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College of Engineering

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

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Abstract

Tremor is a neurological condition characterized by shaking movements in one or more areas of the body, most frequently the hands. it can be difficult e for people to perform work and daily life activities such as writing, eating, painting, and tooth brushing independently. the available wearable or hand-held solutions in the market to assist people with tremors have some limitations. This paper discusses the design of a hand holding self-stabilization device with multiple attachments that can be utilized for a variety of purposes.

Introduction

Essential tremor adversely affects individuals' lives and prevents them from doing their daily life activities independently. In our design, we will address the major limitation by developing a device that is easy to hold and use, has a faster response time, and have a lighter weight. Multi-Purpose Self-Stabilization Device reads and studies the patient's hand movements using a MEMS sensor and then performs the necessary actions to stabilize the hand movement.

Methodology

Multi-Purpose Self-Stabilization Device uses The MPU-9250 to sense the hand motion of the user and sends the data to the Arduino Nano. Arduino Nano will process the data and calculate the angular commands to the Servo Motors. The MG90S servo motors will rotate to stabilize the position of the device.

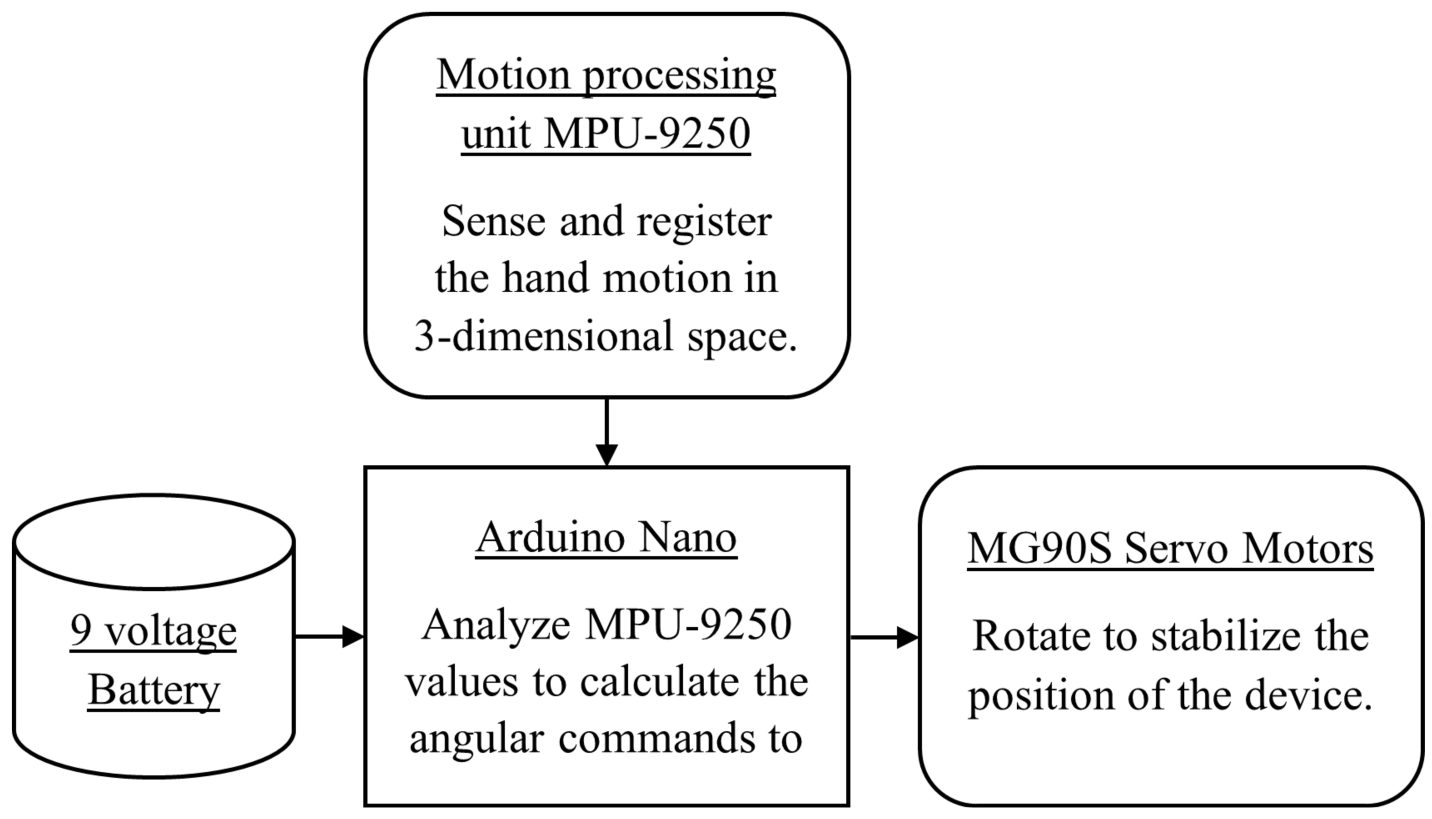

Fig1: Block diagram

Algorithm

The pitch and roll angular movement are the foundations of the Multi-Purpose Self-Stabilization Device system. Pitch and roll are determined using the following algorithms based on data from the MPU-9250 sensor:

$$Pitch = arctan\left(\frac{A_x}{\sqrt[2]{A_y^2 + A_z^2}}\right)$$

$$Roll = arctan\left(\frac{A_y}{\sqrt[2]{A_x^2 + A_z^2}}\right)$$

A_x, A_y, and A_z represent the accelerometer measurement for the three dimensions.

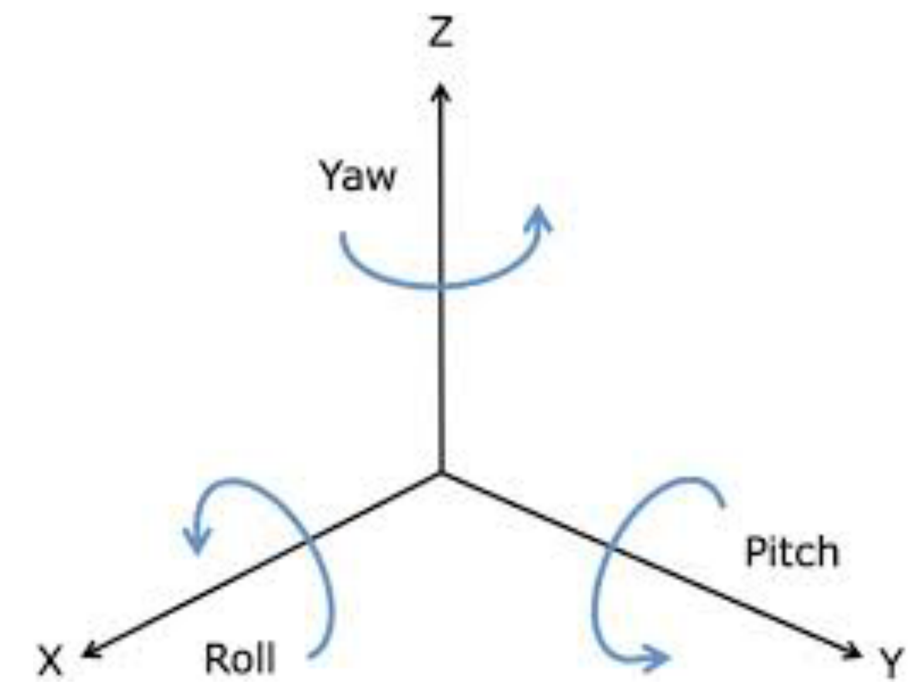

Fig3: Pitch, Roll, and Yaw angles

Implementation

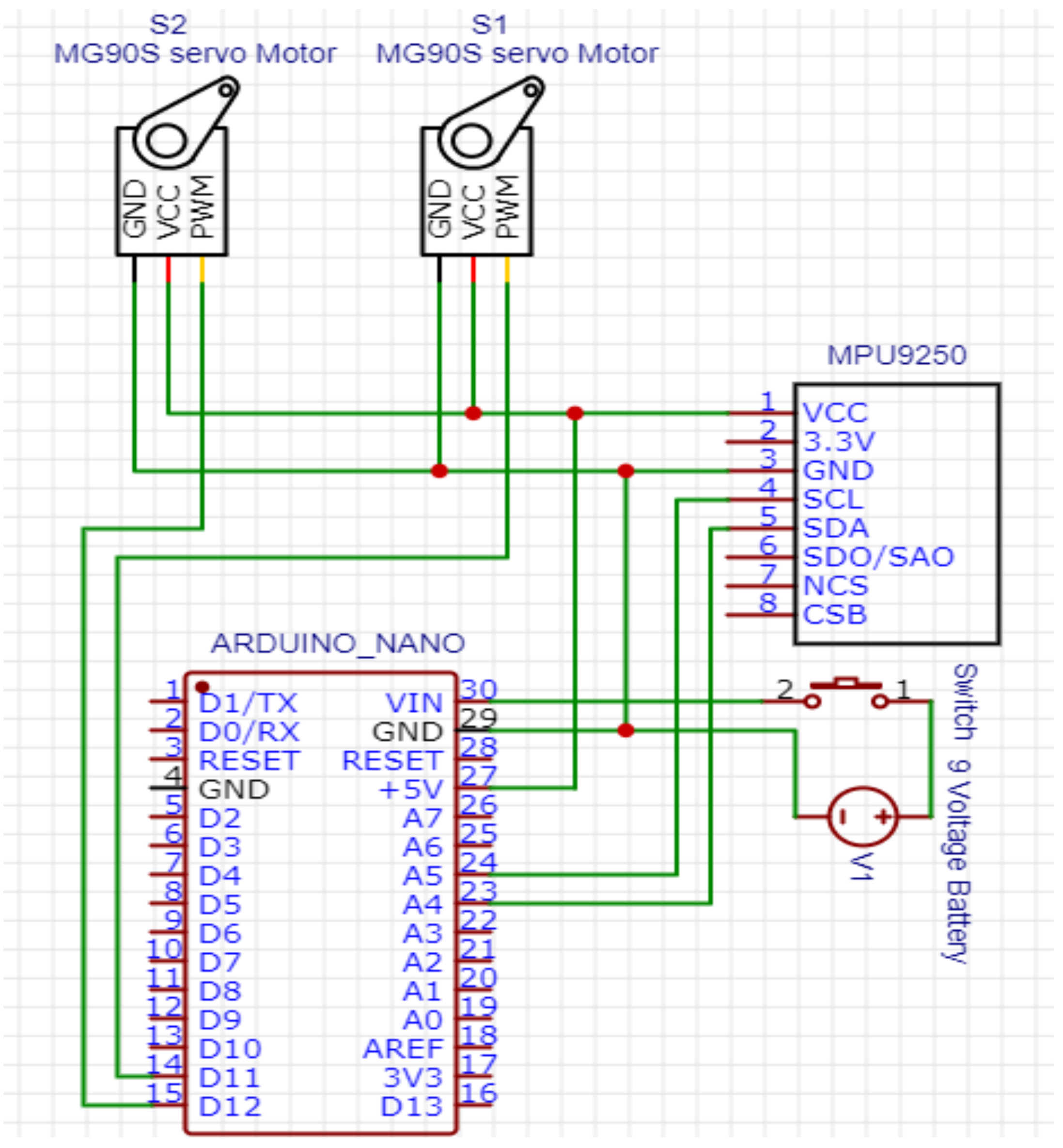

Fig2: Circuit diagram

Prototype

Fig4: Prototype

Results

As far as we conclude We found that the device reduces vibrations significantly, which positively affects the user's hand movement, which makes the user use his hand in several activities.

Conclusions

People with tremors suffer both physically and mentally as a natural result of their tremors, as they are dependent on others to do their basic life activities. We believe that by stabilizing hand tremors, our device will enable people with tremors to work independently. The use of MEMS in our project will assist in overcoming the limits of prior proposed designs and will significantly improve the quality of life of people suffering from tremors.

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Rfid Based Door Lock Authentication Using Gsm

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Abstract

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.

Introduction

The need to secure our home, industries and other related properties has been a subject of interest since the days of our forefathers, since then, an aggressive development in the area of security has exponentially been driven to today's trend.

A system cannot have high assurance if it has poor security and requirements. For high assurance, systems will logically include security requirement as well as availability, reliability, and robustness requirements. The early-men, in their effort to provide security to their house-hold and properties, used crude measures such as stones, grasses and crude weapons to secure themselves.

As the intrusion techniques by intruders outgrows the then security measures and more values added to lives and properties, ore sophisticated measures were developed to ensure an intruder proof environment, which today, has become one of the most interesting aspects of individual, National and even international concern.

However, traditional locks and even some electronic locks can still be picked or hacked, leaving the security of the property at risk. Additionally, traditional locks also require physical keys or manual input, which can be lost or forgotten, making the property vulnerable to unauthorized access.

Objective: to establish a reliable and a robust FANET for search and rescue scenario using multiple UAVs with AODV routing protocol with wide-range coverage and minimum end-to-end delay.

Methodology

This project to implement it to overcome this problem and solve it. our solution depends on the Radio Frequency Identification (RFID) Based Access Control Security system with GSM technology presented in this work helps to prevent unauthorized access to controlled environments (secured premises).

Discussion

1. Arduino microcontroller consists of several key components:

•Microcontroller: The heart of the Arduino board is the microcontroller, which is responsible for executing the user-written code. The most common microcontroller used in Arduino boards is the AVR microcontroller from Atmel.

•Input/Output (I/O) Pins: The I/O pins allow the microcontroller to interact with the outside world by reading signals from sensors or controlling actuators like LED's and motors.

•Power Supply: Arduino boards can be powered through the USB port or by an external power source, such as a battery or a wall adapter.

•Reset Button: The reset button is used to restart the microcontroller, which is useful when uploading new code to the board.

•Crystal Oscillator: The crystal oscillator sets the clock speed for the microcontroller and helps to ensure accurate timing of the code execution.

•Voltage Regulator: The voltage regulator helps to ensure that the microcontroller receives a stable voltage, regardless of fluctuations in the input power.

•USB Port: The USB port is used to connect the Arduino board to a computer for uploading code and for communication between the board and the computer.

2. These are the main components of an Arduino microcontroller board, but there can be variations depending on the specific model of the board.

the steps involved in building an RFID-based door lock authentication system using GSM:

Initialize the components: Connect the RFID reader, GSM module, and microcontroller (Arduino) to each other.

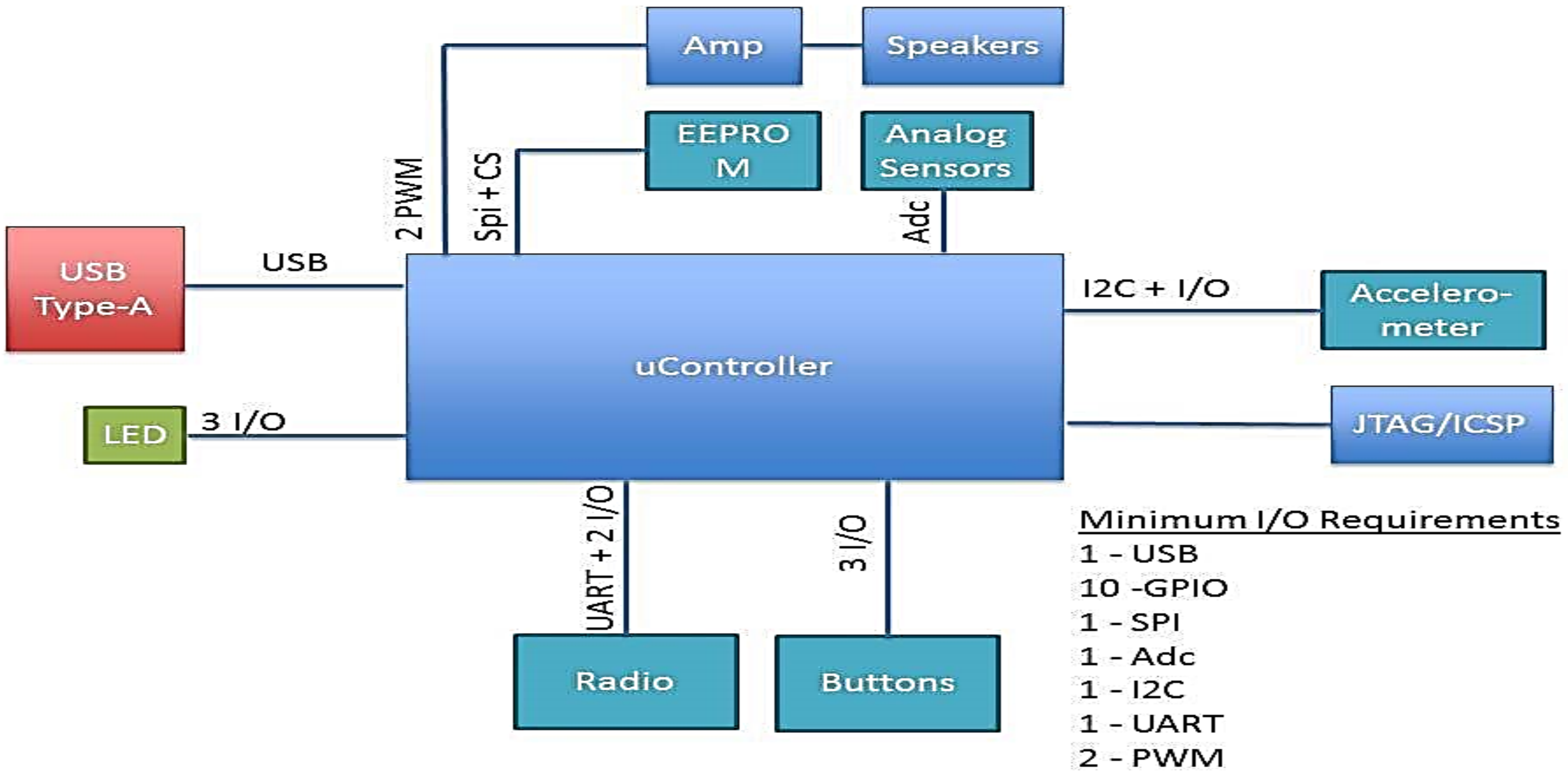
Read the RFID tag: The RFID reader will read the tag when a user brings it close to the reader.

Send the tag data to the microcontroller: The microcontroller will receive the data from the RFID reader and process it.

Verify the tag data: The microcontroller will compare the tag data with a database of authorized users to determine if the user is authorized to access the door.

Control the door lock: If the user is authorized, the microcontroller will send a signal to the door lock to unlock it. If the user is not authorized, the door will remain locked.

Send a message: If the door is unlocked, the microcontroller will send a message via the GSM module to notify the authorized user or administrator.



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

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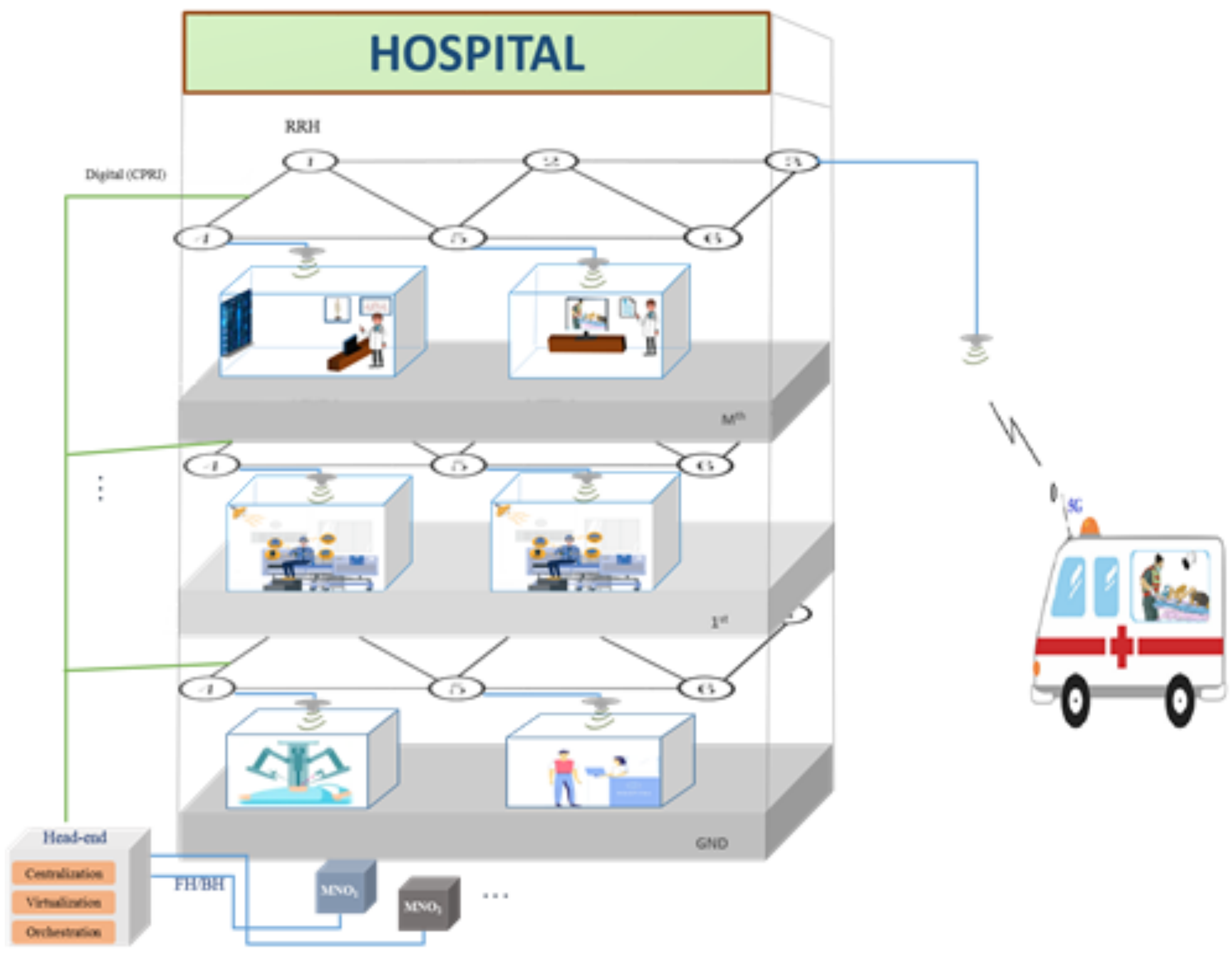
Abstract

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). This is especially true for medical facilities considering the diverse requirements of its emerging use cases. In this project, we propose a novel design algorithm that incorporates neutral host technology and High-availability Seamless Redundancy (HSR) protocol capable of satisfying 5GB Ultra Reliability Low Latency Communication (URLLC) requirements of medical facility use cases. We formulated the system design as an optimization problem, which we have implemented and evaluated over various deployment scenarios to measure its performance considering availability and delay. Finally, simulation results show that our proposed design algorithm achieves significant cost savings while satisfying a target level URLLC for different 5GB-enabled medical facility use cases.

Introduction

- 5GB mobile networks represents a disruptive change to mobile communications systems when compared to its predecessors promising a maximum data rate of 20 Gbps and latency below 1 ms utilizing NR-antennas of higher frequency bands 30 – 300 GHz.
- However, MNOs are facing a TCO – ROI imbalance problem in rolling-out 5GB mobile networks due to the huge number of NR-antennas and the amount of power consumption involved.
- The problem is further exaggerated when considering indoor venues, especially in medical facilities where multiple MNOs are required to collocate, URLLC requirements are various and more stringent, and applications and case cases (such as wearables, connected ambulance, robotic surgery and HDT health monitoring) are the most diverse.



- Compared to conventional solutions, neutral host technology represents an attractive solution for the deployment of 5GB networks of medical facilities as it allows for multi-tenancy, centralized control over resources, and infrastructure sharing.
- In our proposed design we incorporated HSR protocol with neutral host technology to provide medical use cases with stringent URLLC requirements.

Medical Facility Use-Case	5GB Requirements			
	e2e delay (ms)	Jitter (ms)	Availability (%)	Data rate Gb/s
Robotic Tele-surgery	5	2	99.999%	2
Wearables	250	25	99.9%	0.005
Connected Ambulance	10	2	99.999 %	1
HDT - Health Monitoring	0.5	0.01	99.9999%	1

Methodology

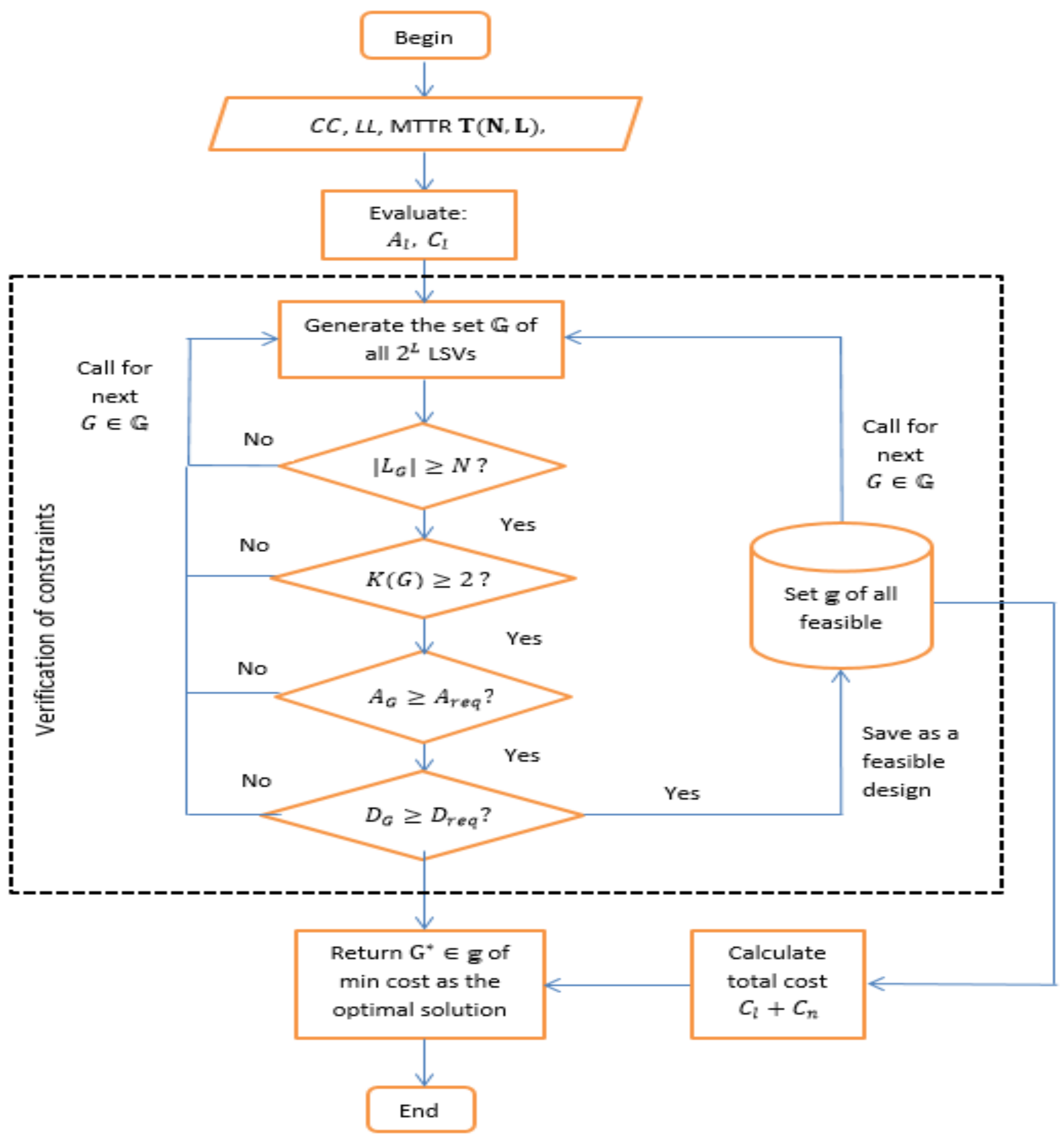
Our optimization problem of designing a 5GB compliant neutral host for medical facilities and use cases is formulated as below:

Objective:

$$G^*(L,N) = \arg\min_{G\in\mathbb{G}} \sum_{m\in M}\sum_{n\in N}\sum_{l\in L} C_l + C_n$$

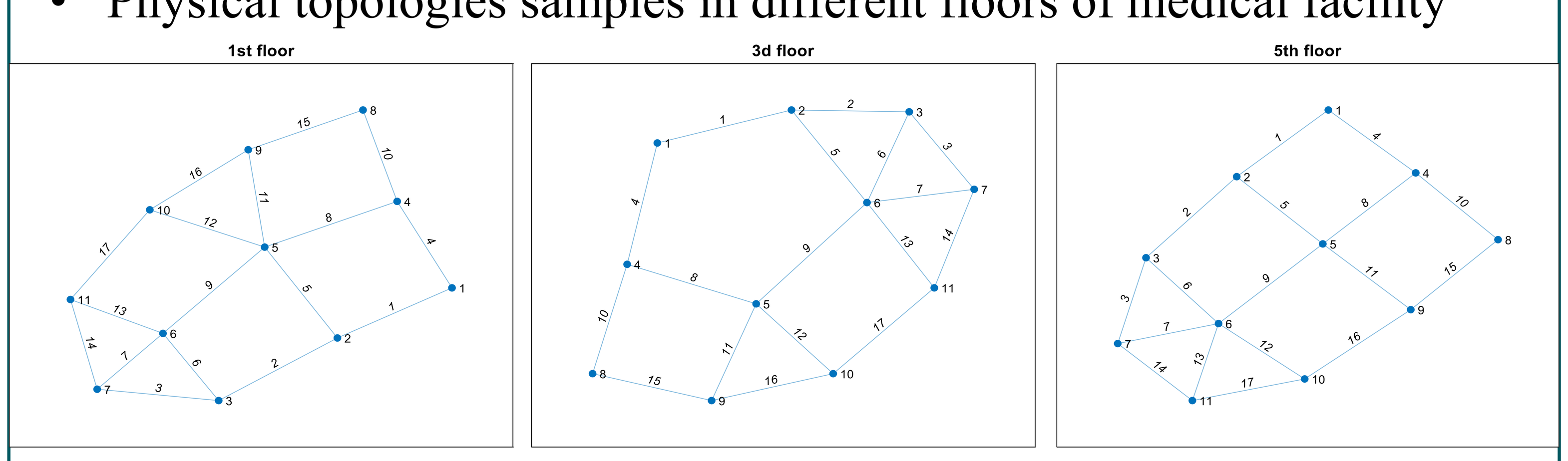
Subject to:

$$|L_G| \geq |N| \quad (1)$$
$$K(G) \geq 2 \quad (2)$$
$$A_G \geq A_{req}(S_i) \quad (3)$$
$$D_G \leq D_{req}(S_i) \quad (4)$$

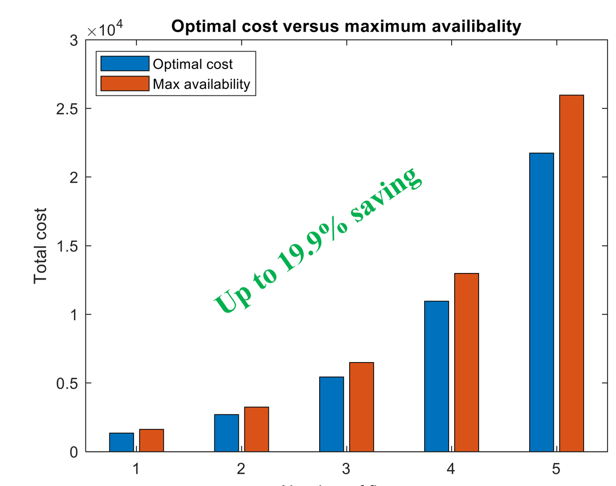


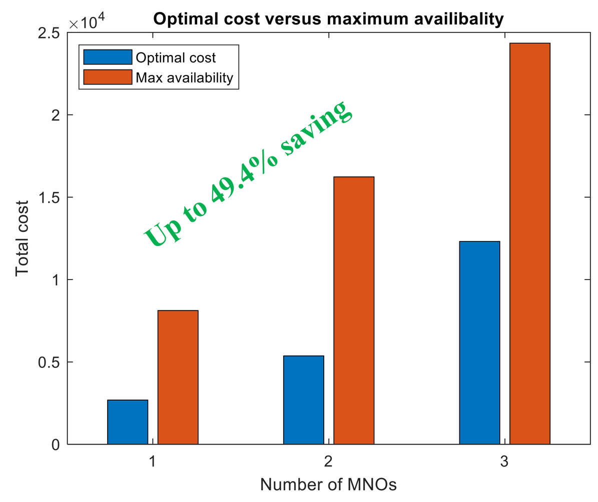
Results & Discussion

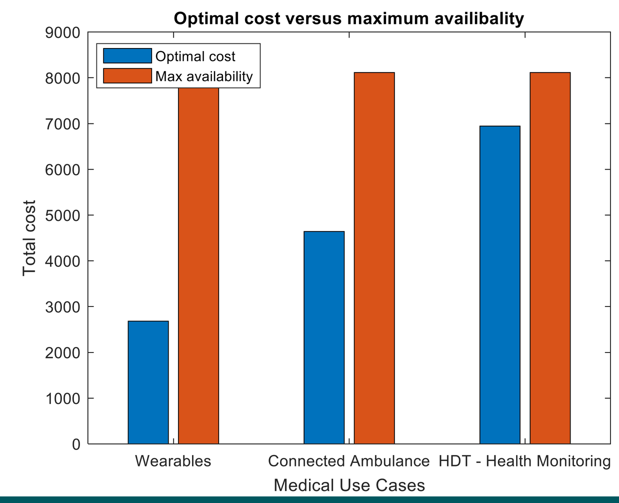
- Physical topologies samples in different floors of medical facility



- Results of optimal design (Min. Cost) in comparison with worst design (Max. Availability) considering cost over different floors, MNOs, and use cases.







- Satisfying URLLC Requirements in terms of Availability and Delay.

Hospital Floor No.	Design Av (%)	Design Delay (ms)
1	99.991946	1.105
2	99.990000	1.105
3	99.990049	1.035
4	99.990053	0.895
5	99.991750	1.470

Conclusions

- We presented a cost efficient design for indoor network access based on neutral host technology and HSR protocol capable of serving medical facility use cases considering their stringent URLLC requirements, which was infeasible using conventional solutions.
- The proposed design assumes that each MNO has their own physical topology while sharing the headend of the neutral host system. This can be extended to allow logical sharing with special attention to capacity dimensioning.
- To find the optimal design, our algorithm relies on exhaustive search, which becomes infeasible when designing for large scale network topologies for which the use of heuristic algorithm is necessary.

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AI Based Navigation Algorithm For Traffic Congestion Avoidance Utilizing 5G Beyond (5GB) Vehicle To Everything (V2X) Network

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Abstract

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. In this project, 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.

Introduction

Traffic congestion is a problem that has grown in prominence over the past few decades to now become a global issue concerning its detrimental impact on the economy and environment. Due to traffic congestion, Saudi Arabia witnessed an increase in car accidents, which led to an increase in traffic-related fatalities.

This problem must be solved because many people suffer from traffic congestion and the constant commuting delay, so we decided to implement a system to solve this problem.

Our proposed solution is to implement the new generation of information and communication technology cellular vehicle-to-everything (C-V2X), where vehicles are able to react by themselves to changes in their surroundings such as infrastructure (V2I), a pedestrian (V2P), network (V2N) and other vehicles (V2V) with low latency and high reliability. Utilizing C-V2X technology will improve traffic efficiency and reduce fuel consumption and carbon emission at the same time. C-V2X can also provide drivers with information about on-road hazards, which they otherwise would not be able to see and this can help reduce traffic related deaths.

Methodology

Our system consists of three layers, a terminal layer, edge layer and a cloud layer:

I- Terminal layer (OBU):

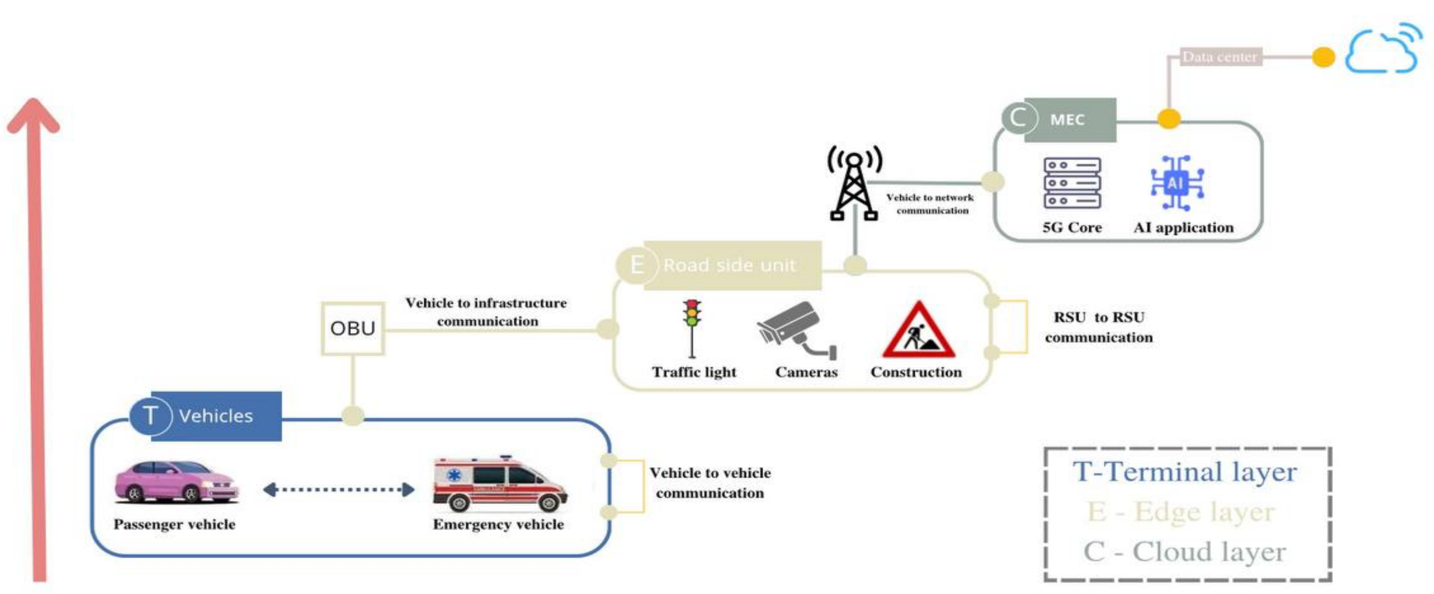
- It Is the closest layer to the end user.
- Vehicles can exchange data with their surroundings using the on board unit OBU.
- The OBU provides communication with the edge layer.

II-Edge layer (RSU):

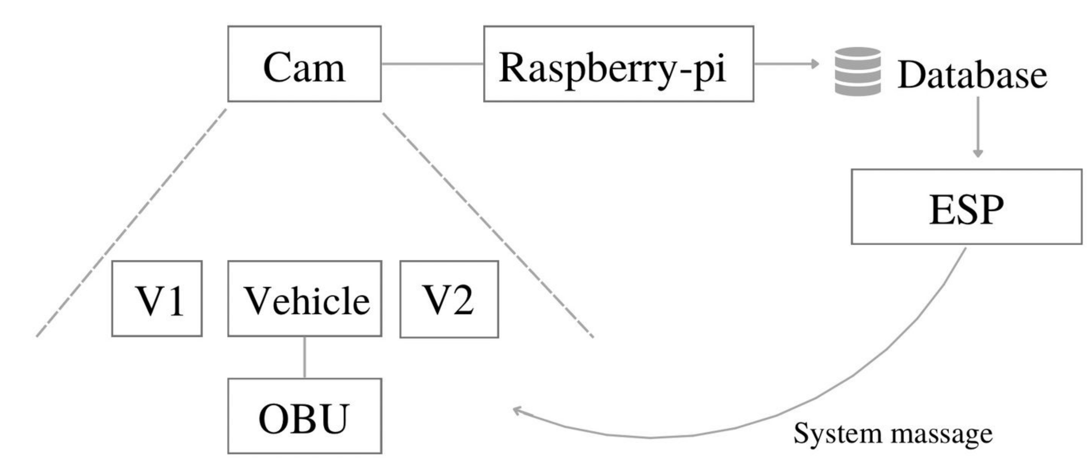
- It is located at the edge of the network and consist of large number of edge nodes called multi edge computing MEC.
- Its main function is to calculate, transmit and store data temporarily at the edge of the network in real time.

III-Cloud layer :

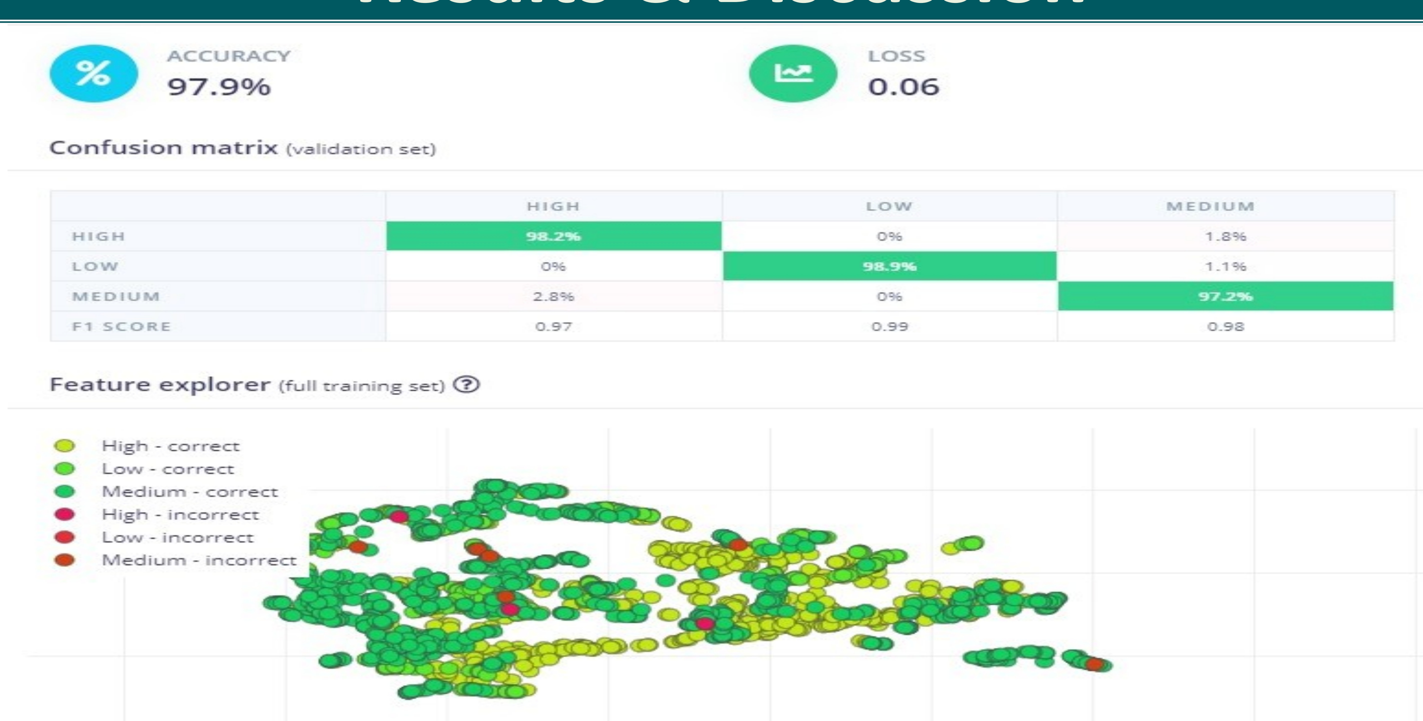
- Includes numerus high performance servers and storage units.
- It can also preform wide range of computational analysis and store data permanently.



- RSU consists of a camera and an Arduino both are installed on a road infrastructure.
- Multi edge computing (MEC) decides wither the car should stay on the road or make the nearest exit according
  - Amount of cars on the road.
  - The space between each car.
- Real time LED screen (OBU) displays the systems notification to the driver.



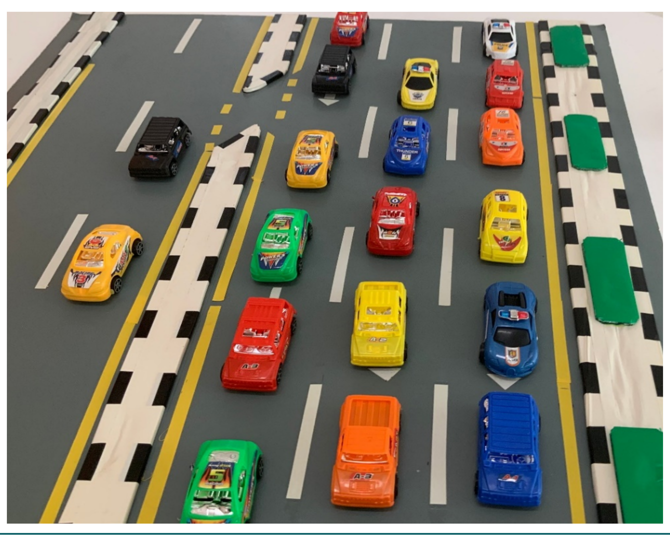
Results & Discussion



	HIGH	LOW	MEDIUM
HIGH	98.2%	0%	1.8%
LOW	0%	98.9%	1.1%
MEDIUM	2.8%	0%	97.2%
F1 SCORE	0.97	0.99	0.98

By implementing the proposed system, we have achieved the following results:

- The multi edge computing is capable of reading the road condition which could be:
  - High traffic condition.
  - Medium traffic condition.
  - Low traffic condition.
- The road side unit receives information about the traffic condition from the multi edge computing, and based on the information RSU broadcasts a message to the drivers on the road in real time.
- By using edge impulse software simulation, the accuracy of the system was 97.9%.



Conclusions

In this project, we have designed a V2X system to improve traffic congestion and reduce carbon emissions. By using the roadside unit, onboard unit, and multi-edge computing. Our system is able to detect whether the road is congested or not accurately. The onboard unit is able to receive information from the multi-edge computing and display it to the driver.

The proposed system was tested via simulation in several scenarios. The final results prove the high accuracy of our proposed approach. This method can be expanded in different transportation areas to reduce traffic congestion and prevent accidents.

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

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Abstract

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 aim of the project is to analyze the cause of an accident, record real-time data of the vehicle, and help insurance companies with their claim settlement and reduce the response time by authorities and emergency services . 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.

Introduction

Traffic accidents are a globally growing issue that leads to fatalities and disrupts communities. According to the World Health Organization, road traffic injuries were the third leading cause of death in Saudi Arabia, as shown in Figure 1.1. One of the important problems with road traffic accidents is associated with the investigation process. The proposed system is a car black box that will help to reduce the response time by authorities and emergency services, analyze the cause of an accident, record real-time data of the vehicle, and help insurance companies with their claim settlement. Also, it helps the research sector to improve vehicle design, driver education programs, and safer road design. By utilizing different sensors, a microcomputer collects data before, during, and after the accident. Global Positioning System (GPS) determines the accident location to send an alert message to the pre-stored number.

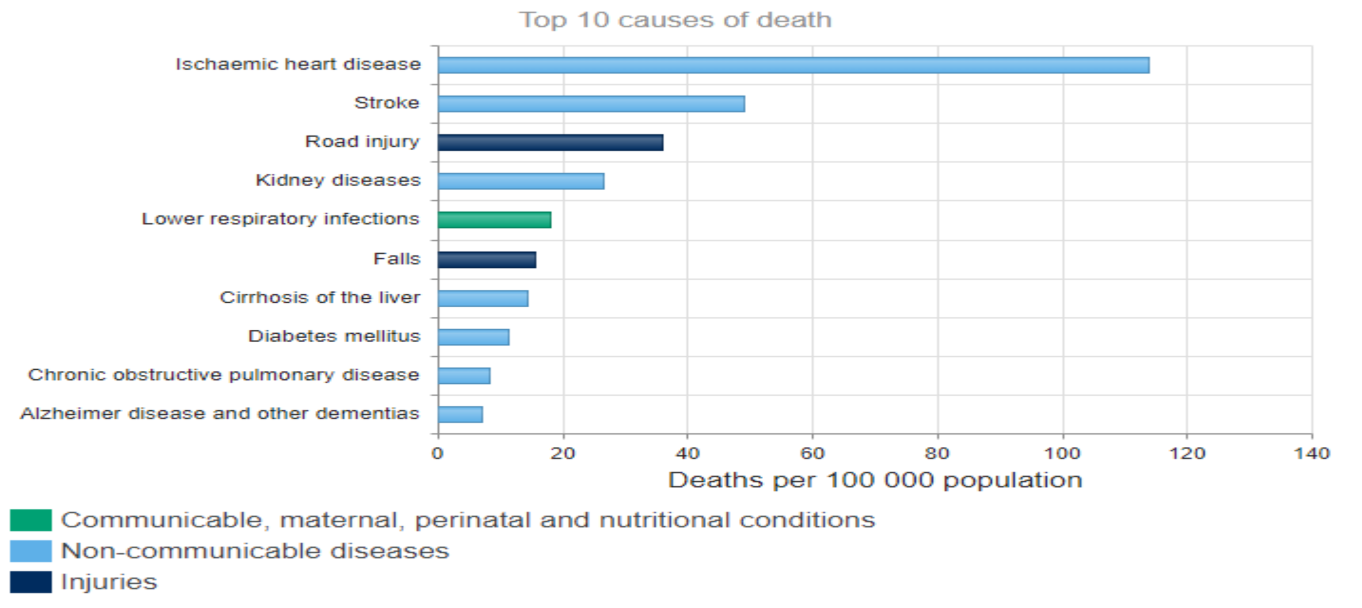


Figure 1.1: Top 10 Causes of Death in Saudi Arabia for Both Sexes Aged all Ages (World Health Organization, 2019)

Methods and Design

The project is being managed using the Waterfall Methodology as shown in Figure 2.1, which is a straightforward approach to project management that involves completing each stage of the project before moving onto the next.

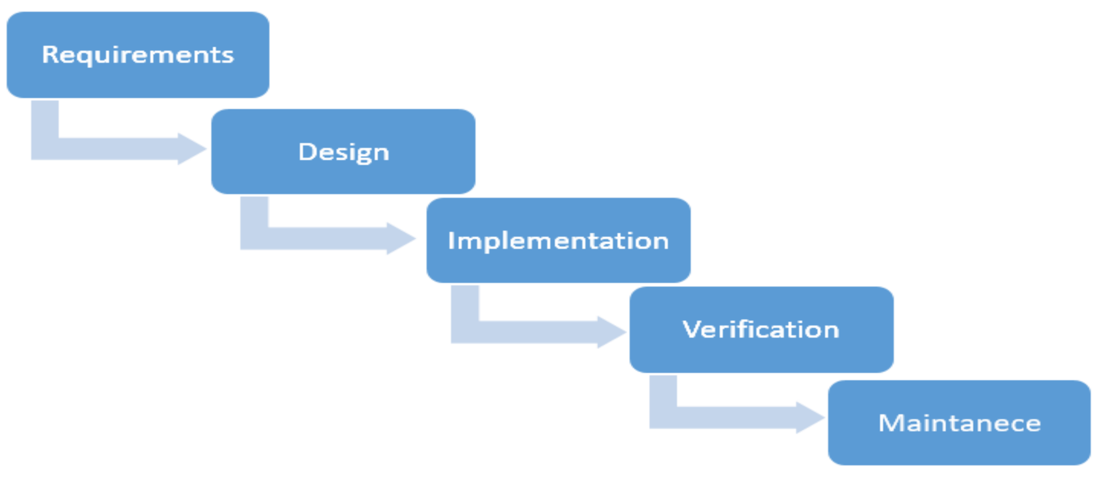
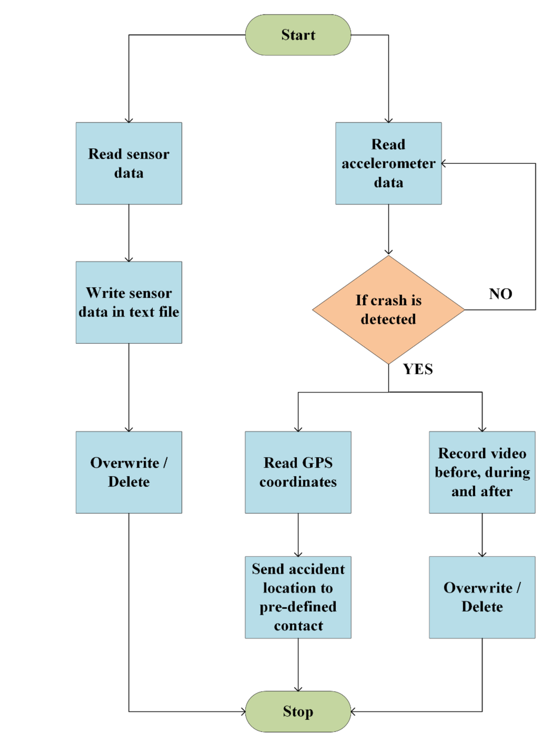


Figure 2.1: Waterfall Method.

The flowchart of the overall system is shown in Figure 2.2. The working is divided into two parts: data recording and video recording. When an accident occurs, the GPS coordinates along with an alert message are sent to the pre-stored numbers. The sensors readings are stored in the SD card to be analyzed. The system architecture of the proposed system is shown in Figure 2.3. Raspberry Pi linked with multiple sensors, GPS module, SD card. and Raspberry Pi camera.



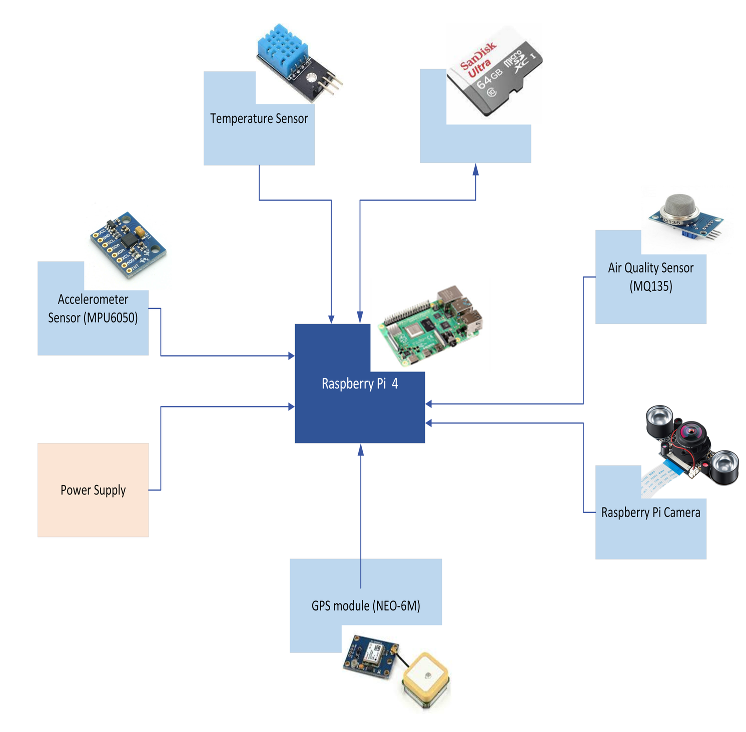


Figure 2.2: System Flow Chart. Figure 2.3: System Architecture.

Results and Discussion

The prototype was implemented as shown in Figure 3.1. The system was designed to log sensor data, record dash-camera footage, as well as alert an emergency contact as soon as a crash is sensed.

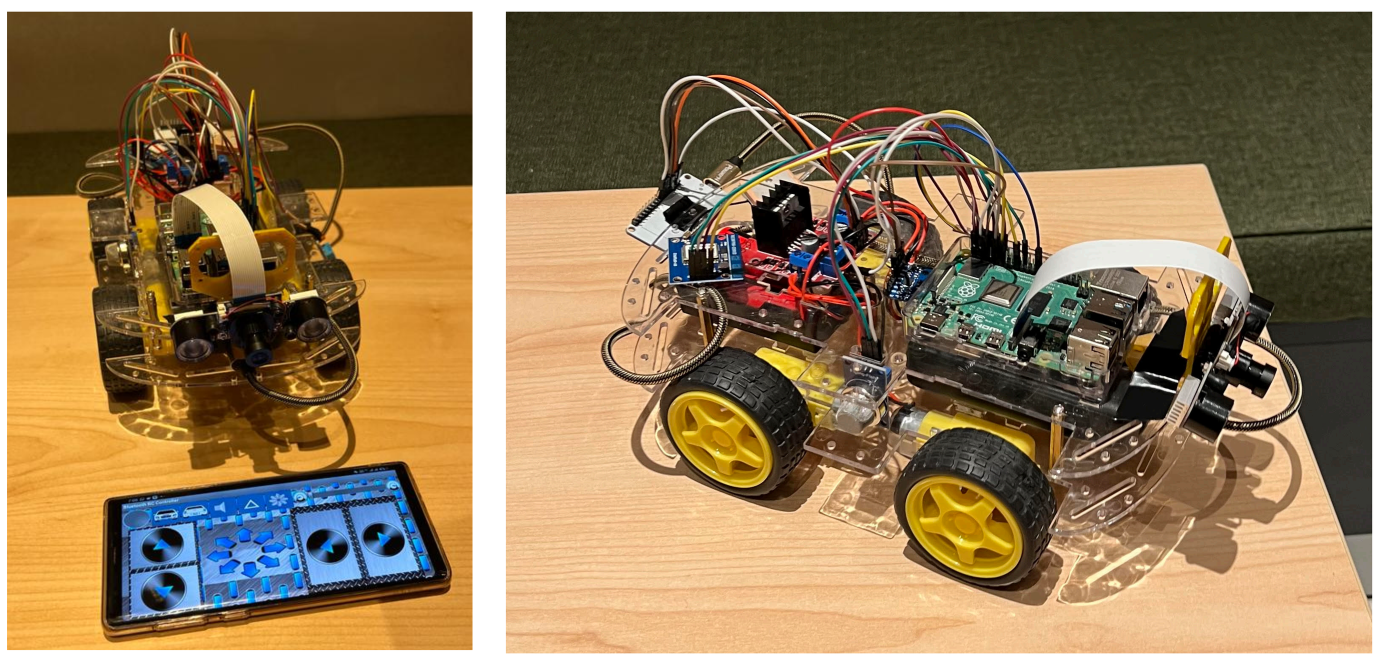


Figure 3.1: Prototype Implementation.

Testing of the prototype took place in two phases. First, the components were programmed and tested individually. Second, the prototype was tested as a whole. Figure 3.2 below shows the final test output screens results.

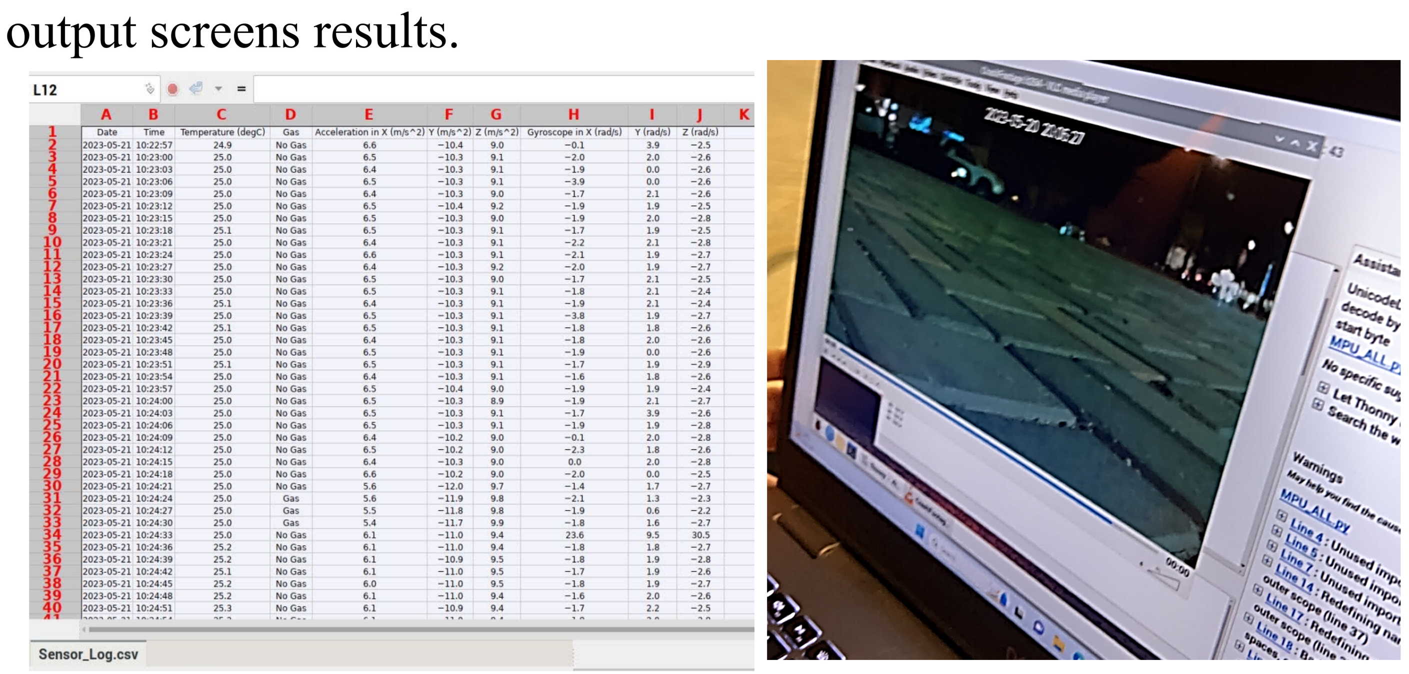


Figure 3.2(a): Data Recording Output Screens.

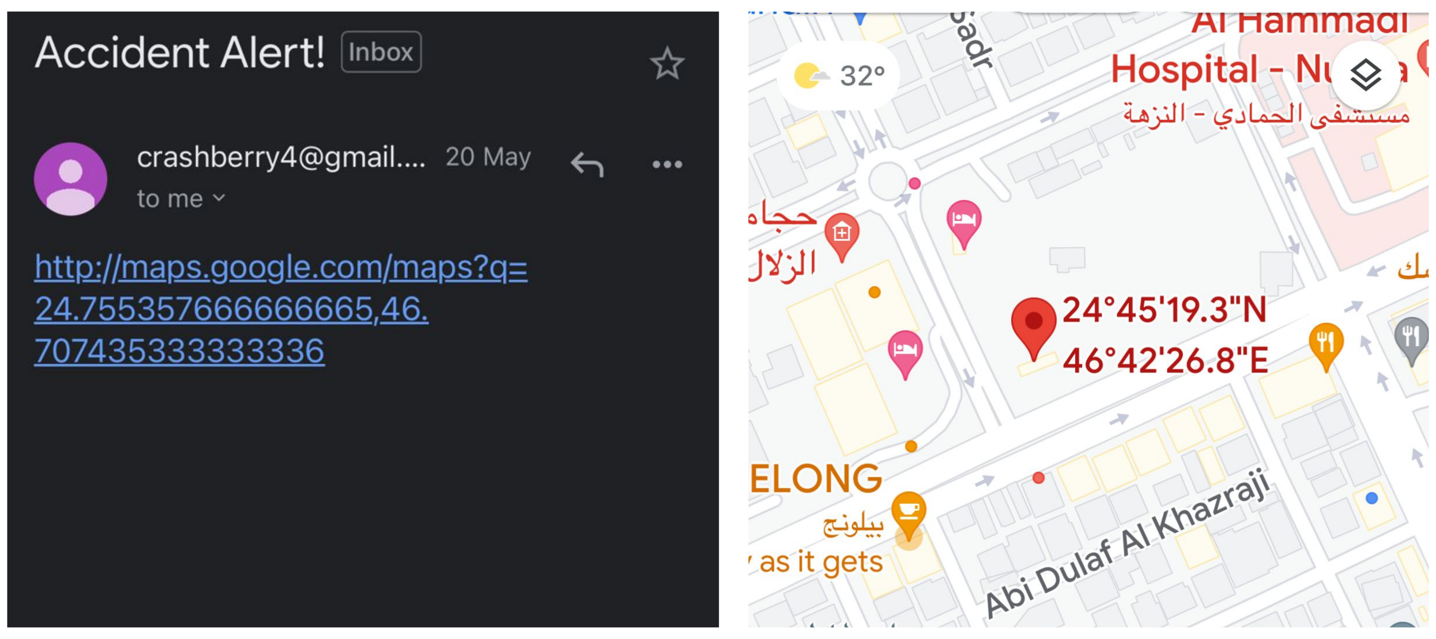


Figure 3.2(b): Emergency Alert Output Screens.
Figure 3.2: Results.

Conclusions

The development of a Vehicle Black Box was achieved. The proposed system employed hardware and programming to read data, store, and retrieve. For the future, the following in sought:

- To interface the system to a real-time vehicle to gather real-time data.
- To incorporate machine learning algorithms.
- To include further test runs for varying road conditions.

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Li-Fi Network Solution in Hospitals

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Abstract

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. This project applies said technology in the medical field and hospitals as the rapid development in medical technologies and the rise of 5G and IOT require high amounts of data transfer and ultra-low latency especially with remote surgeries. Also, to help with the issue of Radio Frequency (RF) and Electromagnetic interference (EMI) that impacts the medical devices and equipment. This solution is proposed to solve the lack of communication link 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, also Li-Fi systems can be much lower in cost as LED's are cheap and easy to acquire. A Li-Fi based patient monitoring system is designed and implemented using Arduino UNO boards. The result is a transmitted signal provided by the used sensor through light.

Introduction

Li-Fi is a technology similar to Wi-Fi, they both transmit and receive data wirelessly, with Wi-Fi using radio frequency in the radio spectrum, and Li-Fi using light frequency in the visible light spectrum as shown in **figure 1**. The working principle of Li-Fi is simple, receiving the light indicates connection, and blocking it indicates disconnection. Li-Fi has many strengths over Wi-Fi such as speed, capacity, security, and cost. But it also has its limitations which are the coverage and its limited range.

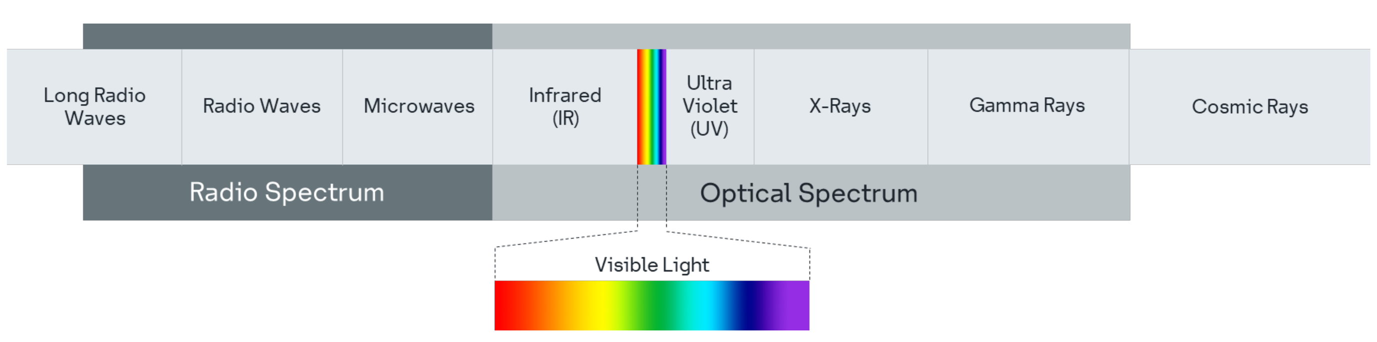


Figure 1: Electromagnetic Spectrum

Medical professionals highly depend on machines and connectivity. But there is the problem of Electromagnetic Interference (EMI) and the impact of Radio Frequency (RF) on not only humans but medical equipment as well. There also is the lack of communication link in the medical field, additionally the delay especially in this kind of field impacts the human life greatly. To accommodate these problems we propose the following solution; Designing a network or a system that utilizes Li-Fi to cover or serve specific areas and tasks in a hospital.

Methodology

We have chosen to design and implement a real time health monitoring system that operates on Li-Fi technology; the vital signs data of the patients is transferred through the transmitter part of the circuit using Arduino UNO, when the patients is connected with the sensors (i.e.: pulse rate, temperature, respiration rate…etc.), this value is then translated by Arduino to a binary value that can be fed to the LED, in which the LED starts to flicker according to the binary value (0 → off , 1 → on). Then at the receiver end of the circuit the photo detector/ transistor senses the visible light pulses emitted from the LED and converts the binary signals back to its original form using Arduino board, which in turn is sent to the receiver device and displayed accordingly. This project consists of two parts a transmitter circuit and a receiver circuit. **Figure 2** shows a block diagram of the system.

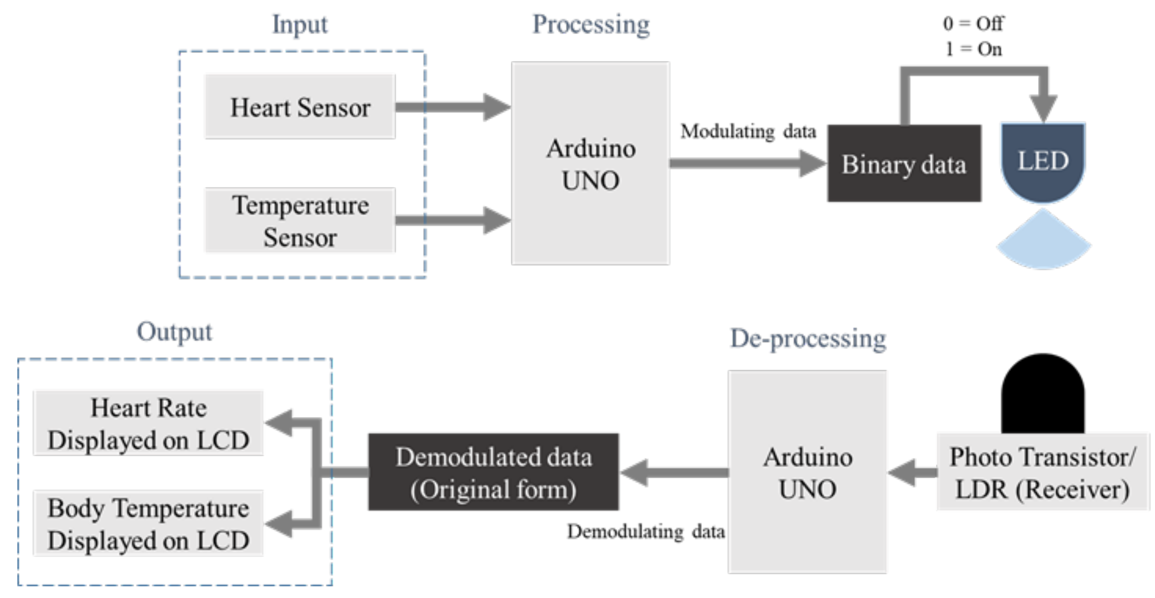
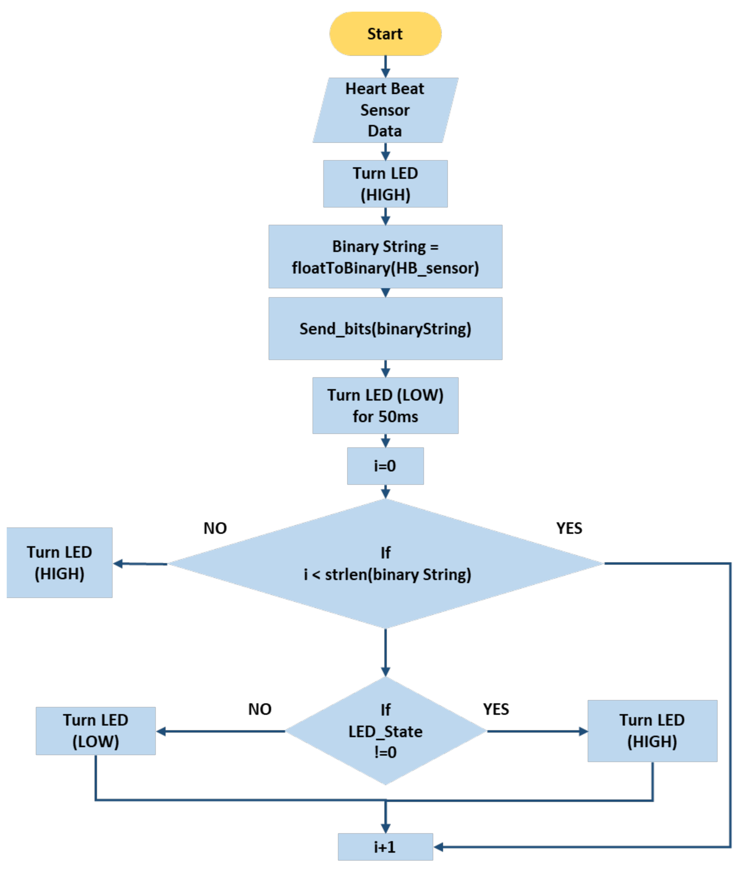
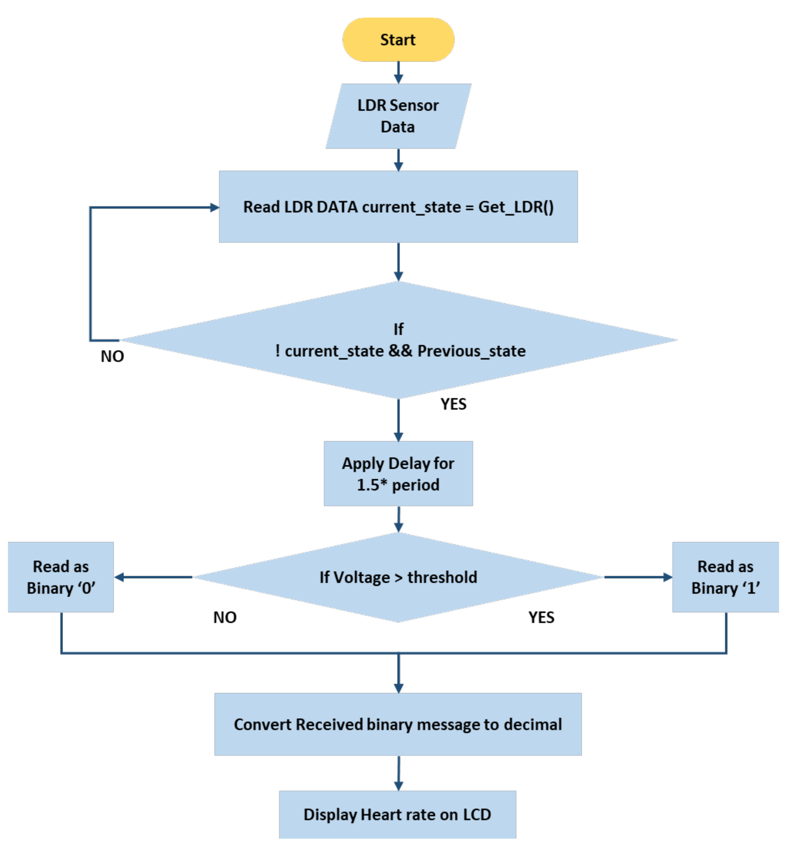


Figure 2: Monitoring System Block Diagram

Transmitter Flowchart



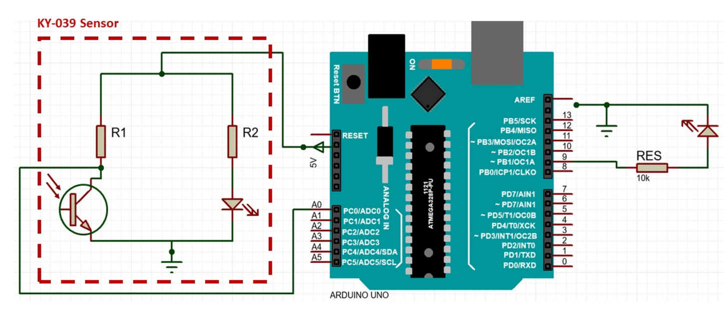
Receiver Flowchart



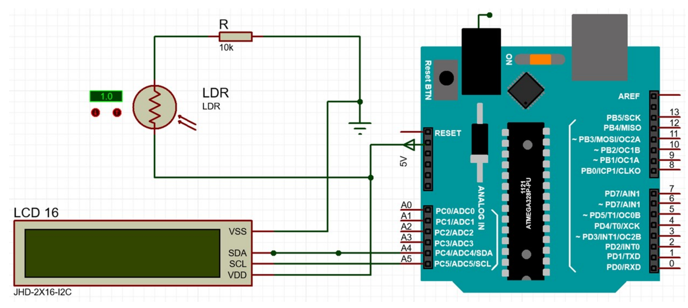
Results

Transmitter components		Receiver components	
Input	Heart rate sensor (KY-039)	Li-Fi receiver	LDR
Data modulation	Arduino Uno Board	Data demodulation	Arduino Uno Board
Li-Fi transmitter	LED	Output	• 16*2 Alphanumeric LCD • I2C Interface module for LCD

Transmitter Circuit Diagram:



Receiver Circuit Diagram:



- The heart beat sensor read measurements per ms .
- The light always kept high at the Tx .
- To start transmitting a change from "on" to "off" state must done as preamble.
- The receiver must recover the message after 1.5 *period of delay time to avoid reading the preamble.
- Binary received message then converted to decimal using this formula:

$$A = x_n * b^n + x_{n-1} * b^{n-1} + \cdots x_1 * b^1 + x_0 * b^0$$

Where; A =integer, x = binary bit, b =2.

- After recovering the message successfully it displays heart beat rate on ICD screen

Figure 3 shows a visual of the prototype to be implemented

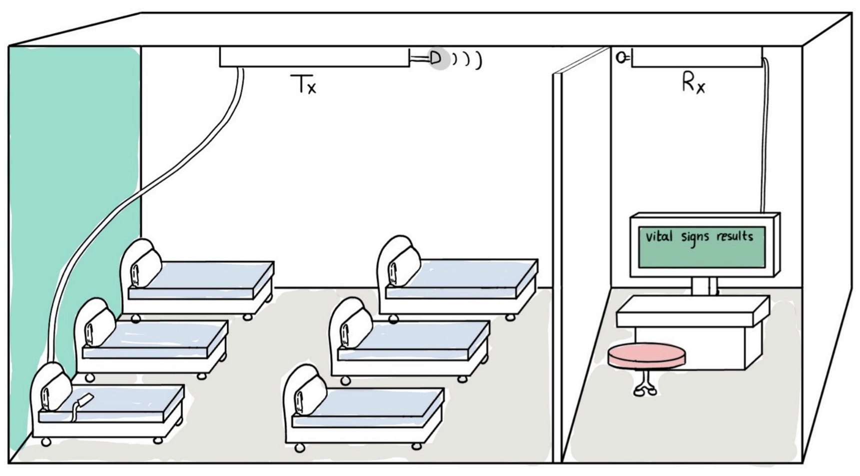


Figure 4: Prototype Visual

Discussion

The main concept behind Li-Fi technology is "data through illumination" meaning light intensity can greatly effect the transmission of information, as we went through this project we have confirmed this statement through experiment. We have implemented the transmitter circuit with different colors of light. It was noticeable that the results of transmission got more accurate when using lights with greater wavelengths. We got the best results using green, blue and white LEDs. Figure 4 shows that white light has the highest wavelength thus is the strongest, also the graph is showing the IV characteristic for each LED color.

	Wavelength (nm)	Color Name
	660	Special Red
	635	High Eff. Red
	633	Super Red
	623	Red Orange
	612	Orange
	592	Amber Yellow
	585	Yellow
	3500K	"Incandescent" White
	5000K	Pale White
	6500+K	Cool White
	574	Super Lime Yellow
	570	Super Lime Green
	565	High Efficiency Green
	560	Super Pure Green
	555	Pure Green
	525	Aqua Green
	505	Blue Green
	470	Super Blue
	430	Ultra Blue

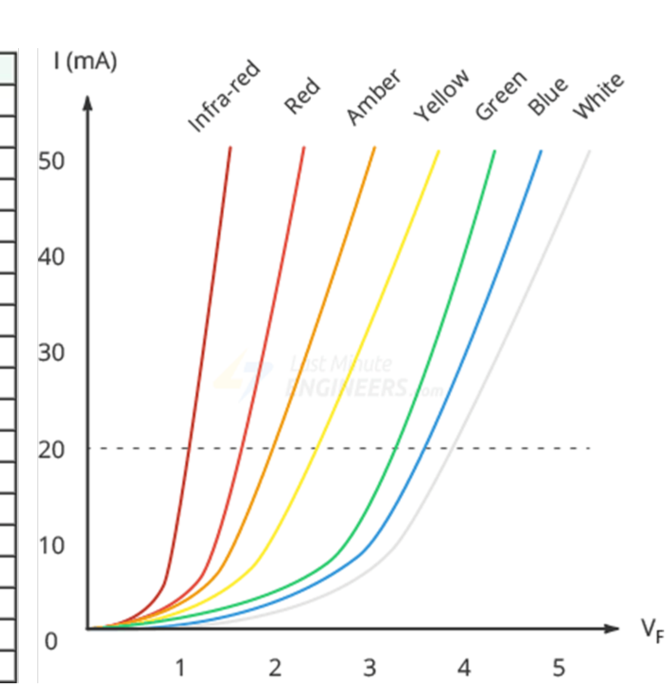


Figure 4: Light Color characteristics

Conclusions

This project explores Li-Fi technology and how it can improve hospital connection with medical devices and equipment to meet their needs using the high data transmission speed and the high power of Li-Fi. This Li-Fi system has been implemented by designing and building a hardware prototype. In addition to showing the capabilities and opportunities that Li-Fi offers. The project results shows the possibility of transferring data through light frequency which solves problems caused by EMI in the medical field.

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Air Pollution based Traffic Light Congestion Control System

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Abstract

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.

Introduction

TRAP is a primary source for gas exposure around the world. Most of the Saudi population is regularly exposed to TRAP from their daily activities. A considerable portion of the population residents are near major highways, with that TRAP is considered a risk factor. Our problem statement is: poorly timed and poorly coordinated traffic lights can increase traffic congestion, which impedes the flow of traffic leading to increase TRAP.

The safe and efficient movement of vehicles at intersections is the primary goal of traffic signal control, which includes the following: Reduce the time of traffic lights on uncrowded roads and increase the time on congested roads to optimize traffic flow and reduce greenhouse gases such as CO2, CO etc. Various types of sensors could be used to measure air pollution. These sensors use technologies such as gas chromatography, optical fiber, semiconducting metal oxide, and calorimetry. MQ-135 sensor detects NH3, C6H6, NOx, smoke, and CO2. The sensor is a well-known, low-cost electrochemical sensor. Because of its low cost, simple driver circuitry, and long-life span, this sensor is more popular. This sensor is used in a wide range of research applications, including pollution monitoring, food quality monitoring, odor detection, electronic nose, and beer quality monitoring. This sensor will be used in the TRAP area for this paper.

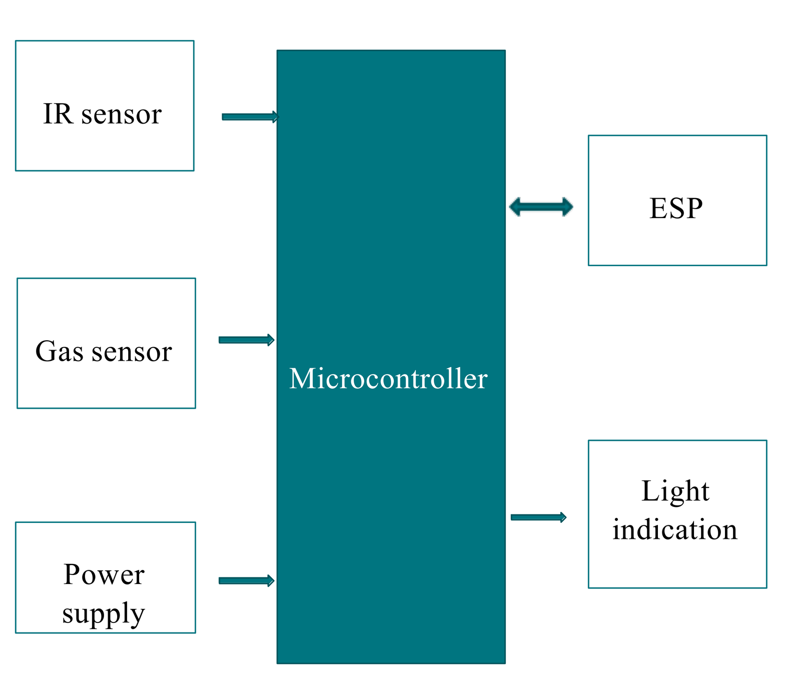

Figure 2.1: Controller block diagram

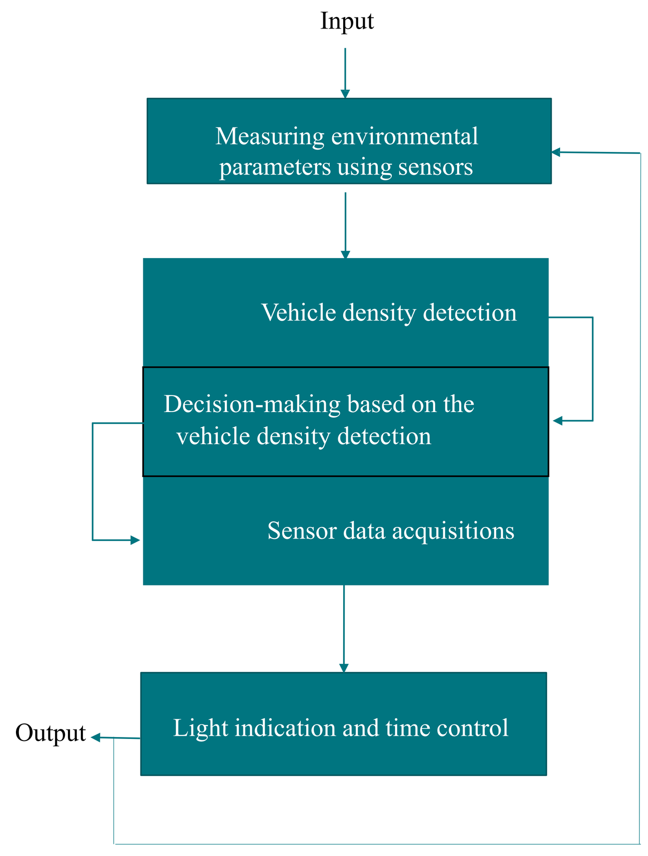

Figure 2.2: System block diagram

Methodology

The design of traffic control system that depends on the surrounding environment rather than registered time is quite unique and depend on several factors such as the estimating car waiting time at a junction, the number of cars , the timing slots for green, yellow, and red lights that best fit the real and veritable situation. The efficient combination of both IR and gas sensor may be challenging. The designed smart traffic light control system corresponds to four junction of two traffic lights leading to four roads in the form of "+" as shown in figure

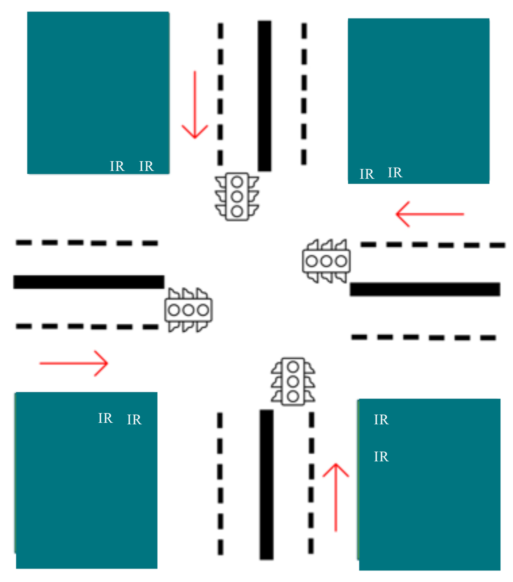

Figure 3.1: IR sensor implementation

The work is equipped with four traffic lights of three colors, green, yellow and red are positioned at the side of the road associated to the car flow coming from roads A and B.

Two pairs of IR transmitters and receivers are established on both side of roads A and B.

The same analysis will apply to the gas sensor except that the gas sensors will be mounted on the top of the traffic light signal to detect and calculate Parts-per-million (PPM) for the emission as shown in figure

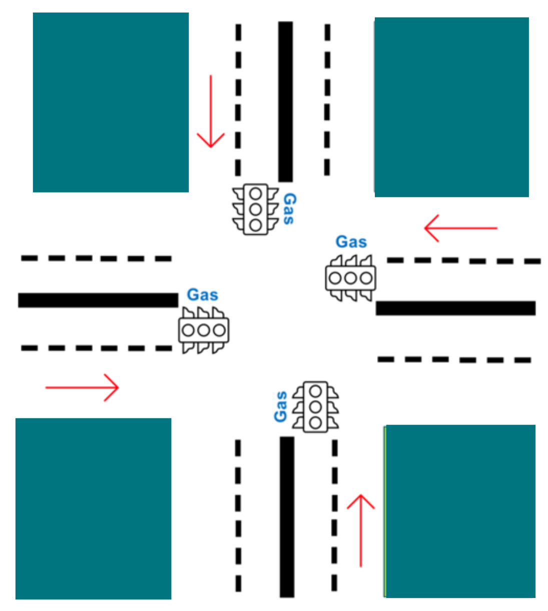

Figure 3.2: Gas sensor implementation

The challenging work is to integrate both sensors together to detect and calculate their desired parameters and link them to the IOT to save and compare these parameters to estimate the best timing slots for each one of the four junctions.

Designing a traffic light control system with vehicle density detection involving several steps, including sensor selection, circuit design, and programming. A simulation circuit design for the traffic light control system is implemented using proteus program and is shown in the figure

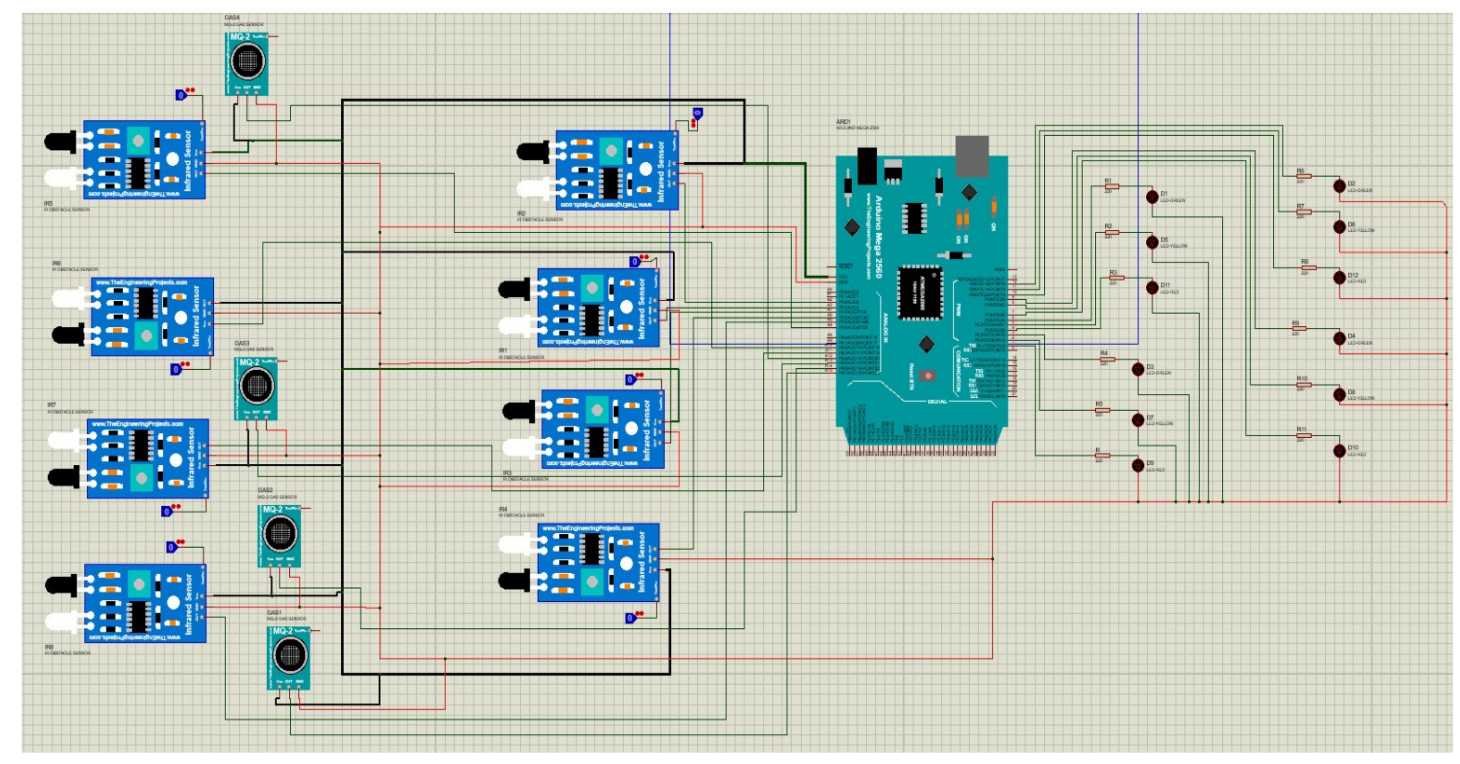

Figure 3.3: Circuit simulation design using proteus

Results

The system demonstrated its effectiveness in dynamically adjusting the timing of traffic lights based on real-time environmental data. By analyzing vehicle density and air quality measurements, the system allocated timing slots to junctions, resulting in improved traffic flow and reduced congestion. The prototype implementation test results shows the effectiveness of the

Table 4.1: IR sensor test cases and results

Case	Junction	No. of vehicles	Light indication	Time (sec)
1	IR Junction 1	0	Off	0
	IR Junction 2	0	Off	0
	IR Junction 3	0	Off	0
	IR Junction 4	0	Off	0
2	IR Junction 1	0	Red	1
	IR Junction 2	0	Red	1
	IR Junction 3	0	Red	1
	IR Junction 4	1	Green	3
3	IR Junction 1	2	Green	3
	IR Junction 2	1	Red	1
	IR Junction 3	0	Red	1
	IR Junction 4	0	Red	1
4	IR Junction 1	1	Red	1
	IR Junction 2	1	Red	1
	IR Junction 3	2	Green	3
	IR Junction 4	0	Red	1

components used in each junction. test results shows the effectiveness of the components used in each junction. The time needed to flip from Red, yellow to green is about 5 seconds.

The implemented smart traffic light control system underwent a comprehensive evaluation to assess its performance and effectiveness in managing traffic flow based on real-time environmental data. The evaluation encompassed various aspects, including system functionality, adaptability to changing traffic conditions, accuracy of sensor measurements, and user experience.

Table 4.2: Gas sensor test cases and results

Case	Sensitivity	PPM in normal condition	PPM in detection range
1	20k ohm	45 ppm	925-898 ppm
2	10k ohm	47 ppm	880 -770 ppm
3	1k ohm	41 ppm	755 – 730 ppm
4	220 ohm	37 ppm	729-700 ppm

Discussion

The smart traffic light control system's evaluation focused on its performance in managing traffic using real-time environmental data. By analyzing vehicle density and air quality, the system adjusted traffic light timings, resulting in improved flow and reduced congestion. Its adaptability and responsiveness were evident across various scenarios, ensuring smooth management even during peak hours.

Accurate sensor measurements played a crucial role in making informed decisions for traffic light timing. User feedback from traffic authorities and drivers confirmed the system's positive impact, with reduced waiting times and smoother driving experiences. Integration of gas and IR sensors facilitated data sharing and remote monitoring, enhancing user-friendliness. Overall, the tested smart traffic light control system efficiently managed traffic by adapting timings based on real-time data, promising enhanced flow and sustainable driving conditions.

Conclusions

Traffic safety and flow are impacted when drivers spend about 2% of their journey time passing through signalized junctions. Using a new system, which is dependent on the surrounding environment and takes several factors into account. To address the issue of traffic congestion, a new framework for dynamic and automatic traffic light control system is proposed in this work. Based on epidemiological studies and reviews, the proposed system's objective is to create a traffic light control system that aids in mitigating TRAP considering the anticipated large body of literature in this area. To be able to set the time duration of red and green light signals automatically and dynamically, we designed a traffic simulation model and a prototype to evaluate system performance.

In conclusion, a successful traffic light control system with vehicle detection should leverage advanced technologies, integrate with other smart city systems, and adapt to changing traffic conditions. By incorporating these features and maintaining a focus on security, sustainability, and efficiency such a system can greatly contribute to improved urban mobility and enhanced quality of life for city residents.

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Sand
Adaptive Above-knee Prosthesis

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Supervised By Dr.Shaeen Kalathil

Abstract

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 prothesis 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.

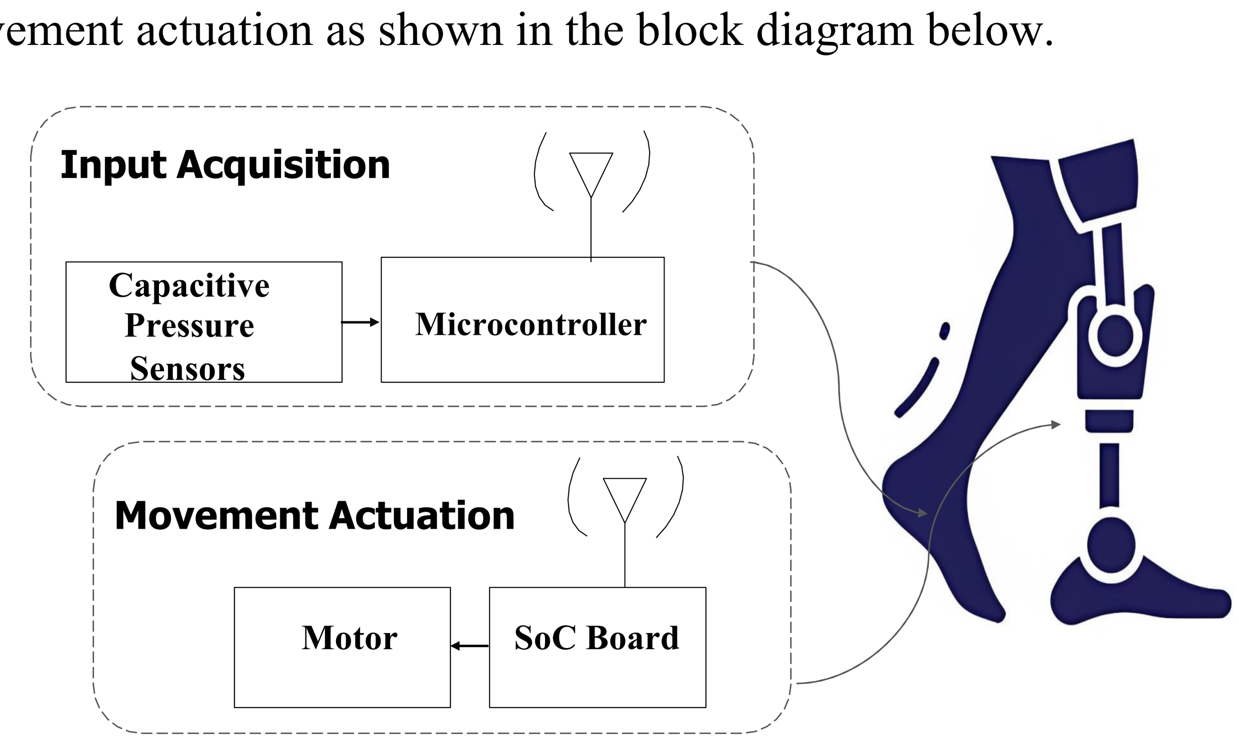
Introduction

All over the world, a lot of people are suffering from limb loss, mainly due to diabetes, road traffic accidents (RTAs), and cancer. Almost half of limb amputations in Saudi Arabia are performed to people suffering from diabetes where lower extremity amputations are more prevalent, above-knee amputation constitutes 26% of these amputations. Artificial limbs with advanced features will be a game changer for millions of people not only in Saudi Arabia but all around the world. Innovation of above knee prostheses has prominently focused on utilizing biological signals mainly EMG and EEG signals as well as microprocessors which are solely based on line-by-line programming . An adaptive above knee prosthetic system employing capacitive sensors and parallel programming is practically inexistant, it's an understudied approach that can greatly increase the efficiency of the prosthetic in the present day. Our proposed solution, **Sanad**, mainly consisting of two phases. Firstly, a shoe insole on the healthy leg that has four capacitive sensors connected to a Raspberry Pi zero where the input signal is acquired then wirelessly transmitted. In the second phase, the signal is received and processed by the DE-10 Nano SoC board that in turn sends the signal to the motor, which is acting as the knee joint of our prosthetic, therefore actuating the required movement. As a result, ensuring the highest level of synchronization due to implementing a digital input and the fast processing speed of the SoC.

Methodology

Block Diagram

Sanad as a system consists of two main sections, input acquisition, and movement actuation as shown in the block diagram below.



Components List

The two sections collectively will be using the following components:

- Digital capacitive sensor.
- Raspberry Pi zero w v1.1.
- Arduino Uno.
- Terasic Servo Motor Kit.
- DE10-Nano SoC board.
- RFS 2 board.
- Ceramic Capacitors

Operating System

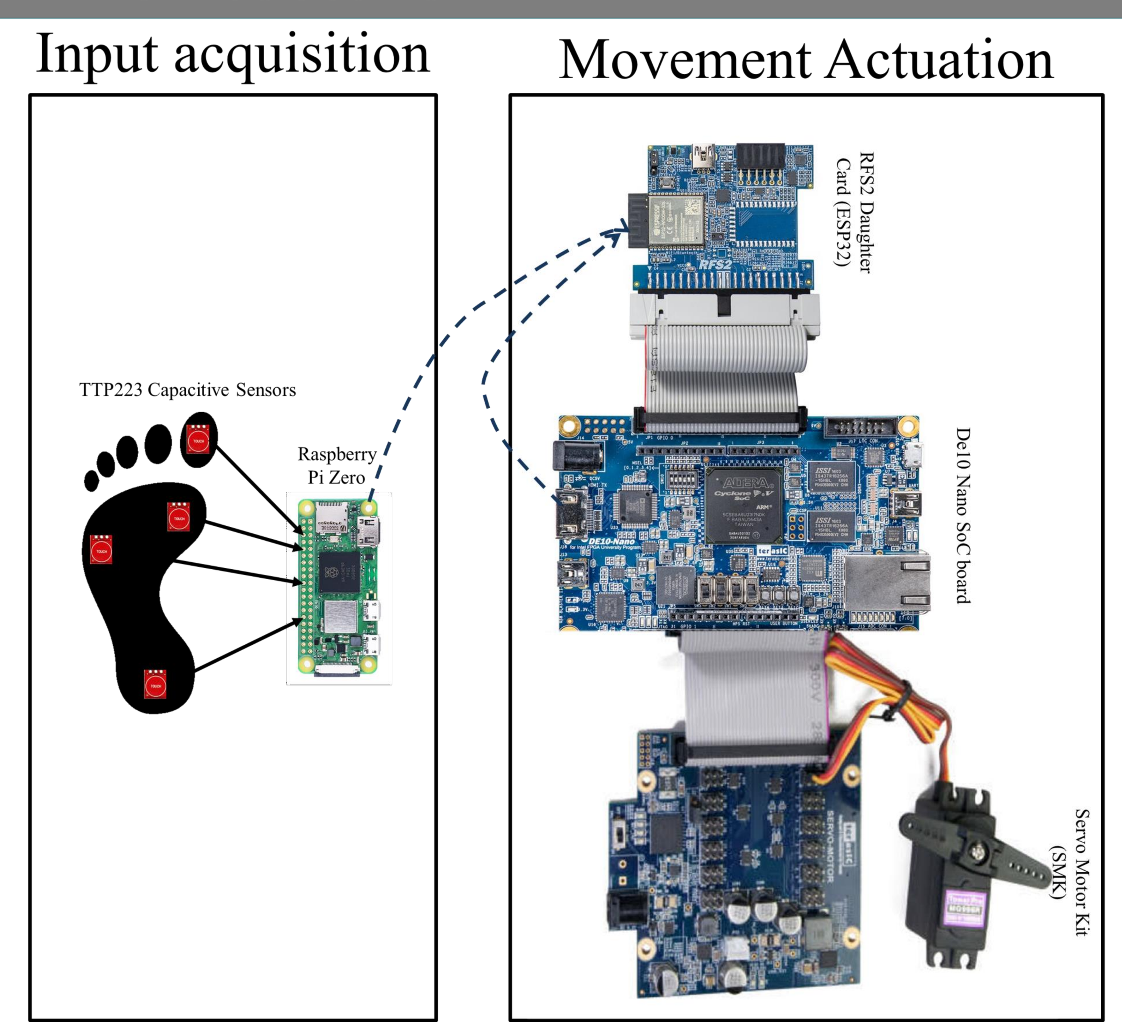
Different versions of the Linux operating system are used in these components based on the specific hardware requirements.

Programming Languages

The programming languages used in **Sanad** are:

- Verilog.
- VHDL.
- C.
- C++.
- Python.
- Bash.

System Architecture



Results & Discussion

To evaluate the effectiveness of **Sanad** during the testing phase, the system was tested on several prostheses in terms of its ability to synchronize with the healthy leg and imitate its gait movement. The results showed that the novel System on Chip (SoC) architecture effectively received the capacitive signal from the healthy foot and actuated the expected movement on the prosthesis with no delay. It was observed that this approach resulted in a more natural walking cycle, with improved synchronization between the healthy leg and the prosthetic. Furthermore, the testing phase highlighted the importance of proper calibration and integration of our proposed solution with existing prostheses. The testing also revealed potential ethical considerations related to the safety of walking, which should be addressed. Further research and development are needed to address the limitations identified in the testing phase and ensure the safety and effectiveness of **Sanad** for amputees..

Conclusion

Although developments have already been made in the field of prosthetic leg system, they are not quite fulfilling in terms of the ease of use, convenience for above-knee amputees, and financial affordability for most people. Here, an attempt is made to design an actuated prosthetic leg which enables the user to gain back their natural walking gait with ease of use. The test results were very promising in terms of synchronization and response time. These positive results will lead to take the testing phase of **Sanad** further, regarding working with amputees, as well as improving the system.

Future Work

For future work, three goals can be focused on. Including more movements to the system other than walking such as climbing up and down the stairs or sitting and standing. Testing **Sanad** with amputees to further improve its accuracy. As well as working on developing a custom PCB board with the needed features only instead of using full evaluation board to ensure compatibilty.

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

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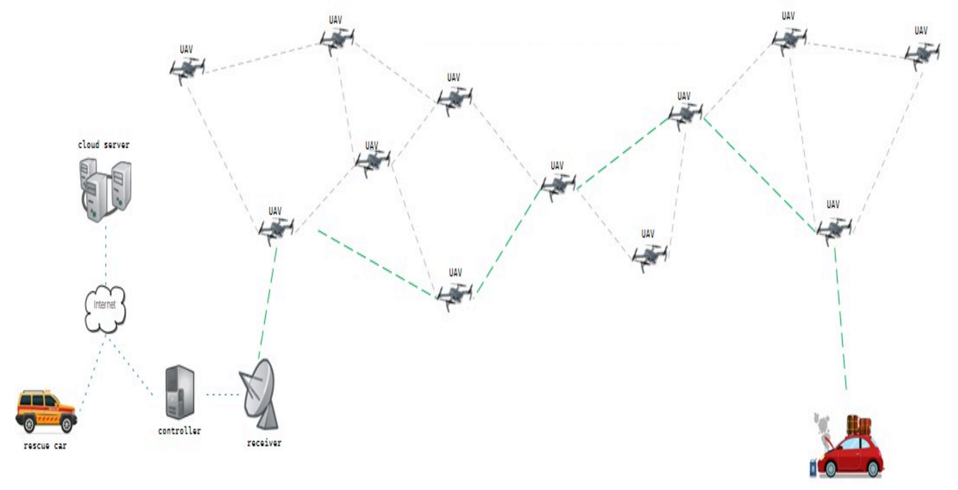
Abstract

With the rapid development of Unmanned Aerial Vehicles (UAVs), the importance of Flying Ad-Hoc Networks (FANETs) has increased. FANETs can be used 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 compared to a single UAV. In this project, a network of UAVs will be used to find a lost vehicle in the outskirts of Riyadh. The signal will be passed to a controller where it will be shared with the nearest rescue vehicle. Movement of UAVs will be simulated using a 3D mobility model. The Ad Hoc On-Demand Distance Vector Routing (AODV) Protocol will be used to find the optimum path to forward messages. The network will be simulated using OMNeT++ and performance measurement will be obtained which is the end-to-end delay, network latency, and power consumption.

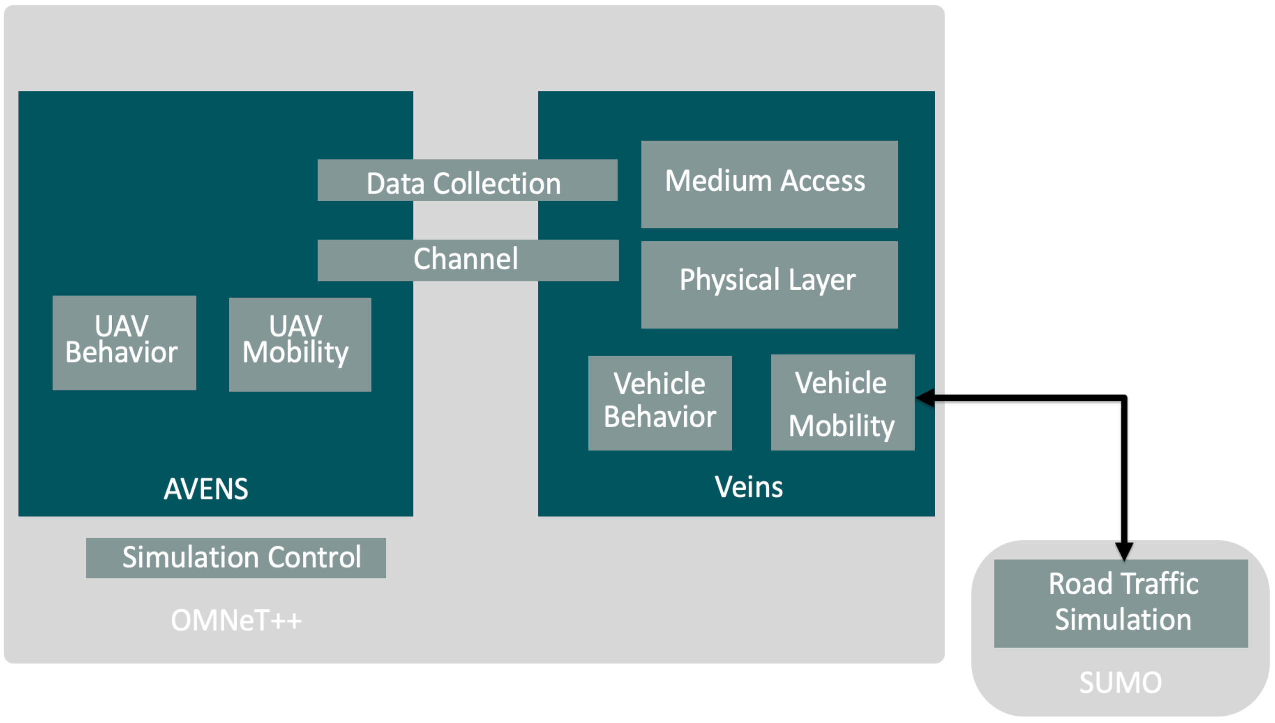
Introduction

Swarms of UAVs are an emerging technique for search and rescue, especially in remote areas. In this project, a network of UAVs will be used to search for lost vehicles in the outskirts of Riyadh. The network will be simulated using OMNeT++ and will use the AODV protocol to forward messages. The location of lost vehicles will be transmitted dispatch rescue vehicle. The project will be tested in various designs to provide an efficient and reliable solution for search and rescue operations.



Methodology

To provide required system simulation, OMNeT++ with the help of Veins, AVENS, and SUMO are used.

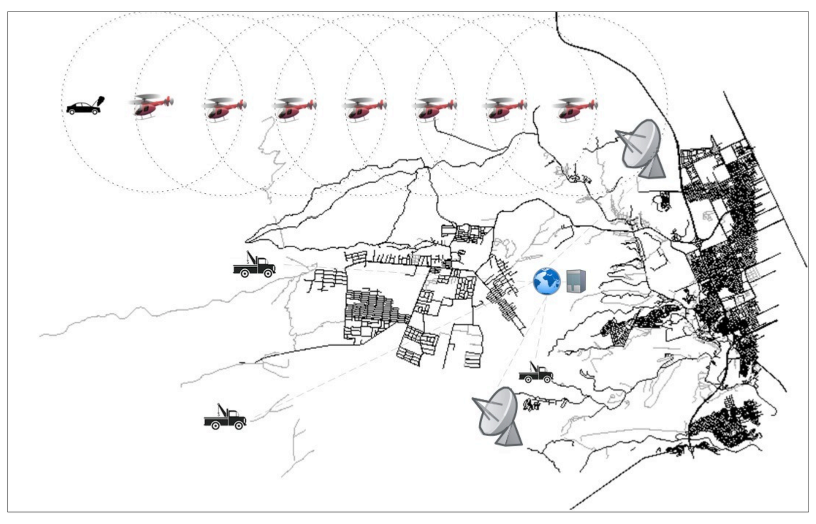


Simulation parameters of our network are as following:

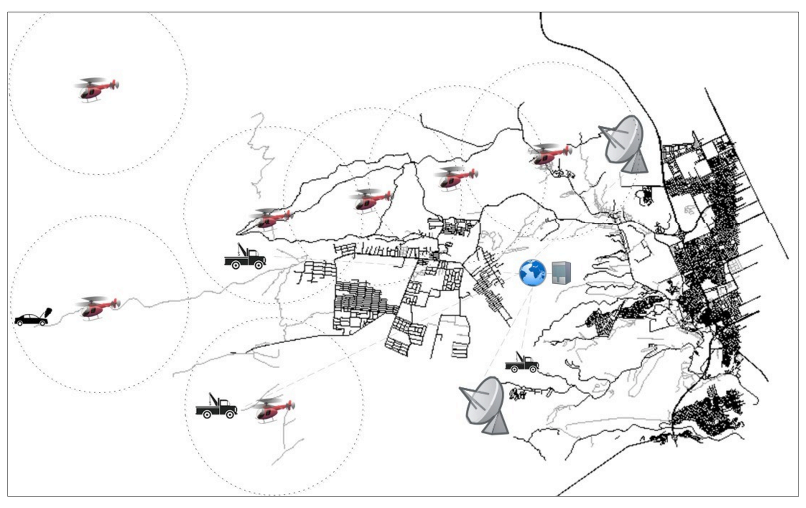
Simulation Parameter	Value
Unmanned Aerial Vehicles (UAVs) number	7
Area	20 km × 15 km
UAVs Height	50 m
Transmission and Reception Energy	50 nJ/bit
Amplification Energy at Transmitter	0.0013 pJ/bit/ m^4
Data Aggregation	0.5 J/bits
Number of bits per Packet	4000 bits
Constant for Free Space Energy	10 pJ/bits m^2

To compare the performance of the network in different situations, three different scenarios are designed based on the distribution of UAVs as following:

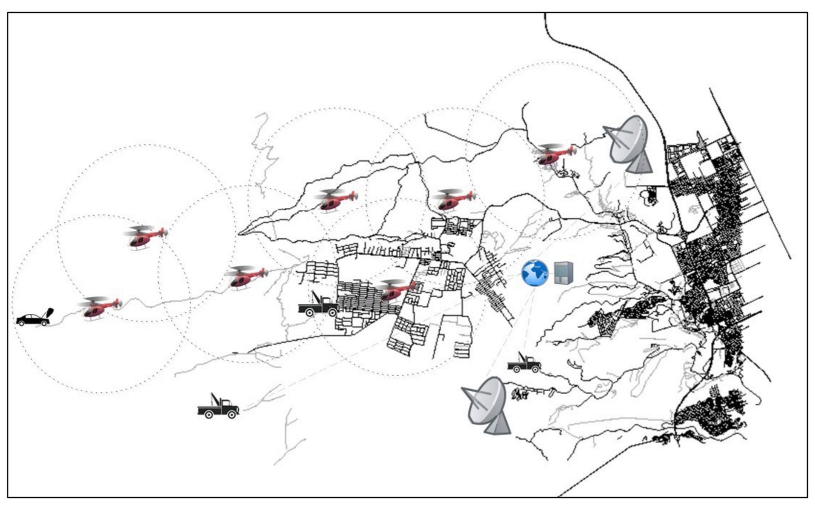
- **Fair Spread Scenario:** this scenario depends on distributing the distances equally between the UAVs.



- **Priority Spread Scenario:** this scenario uses the minimum number of UAV to ensure connectivity in a given area and uses the rest of the UAVs for the search process without being restricted. If the lost vehicle is found or after certain time, the random-flying UAV returns to the line of UAVs again.

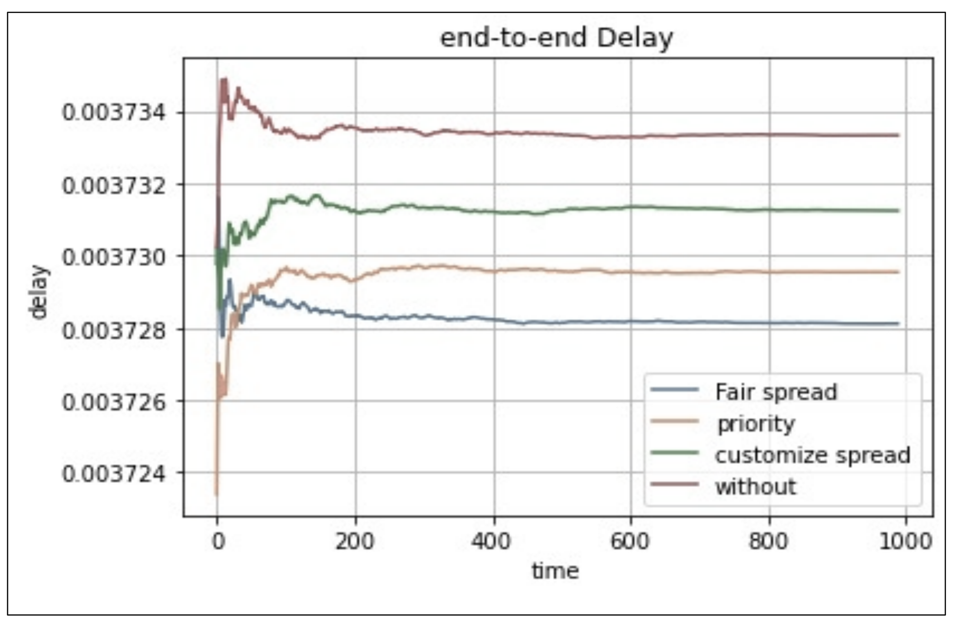


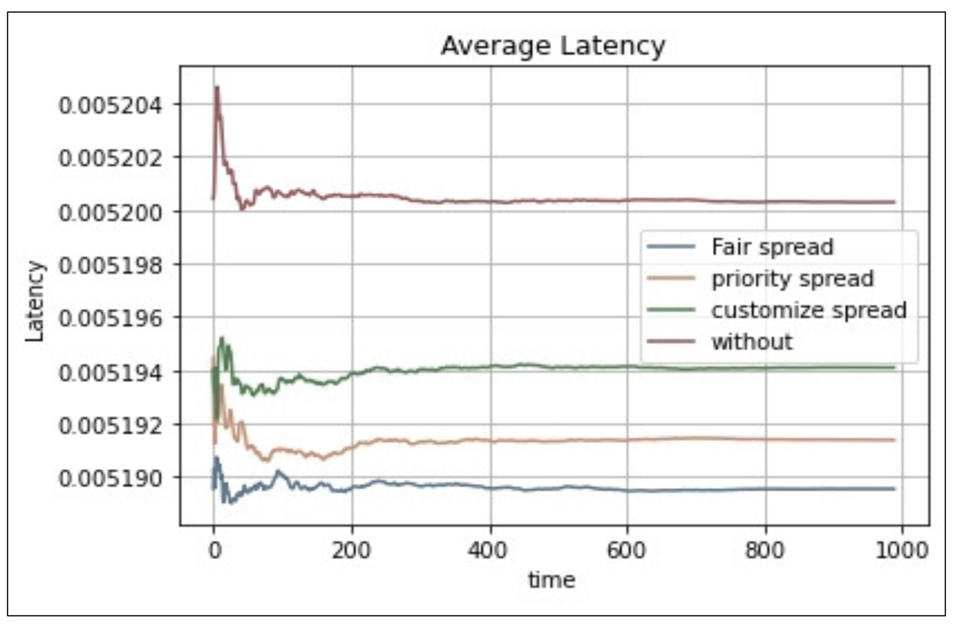
- **Customized Spread Scenario:** this scenario depends on reducing the energy consumption of UAVs in order to be able to search for a longer time by reducing the speed and allocating the roles and locations of the UAVs.

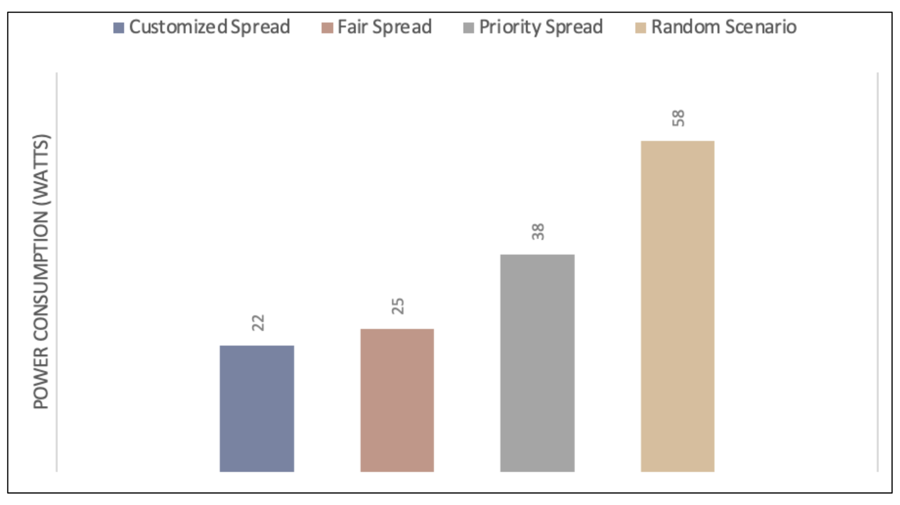


Results

Scenarios are evaluated based three performance metrics which are End-to-End Delay, Average Latency, and Power Consumption.







Discussion

	Fair Spread Scenario	Priority Spread Scenario	Customized Spread Scenario
Advantages	The rapid spread of UAVs	The number of UAVs that deliver data is reduced	The ability to work longer hours
Disadvantages	Covers a limited area and cannot be spread more	More outages and reconnections	High delay in delivering information

Conclusion

In conclusion, the project has met its objective which is to use a Flying Ad hoc Network (FANET) to to facilitate the communication between UAVs and a controller to locate a lost vehicle as quick as possible by sitting up three different scenarios to cover up the most possible situations. The scenarios were tested to obtain the best performance from different parameters which are End-to-End delay, Average Latency, and Power Consumption.

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