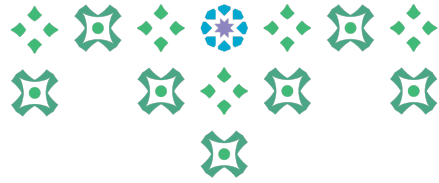


On the Design of Indoor Neutral-Host for Medical Facilities in the Context of 5G and Beyond Mobile Networks

Alhanouf Alshahrani, Eman Alqurtas, Maha Almutairi, Ghaida Alessa
Supervisor: Dr. Yazan Allawi

Lack of seamless mobile coverage and poor user experience is unfortunately common in many indoor and outdoor deployment venues. Traditional cellular systems used in indoor and outdoor venues are too costly and complex, especially for small enterprise indoor deployment scenarios. At the same time, mobile network operators (MNOs) are struggling to rollout 5G and Beyond (5GB) mobile network infrastructure by having an unbearable Total Cost of Ownership (TCO) when compared to their anticipated Return on Investment (ROI). In this project, we discuss the challenges facing the successful rollout of 5GB mobile networks infrastructure in indoor venues especially medical facilities considering the diverse requirements of its emerging use cases. Accordingly, we present a novel design that incorporates neutral host technology and High-availability Seamless Redundancy (HSR) protocol to insure high quality healthcare services. Our design focuses mainly on satisfying Ultra Reliability Low Latency Communication (URLLC) type of use cases. We formulated our proposed design as an optimization problem and conducted performance evaluation over various deployment scenarios to measure its efficiency considering multiple key performance indicators. Finally, simulation results show that our proposed design algorithm is capable of achieving significant cost savings while satisfying a target level availability and delay, and consequently guaranteeing URLLC of different 5GB-enabled medical facility use cases.





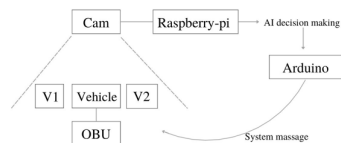
AI Based Navigation Algorithm for Traffic Congestion Avoidance Utilizing 5G beyond (5GB) Vehicle to Everything (V2X) Network

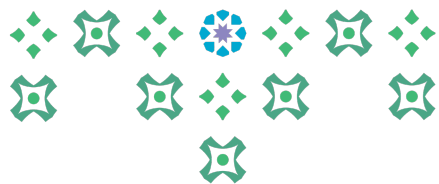
Amjad Alotaibi, Joud Almousa, Rana Alhaidari, Ohoud Alotaibi, Hadeel Alshammary

Supervisor: Dr. Samia Rabeh Larguech

Supervisor (out of CEN): Eng. Mohammed Alsehal, Eng. Abdulaziz Alhrthi

The problem of vehicle traffic congestion has grown in prominence over the past few decades and become a global issue concerning its detrimental impact on the economy and environment. Therefore, scientists and politicians are vigorously pursuing solutions that can improve traffic management efficiency and reduce fuel consumption and carbon emission simultaneously. Utilizing the cellular-based vehicle-to-everything (V2X) networks. In this paper, we propose an AI-based navigation algorithm for traffic congestion avoidance utilizing 5G Beyond (5GB) Vehicle to Everything (V2X) NETWORK in real-time and re-calculating the route for the journey ahead. This is achieved in our design by incorporating – (i) the new radio V2X networks disseminate the time-sensitive traffic condition updates (e.g., vehicle position and speed) periodically relying on basic safety messages, (ii) the Multi-Edge Computing (MEC) technology to provide real-time analytics with low latency and reduced cloud data storage, and (iii) an AI algorithm to calculate the best route among the congestion-free alternatives.

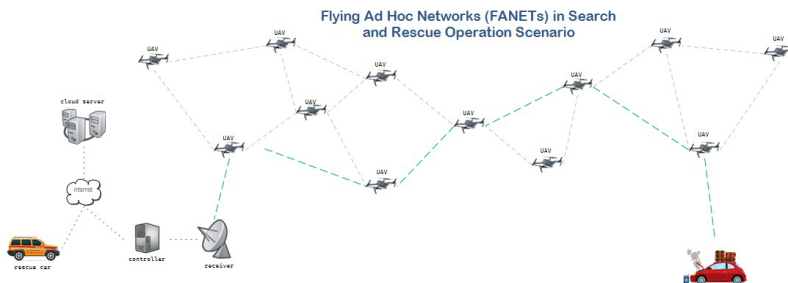


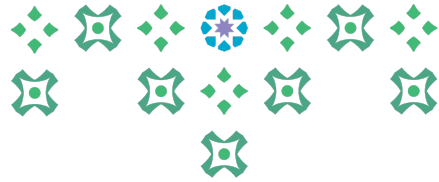


Flying Ad Hoc Networks (FANETs) in Search and Rescue Operation Scenario

Alhanouf Turki Alhazzany, Ruba Nasser Alsharekh, Reem Ahmed Aseeri, Norh Nasser Alsuwayh, Sadeem Haif Gammash
Supervisor: Dr. Tariq Omer

With the rapid development of the Unmanned Aerial Vehicles (UAVs) the importance of Flying Ad-Hoc Networks (FANETs) has increased which aims to construct self-organizing networks with flying UAVs in the sky. FANETs have an immense advantage in search and rescue (SAR) scenarios which is increasing the coverage area and time efficiency exist in a single UAV. In this project, the network consists of multiple UAVs where one of them will acts as a master node the is connected to the ground station while other UAVs are connected with each other in an ad-hoc manner. After establishing the network, the implemented scenario is to have a lost car in the outskirts of Riyadh where FANET will be used to find the location of this car. After that, the signal will be passed to a receiver and the receiver will pass it to the cloud where the data will be stored there to share this data with the nearest rescue car. Movement of UAVs will be simulated using a 3D mobility model since FANETs nodes which is UAVs have a path planning that must be defined in a three-dimensional mobility model to provide realistic movement pattern. As FANET considered as an ad-hoc network, Ad Hoc On-Demand Distance Vector Routing (AODV) Protocol will be used to find the optimum path to forward messages from source to destination. To provide a significant validation, the network will be simulated using a real-world environment simulator which is OMNeT++ to obtain the network measurement which is the end-to-end delay.

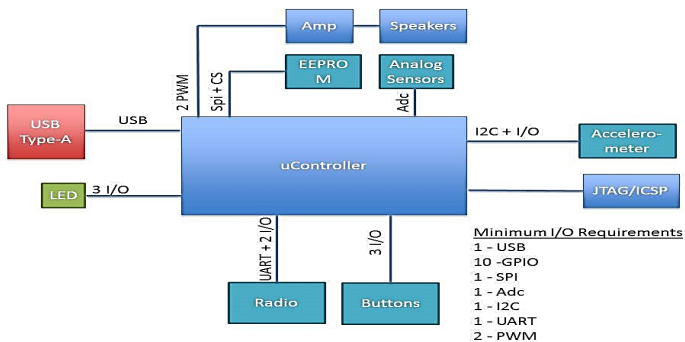


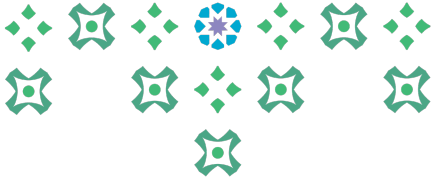


RFID Based Door Lock Authentication Using GSM

Sdeem Alhoeriny, Alanoud Alhorishi, Alanoud Aldriwesh
 Supervisor: Dr. Heba Jaber

Radio Frequency Identification (RFID) based door lock authentication using Global System for Mobile Communications (GSM) technology is a system that provides secure access to doors through the use of RFID technology and GSM networks. The system works by granting access to the door only to authorized users with valid RFID tags. When an authorized user approaches the door, the RFID reader reads the tag and sends the information to the GSM module, which then verifies the identity of the user and sends a signal to the lock mechanism to open the door. This system enhances security by reducing the possibility of unauthorized access and helps to keep track of who has entered and exited a building.





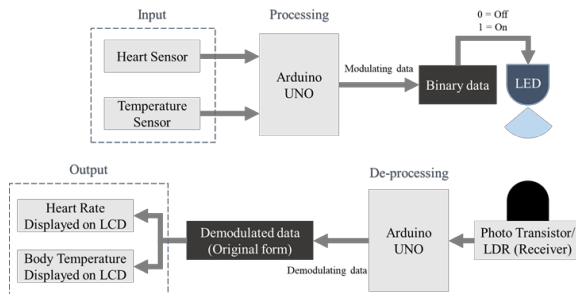
Li-Fi Network Solution in Hospitals

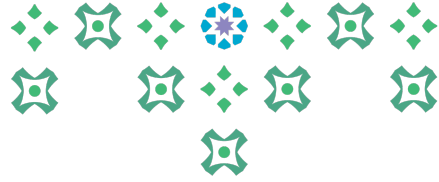
Atheer Alzahrani, Lana Alharbi, Najla Alkhowaiter, Qateralnada

AlFaour, Renad bin Rushood

Supervisor: Iamia Osman. Widaa

Light Fidelity or (Li-Fi) is a new and emerging technology that can be used for transferring very high amounts of data at super high speeds, as Li-Fi is about 100x faster than Wi-Fi. This project applies said technology in the medical field and hospitals. As the rapid development in medical technologies and IOT require high amounts of data transfer and ultra-low latency, especially with remote surgeries. Also there's the concern of the use of high radio frequency bands which cause interferences that impact medical equipment and patients' lives this is also called Electromagnetic Interference (EMI). This solution is proposed to solve the lack of communication links that transfers high amounts of data and the delay in reception for medical equipment, in addition to a better environment for the patient as light is safer than RF. Additionally Li-Fi systems can be much lower in cost as LED's are cheap and easy to acquire. A Li-Fi based system used indoor is designed and implemented using Arduino UNO boards and possibly evaluate Li-Fi technology using Matlab/Simulink. The expected output is a low latency connection and data transfer at high speeds





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