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DESIGN AND IMPLEMENTATION OF SEAT OCCUPANCY DETECTION SYSTEM IN RAILWAYS BY USING IOT

L. Vasu [1], *V. Naveen Babu* [2], P. Sruthi [2], *A. Vani Sahithi* [2], J. Vishnu [2]

ABSTRACT

Detection of seat occupancy by unreserved candidates in railway coaches remains a significant challenge and there are also some situations that ticket collector allotted the seats to ordinary ticket holders who handed him some monitory benefits without any receipt. There is therefore, the need for seat occupancy monitoring system to provide readily accessible seat occupancy information to government of this railway compartment. This proposed project "the design and implementation of low cost seat occupancy detection and display system" which is capable of monitoring seat occupancy in railway compartment efficiently. The system use capacitive seat sensors which is designed based on the loading mode technology. It detects the presence of human occupant using a load Sensors. Occupancy data is relayed to a WiFienabled microcontroller unit (Node MCU) which process data and wirelessly transfer the processed data to a server over a network for graphical & numerical display of occupied seats. Real time commands are also transferred to the ticket collector using GSM mode.

Keywords: Load Cell, Railway Compartment, Node Microcontroller unit (MCU)

1.INTRODUCTION:

Each day, our lives become more dependent on 'embedded systems', digital information technology that is embedded in our environment. More than 98% of processors applied today are in embedded systems, and are no longer visible to the customer as 'computers' in the ordinary sense. An Embedded System is a special-purpose system in which the computer is completely encapsulated by or dedicated to the device or system it controls. Unlike a general-purpose computer, such as a personal computer, an embedded system performs one or a few pre-defined tasks, usually with very specific requirements. Since the system is dedicated to specific tasks, design engineers can optimize it, reducing the size and cost of the product. Embedded systems are often mass-produced, benefiting from economies of scale. The increasing use of PC hardware is one of the most important developments in high-end embedded systems in recent years. Hardware costs of high-end systems have dropped dramatically as a result of this trend, making feasible some projects which previously would not have been done because of the high cost of non-PC-based embedded hardware. But software choices for the embedded PC platform are not nearly as attractive as the hardware.

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Typically, an embedded system is housed on a single microprocessor board with the programs stored in ROM. Virtually all appliances that have a digital interface -- watches, microwaves, VCRs, cars -- utilize embedded systems. Some embedded systems include an operating system, but many are so specialized that the entire logic can be implemented as a single program.

Physically, Embedded Systems range from portable devices such as digital watches and MP3 players, to large stationary installations like traffic lights, factory controllers, or the systems controlling nuclear power plants.

In terms of complexity embedded systems can range from very simple with a single microcontroller chip, to very complex with multiple units, peripherals and networks mounted inside a large chassis or enclosure.The Internet of Things (IOT) is an important topic in technology industry, policy, andengineering circles and has become headline news in both the specialty press and the popular media. This technology is embodied in a wide spectrum of networked products, systems, and sensors, which take advantage of advancements in computing power, electronics miniaturization, and network interconnections to offer new capabilities not previously possible.

An abundance of conferences, reports, and news articles discuss and debate the prospective impact of the ‑IOT revolution‖—from new market opportunities and business models to concerns about security, privacy, and technical interoperability.

The large-scale implementation of IOT devices promises to transform many aspects of the way we live. For consumers, new IOT products like Internet-enabled appliances, home automation components, and energy management devices are moving us toward a vision of the ‑smart home'', offering more security and energy efficiency. Other personal IOT devices like wearable fitness and health monitoring devices and network-enabled medical devices are transforming the way healthcare services are delivered. This technology promises to be beneficial for people with disabilities and the elderly, enabling improved levels of independence and quality of life at a reasonable cost. IOT systems like networked vehicles, intelligent traffic systems, and sensors embedded in roads and bridges move us closer to the idea of ‑smart cities'', which help minimize congestion and energy consumption. IOT technology offers the possibility to transform agriculture, industry, and energy production and distribution by increasing the availability of information along the value chain of production using networked sensors. However, IOT raises many issues and challenges that need to be considered and addressed in order for potential benefits to be realized.

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Fig .1. Representation of Smart Home using IOT

Some observers see the IOT as a revolutionary fully–interconnected ‒smart‖ world of progress, efficiency, and opportunity, with the potential for adding billions in value to industry and the global economy. Others warn that the IOT represents a darker world of surveillance, privacy and security violations, and consumer lock–in. News headlines about the hacking of Internet-connected automobiles, surveillance concerns stemming from voice recognition features in ‒smart‖ TVs, and privacy fears stemming from the potential misuse of IOT data have captured public attention. This ‒promise vs. peril‖ debate along with an influx of information though popular media and marketing can make the IOT a complex topic to understand.

Fundamentally, the Internet Society cares about the IOT as it represents a growing aspect of how people and institutions are likely to interact with the Internet in their personal, social, and economic lives. If even modest projections are correct, an explosion of IOT applications could present a fundamental shift in how users engage with and are impacted by the Internet, raising new issues and different dimensions of existing challenges across user/consumer concerns, technology, policy and law. IOT also will likely have varying consequences in different economies and regions, bringing a diverse set of opportunities and challenges across the globe.

2. PROPOSED SYSTEM:

The proposed system prepaid energy meter with data acquisition using IoT. This proposed meter helps to track the energy consumption and calculate bill. This data is stored in server and send to consumer by using GSM module application. Data is transmitted to server through node MCU module. The user interface created can be used by consumer to track his electricity consumption information.

The block diagram of the proposed system

is shown in .2.

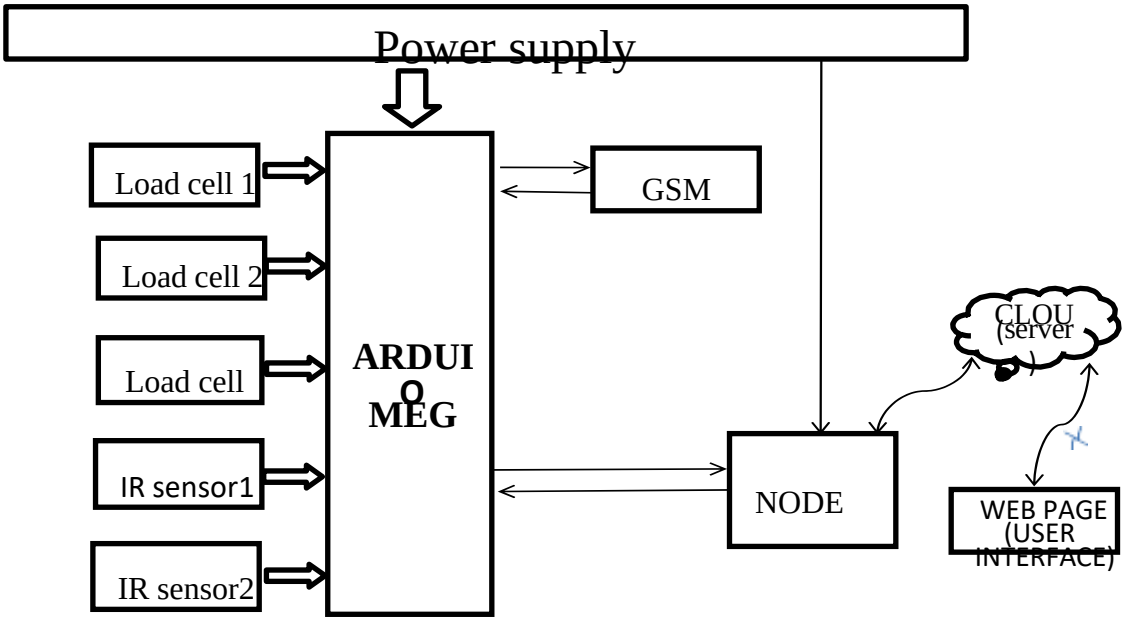

Fig. 2. Block diagram of the proposed Method (At Household Side)

The basic description about the Hardware components:

- Arduino Mega
- GSM Module
- Node MCU Module
- Load Cell
- IR Sensors

2.1.FUNCTIONS OF EACH BLOCK

ARDUINO BOARD

It is a simple **microcontroller** board. It is an open source computing platform and has an environment for developing software for the Arduino board. It can be used to make computers. It is used to create interactive projects. It takes input from sensors or **switches** and controls the outputs. Arduino boards are inexpensive compared to other micro controller based devices. It can stand-alone or can communicate with the software of the computer. Arduino software can run on Windows, Linux and Macintosh OSX. It provides an Integrated Development Environment (IDE) which is written on Java for programming microcontrollers. It supports C, C++ programming languages. So anyone who knows

the basic programming C can easily access Arduino IDE. It is very simple. Arduino has built-in functions. It can access serial port. It does not need to access the register details. It can simply call the functions and easily perform the functions. So the coding and debugging are fast and efficient. **Arduino** IDE displays the data which is into and out of the serial port.

Fig. 3. Arduino Mega and UNO Board

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The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 (datasheet). It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 Analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with an AC to DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila.

GSM MODULE The words, ―Mobile Station‖ (MS) or ―Mobile Equipment‖ (ME) are used for mobile terminals supporting GSM services.

A call from a GSM mobile station to the PSTN is called a ―mobile originated call‖ (MOC) or ―Outgoing call‖, and a call from a fixed network to a GSM mobile station is called a ―Mobile Terminated Call‖ (MTC) or ―Incoming call‖.

Fig.4. GSM Module

o What is GSM?

GSM (Global System for Mobile communications) is an open, digital cellular technology used for transmitting mobile voice and data services.

2.2. GSM Interfacing with Arduino:

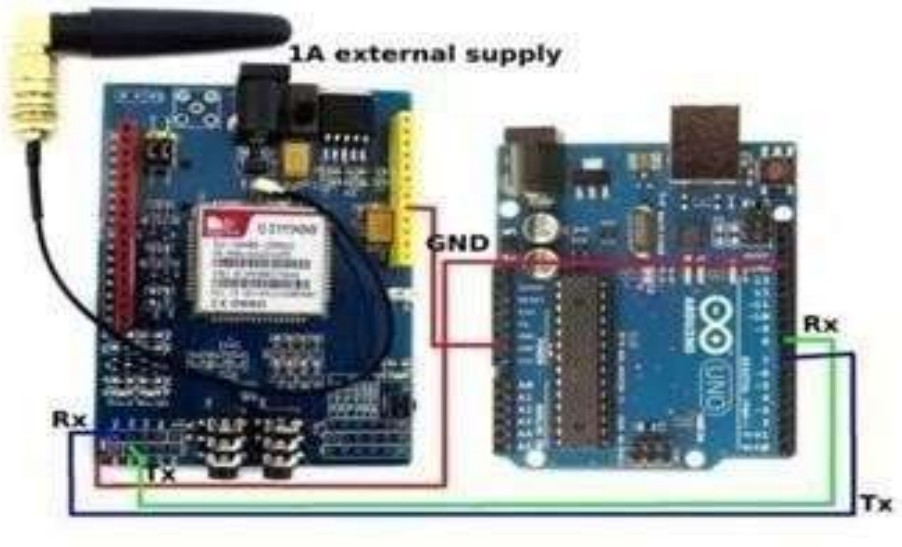

Fig.5. GSM Interfacing with Arduino

2.3.NODE MCU:

The Node MCU (***N***ode ***M***icro***C***ontroller ***U***nit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (WiFi), and even a modern operating system and SDK. That makes it an excellent choice for the Internet of Things (IoT) projects of all kinds.

However, as a chip, the ESP8266 is also hard to access and use. You must solder wires, with the appropriate analog voltage, to its pins for the simplest tasks such as powering it on or sending a keystroke to the ‒computer‖ on the chip. You also have to program it in low-level machine instructions that can be interpreted by the chip hardware. This level of integration is not a problem using the ESP8266 as an embedded controller chip in mass-produced electronics. It is a huge burden for hobbyists, hackers, or students who want to experiment with it in their own IoT projects.

But, what about Arduino? The Arduino project created an open-source hardware design and software SDK for their versatile IoT controller. Similar to NodeMCU, the Arduino hardware is a microcontroller board with a USB connector, LED lights, and standard data pins. It also defines standard interfaces to interact with sensors or other boards. But unlike NodeMCU, the Arduino board can have different types of CPU chips (typically an ARM or Intel x86 chip) with memory chips, and a variety of programming environments. There is an Arduino reference design for the ESP8266 chip as well. However, the flexibility of Arduino also means significant variations across different vendors. For example, most Arduino boards do not have WiFi capabilities, and some even have a serial data port instead of a USB port.

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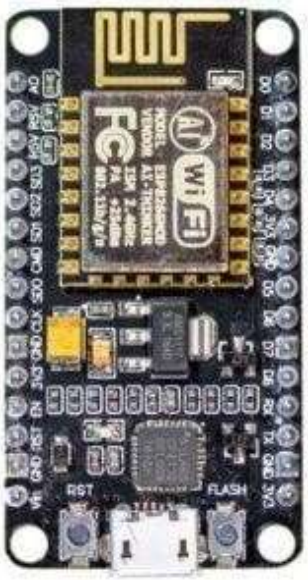

Fig.6. Node MCU

2.4.Interfacing NodeMCU with Arduino:

NodeMCU is great for connecting cloud and arduino is great at talking with different sensors. Nodemcu has only one analog pin. In this blog we will see how to connect arduino to nodemcu and post data to an mqtt broker. Arduino will take temperature readings and send the readings to nodemcu over serial connection. Nodemcu will send a mqtt message for every reading it receives. If you have just one sensor to monitor you can directly use the analog input available on nodemcu, see this blog on how to use the analog pin of nodemcu.

On Arduino side, we will take sample periodically and send a JSON message over soft serial to nodemcu. Please note that Arduino uno works on 5v and nodemcu works 3v3 level. So you should use a level shifter to connect arduino soft serial pins to the nodemcu uart port (It also works without level converter, but it is not recommended).

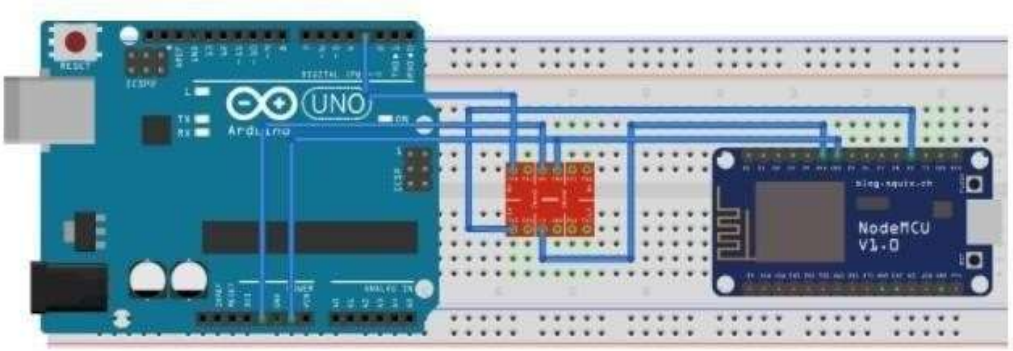

Fig.7. Interfacing ZigBee with Arduino

On nodemcu side we need to receive the messages sent by arduino over serial. Arduino will send the messages in JSON format. We will not be doing any processing on nodemcu (It is possible to process the messages before sending to cloud, for example you can compare the present reading with the previous published messages and send the message only if the reading is different) . You need to have working MQTT broker account. You can follow this blog to create and test mqtt account

2.5.LOAD CELLS (16X2):

A **load cell** is a force transducer. It converts a force such as tension, compression, pressure, or torque into an electrical signal that can be measured and standardized. As the force applied to the load cell increases, the electrical signal changes proportionally. The most common types of load cell used are strain gauges, pneumatic, and hydraulic.

Strain gauge load cell : Strain gauge load cells are the kind most often found in industrial settings. It is ideal as it is highly accurate, versatile, and cost-effective. Structurally, a load cell has a metal body to which strain gauges have been secured. The body is usually made of aluminum, alloy steel, or stainless steel which makes it very sturdy but also minimally elastic. This elasticity gives rise to the term "spring element", referring to the body of the load cell. When force is exerted on the load cell, the spring element is slightly deformed, and unless overloaded, always returns to its original shape. As the spring element deforms, the strain gauges also change shape. The resulting alteration to the resistance in the strain gauges can be measured as voltage. The change in voltage is proportional to the amount of force applied to the cell, thus the

amount of force can be calculated from the load cell's output.

Strain Gauges

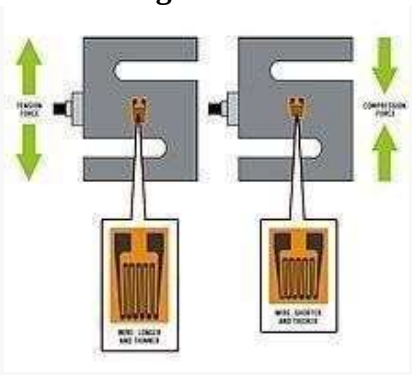

Fig. 8. Model strain gauges

A strain gauge is constructed of very fine wire, or foil, set up in a grid pattern and attached to a flexible backing. When the shape of the strain gauge is altered, a change in its electrical resistance occurs. The wire or foil in the strain gauge is arranged in a way that, when force is applied in one direction, a linear change in resistance results. Tension force stretches a strain gauge, causing it to get thinner and longer, resulting in an increase in resistance.

Compression force does the opposite. The strain gauge compresses, becomes thicker and shorter, and resistance decreases. The strain gauge is attached to a flexible backing enabling it to be easily applied to a load cell, mirroring the minute changes to be measured.

Since the change in resistance measured by a single strain gauge is extremely small, it is difficult to accurately measure changes. Increasing the number of strain gauges applied collectively magnifies these small changes into something more measurable. A set of 4 strain gauges set in a specific circuit is called Wheatstone bridge.

2.6. **IR SENSORS:**

IR sensor is an electronic device that emits the light in order to sense some object of the surroundings. An IR sensor can measure the heat of an object as well as detects the motion. Usually, in the **infrared spectrum**, all the objects radiate some form of thermal radiation. These types of radiations are invisible to our eyes, but infrared sensor can detect these radiations.

Fig.9. IR Sensor

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The emitter is simply an IR LED (Light Emitting Diode) and the detector is simply an IR photodiode. Photodiode is sensitive to IR light of the same wavelength which is emitted by the IR LED. When IR light falls on the photodiode, the resistances and the output voltages will change in proportion to the magnitude of the

3 . FLOWCHART & WORKING PROCEDURE:

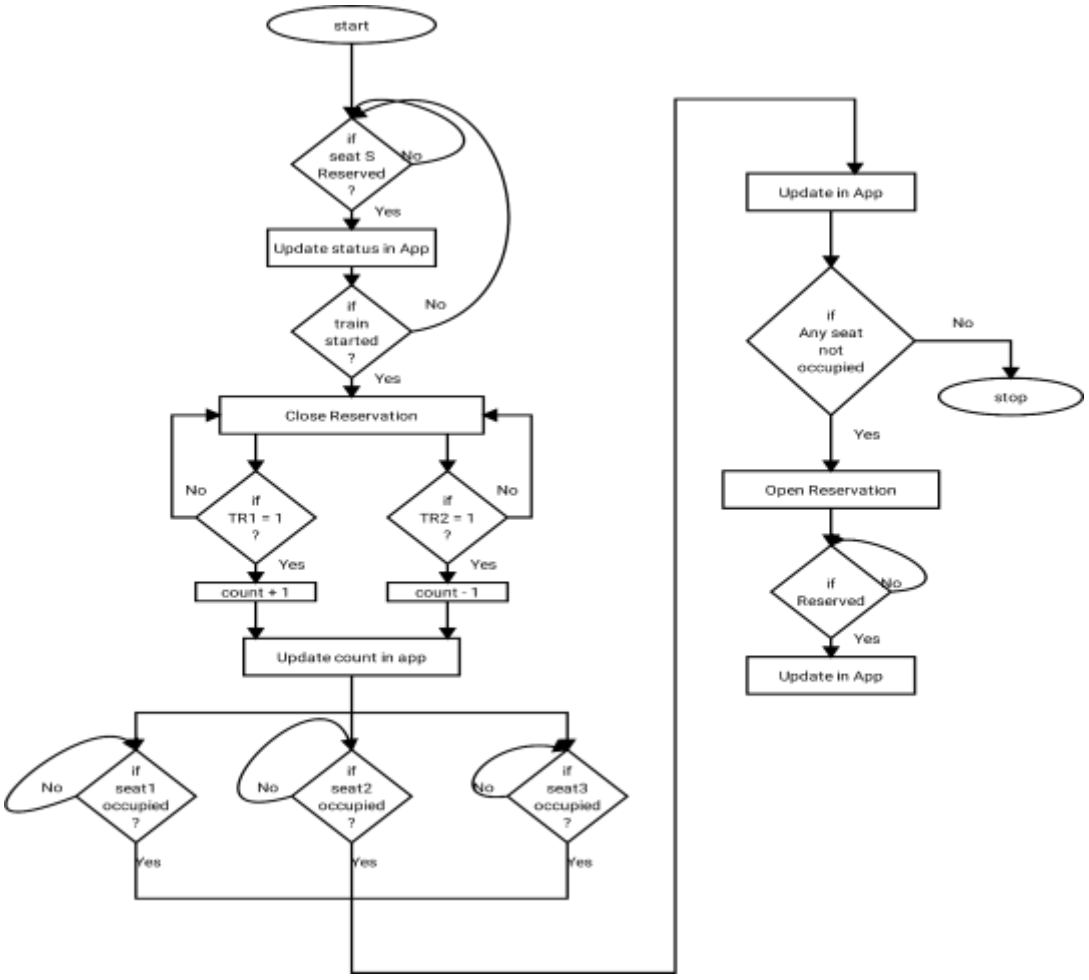

Fig.10. Flowchart of Proposed Method

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3.1 ADVANTAGES & DISADVANTAGES

ADVANTAGES:

- Real time monitoring.
- ExactExact count of passengers in train.
- Live status of seats occupancy.
- Real time bill monitoring.
- Time reduced receiving bill.
- Able to reverse unoccupied seats.

DISADVANTAGES:

- Require internet all the time.
- Require qualified technicians to operate.

4. RESULTS

Fig.11. Prototype Of Proposed Model

Fig.12.Reservation App welcome

- When passenger opens the reservation application it says welcome to the

passengers.

Fig.13.Reservation App closes reservation

- When train starts reservation App closes the reservation process.

Fig.14.Reservation App shows number of passengers in train.

- After train starts App closes reservations and shows the number of passengers in train

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Fig.15. Reservation App shows remaining vacant seats and enables reservation.

- Passengers After train started application shows remaining seats in train and enable the reservation option to the next station passenger's.

Fig.16. Reservation App shows total number of vacant and number of passenger

- when reservation app enable reservation for next station that vacant seats will be reserved by the passenger's who are boarding in next station.

Fig.17. Reservation App shows total nunber of passengers.

- The reservation application shows the total number of passengers once all seats are reserved.

5. CONCLUSION

A system for dynamically monitoring seat occupancy in Railways has been proposed and tested. From empirical and theoretical results, the occupied seat state capacitance was more than double the unoccupied seat state capacitance. This proves that the occupancy detection system clearly differentiates between the two seat states. The system is therefore a viable option for the detection of human occupants on seats. Compared to other occupancy detection and monitoring systems, the system is more efficient, accurate and cost effective. Wireless communication adapted into this system reduces cabling require for communication and control making seat occupancy monitoring easier and cheaper. The designed system was highly practical and adaptable for installation in any seat setting. The system is also very portable and can be used to cater for already built seats. It also enables railways establishments to operate independent of users.

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FINAL YEAR PROJECT PRESENTATION

PBR VISVODAYA INSTITUTE OF TECHNOLOGY AND SCIENCE

DESIGN AND IMPLEMENTATION OF SEAT OCCUPANCY DETECTION SYSTEM IN RAIWAYS BY USING IOT

BATCH NO:C6

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ABSTRACT

•Detection of seat occupancy by unreserved candidates in railway coaches remains a significant challenge and there are also some situations that ticket collector allotted the seats to ordinary ticket holders who handed him some monitory benefits without any receipt. There is therefore, the need for seat occupancy monitoring system to provide readily accessible seat occupancy information to government of this railway compartment. This proposed project "the design and implementation of low cost seat occupancy detection and display system" which is capable of monitoring seat occupancy in railway compartment efficiently. The system use capacitive seat sensors which is designed based on the loading mode technology. It detects the presence of human occupant using a load Sensors. Occupancy data is relayed to a WiFienabled microcontroller unit (Node MCU) which process data and wirelessly transfer the processed data to a server over a network for graphical & numerical display of occupied seats. Real time commands are also transferred to the ticket collector using GSM mode.

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➢ Conclusion

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INTRODUCTION

- This proposed project "design and implementation of low cost seat occupancy detection and display system" which is capable of monitoring seat occupancy in railway compartment efficiently. The system use capacitive seat sensors which is designed based on the loading mode technology. It detects the presence of human occupant using a load Sensors.

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WHAT IS IOT?

- IOT is short for Internet of things.
- The internet of things(IOT) is inter-networking of physical devices. This system has ability to transfer data over a network without requiring human-to-human interaction.

WHY IS IOT?

- IOT has many applications in agriculture, smart cities smart home, healthcare ,business sectors, traffic monitoring, transport and logistics etc.
- This is a growing mega trend that will influence everything from business to our daily personal lives.

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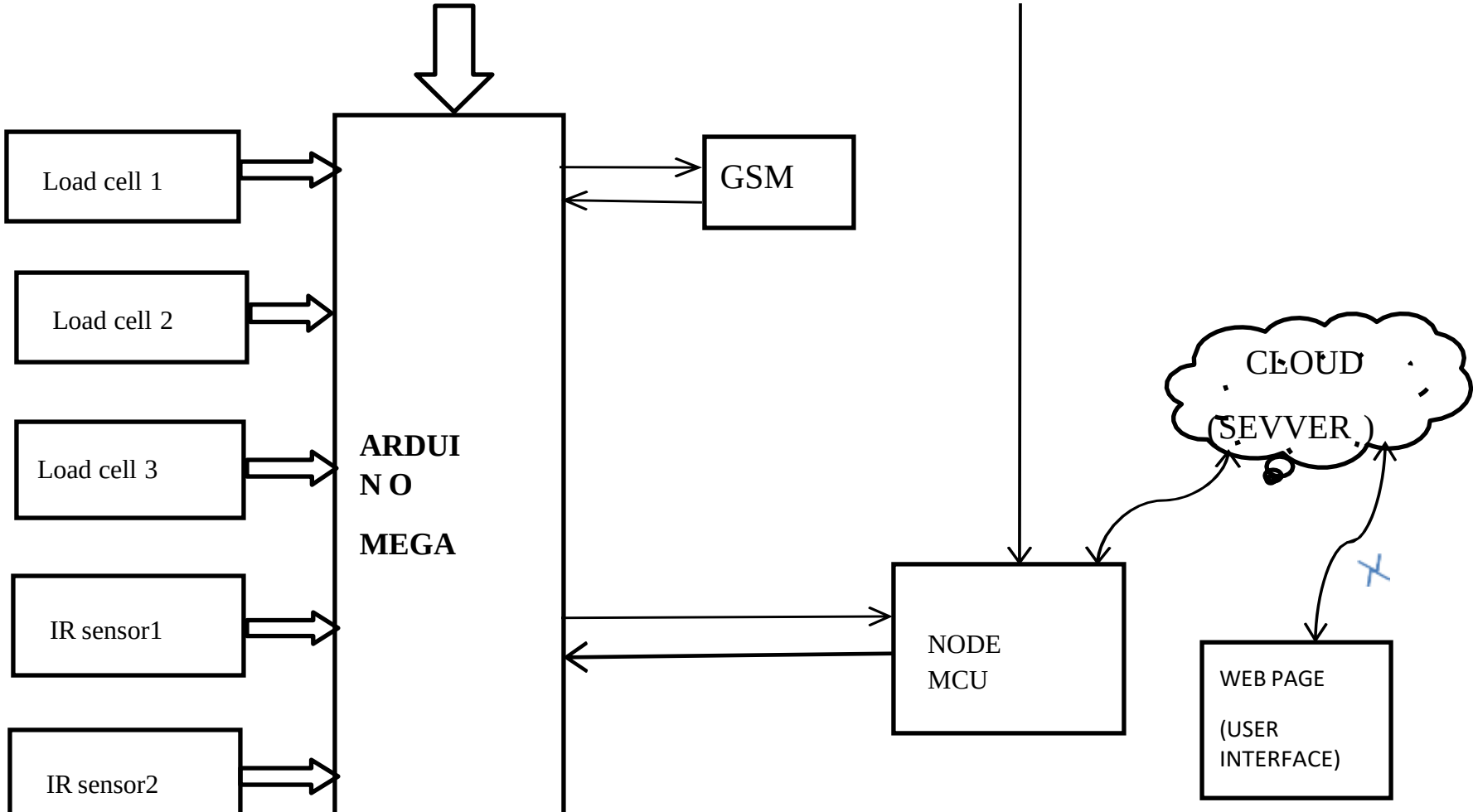
BLOCK DIAGRAM



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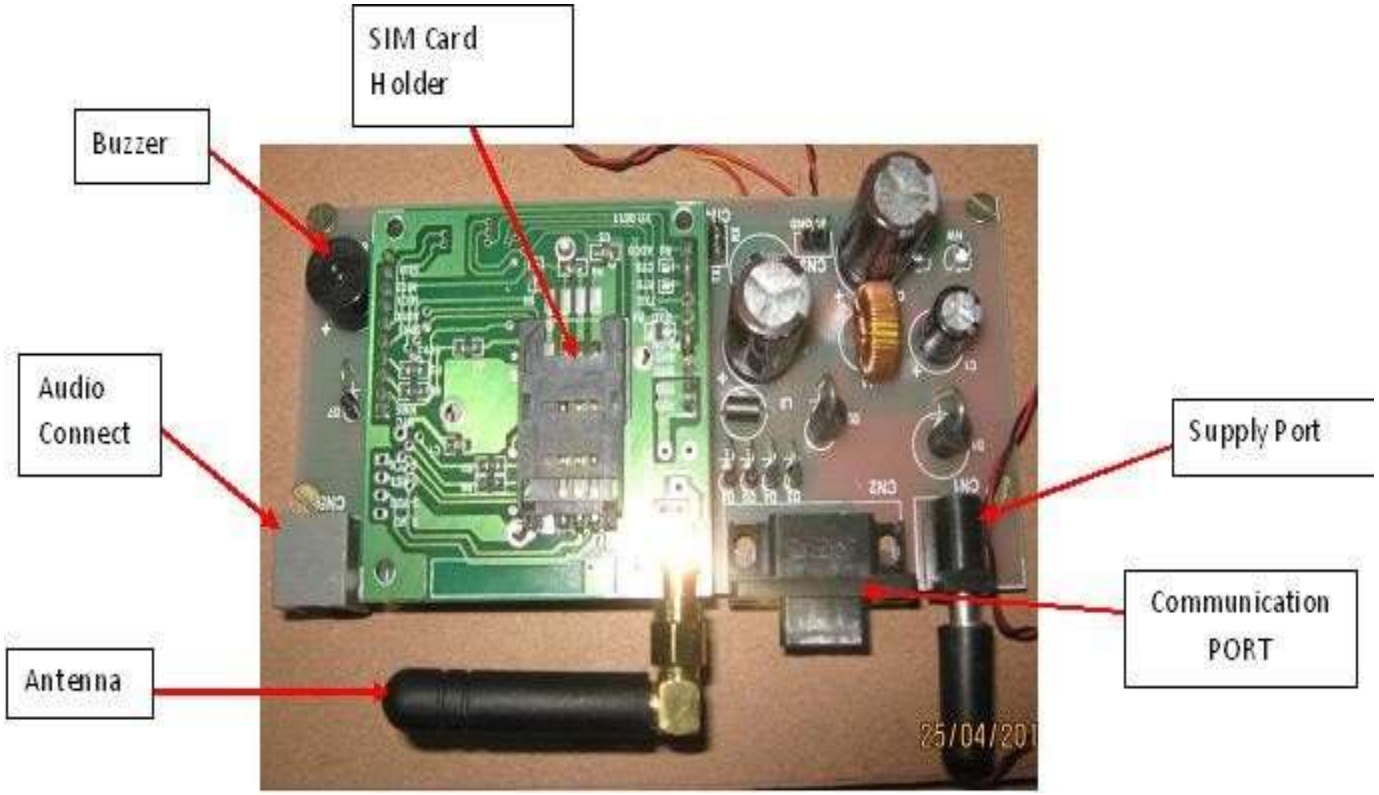
COMPONENTS OF THE DEVICE

GSM MODEM:

- A GSM Modem is a specialized type of modem which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone. From the mobile operator perspective, a GSM modem looks just like a mobile phone.
- When a GSM modem is connected to a computer, this allows the computer to use the GSM modem to communicate over the mobile network. While these GSM modems are most frequently



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used to provide mobile internet connectivity, many of them can also be used for sending and receiving SMS and MMS messages.

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ARDUINO:

- Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a Twitter message - and turn it into an output - activating a motor, turning on an LED, publishing something online.

- The Arduino Mega 2560 is a microcontroller board based on the ATmega2560 (datasheet). It has 54 digital input/output pins (of which 14 can be used as PWM outputs), 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC to DC adapter or battery to get started. The Mega is compatible with most shields designed for the Arduino Duemilanove or Diecimila.

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Microcontroller	ATmega2560
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limits)	6-20V
Digital I/O Pins	54 (of which 14 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	40 mA
DC Current for 3.3V Pin	50 mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8 KB
EEPROM	4 KB

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Clock Speed	16 MHZ

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IR SENSOR:

An IR sensors an electronic device that measures and detects infrared radiation in its surrounding environment.IR sensors are two types.They are active and passive IR sensors.Active IR sensors have two parts,they are LED and receiver.IR sensors are commonly used for the optical detection purpose(such as robots).Passive IR sensors only detect the radiation.They are commonly used for motion based
Detection.

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- **LOAD CELL:**

A loadcell is a force transducer.It converts force as tension,compression,pressure, Or torque into an electrical signal that can be measured.Although there are many vareties of force sensors,strain guage load cells are commonly used.

A load cell works by coverting mechanical force into the digital values that user can read and record.The inner working depends on the type of load cell you choose.

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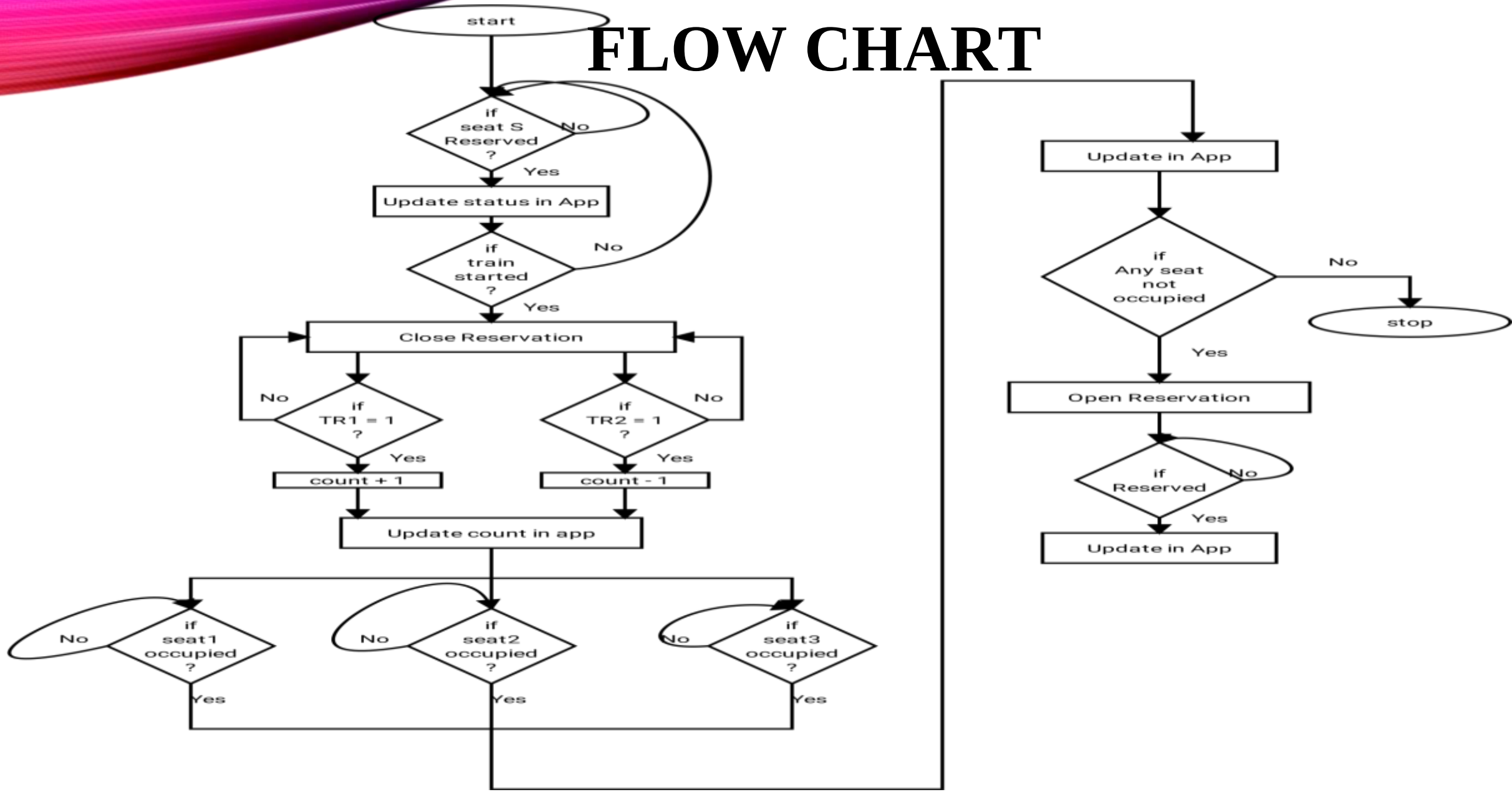
FLOW CHART



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PROGRAMMING LANGUAGES

- **EMBEDDED C LANGUAGE:**

It is the language which we use in Arduino board.Embeeded C is generally an extension of the C language, they are more or less similar. However, some differences do exist, such as:C is generally used for desktop computers, while embeeded C is for microcontroller based applications.C can use the resources of a desktop PC like memory, OS, etc

- HTML,PHP(Hypertext Markup Language, Hypertext Preprocessor**):**

These are the languages which we use on server side.HTML is a language used to describe to a browser how to display text and other objects in a browser window. It is not a programming language.HTML works on a client computer (the system on which the page is being viewed).PHP is a scripting language, and can be used to create web pages written in HTML.

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ADVANTAGES

Advantages:

1. Real time monitoring
2. Exact count of passengers in train
3. Live status of seats occupancy
4. Able to reserve unoccupied seats

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DISADVANTAGES

Disadvantages:

1. Require internet all the time.
2. Require qualified technicians to operate

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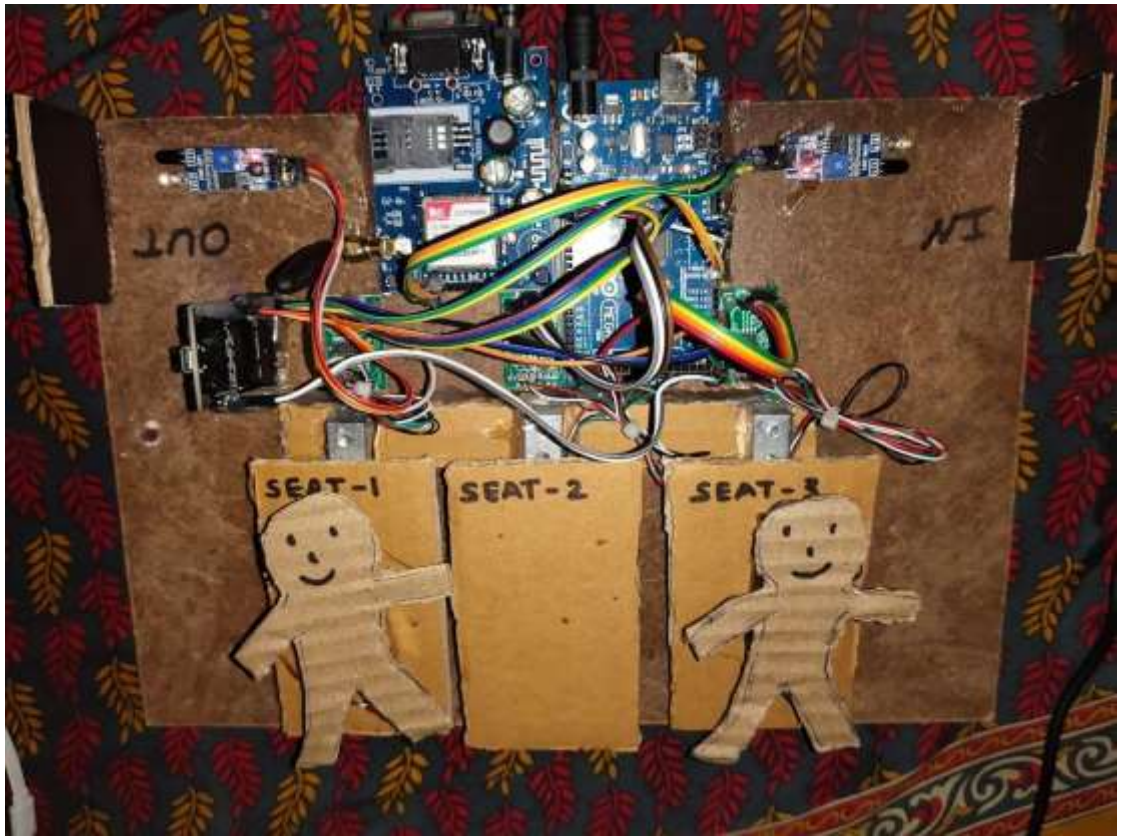

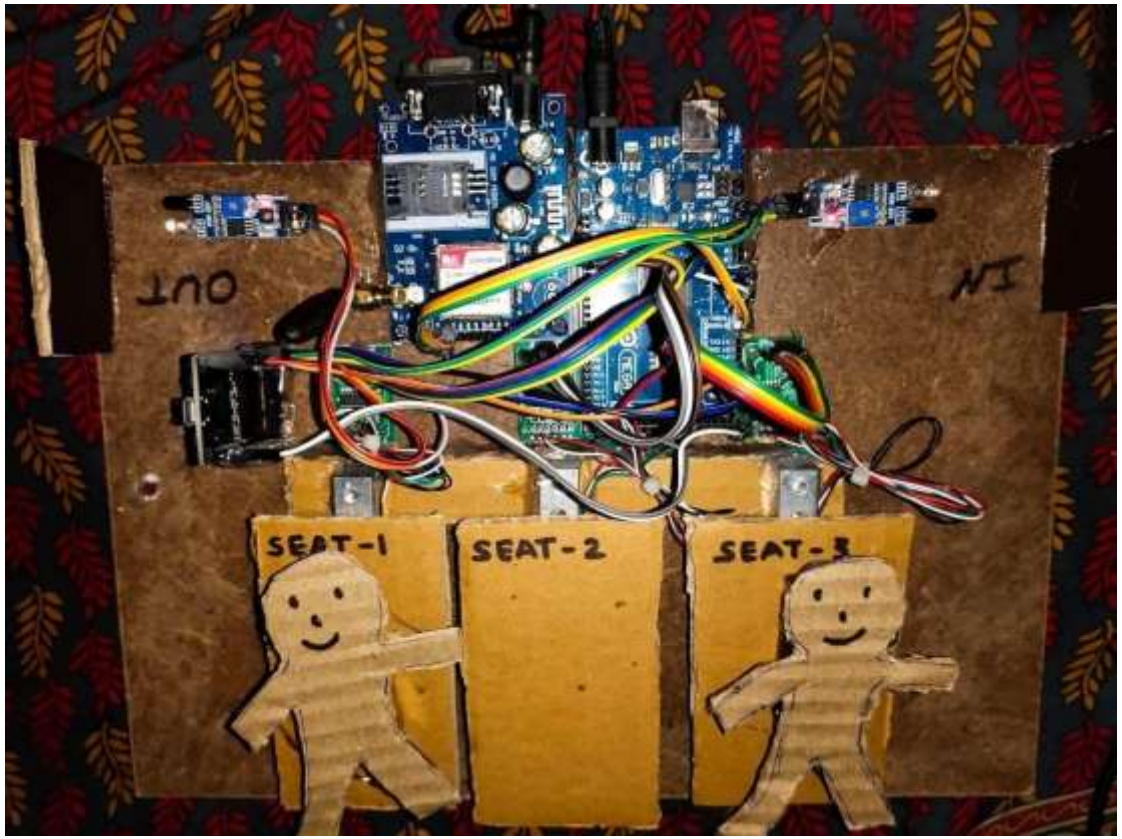

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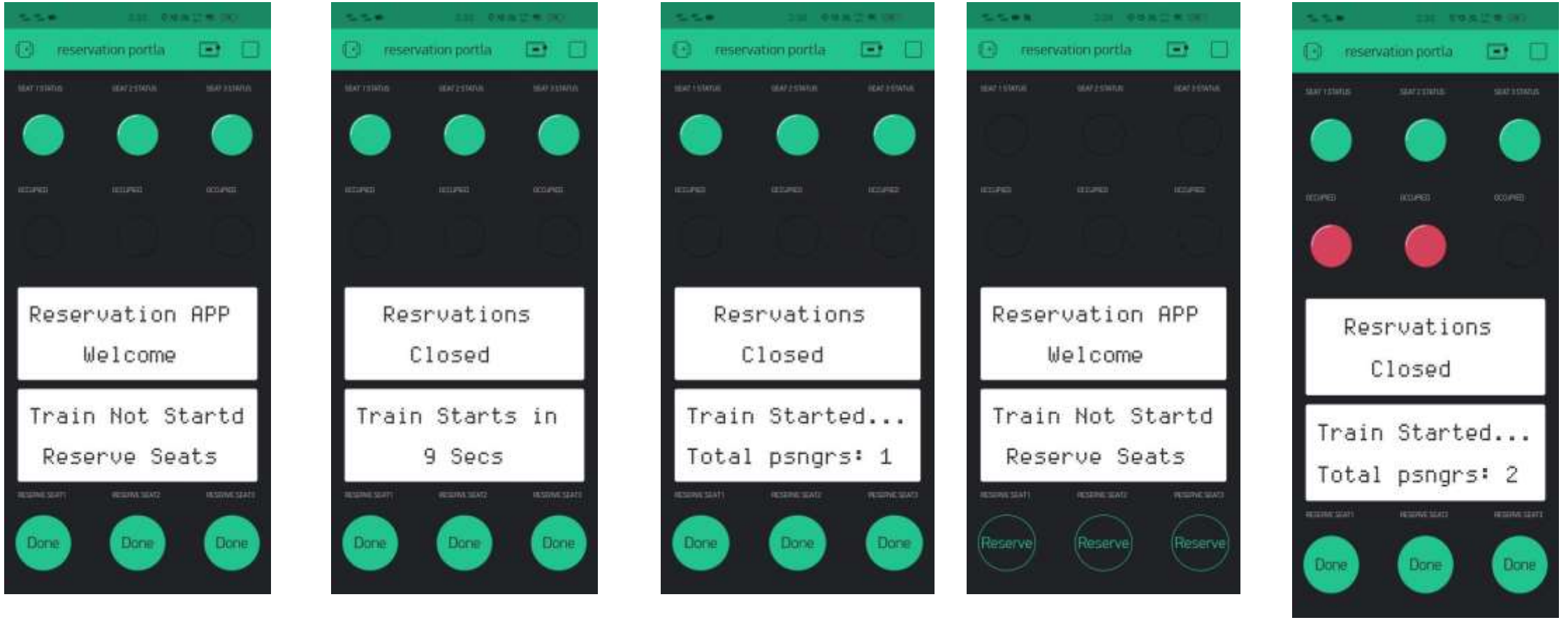

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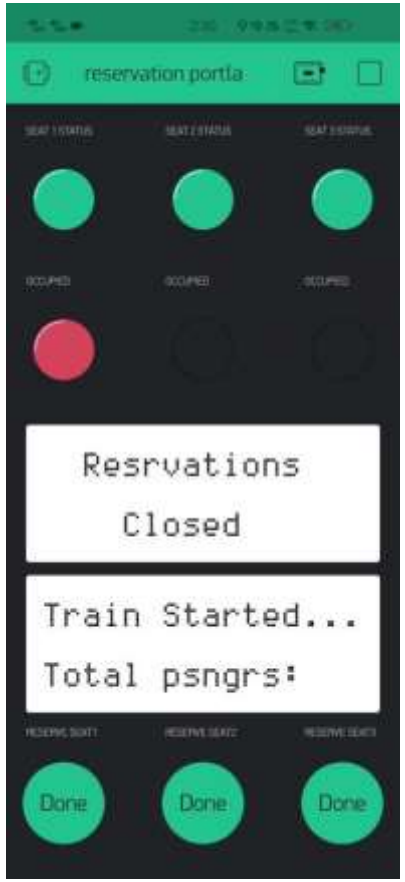

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CONCLUSION

- The prototype of the GSM base outdoor wireless display by using IOT was efficiently designed. This prototype has facilities to be integrated with a display board thus making it truly mobile. It accepts the message, stores it, validates it and then displays it in the LED module.
- The message is in different colors by using RGB. The message is scrolling on the wireless display by shifting data. The message can be updated by using mobile phones through internet.
- These displays can be used anywhere to display messages.

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THANK YOU

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