IoT Based Automatic Seat Vacancy Detection in Travel Buses using Cloud Database

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Abstract: The world has improving with lot of people utilities for living case. In this development technologies make the purpose of surviving easier. Internet of things is the inter-connecting technology used to pass the data to the required people via physical devices which are embedded with the software's, sensors, electronics etc. IoT lift up smart cities, transportation, industries with new innovations for the development. The proposed system is done in transport sector to effectively manage the vacant seats particularly on travel buses. The vacant seats may happen due to last minute cancellation, the passengers who missed bus, or the passengers who doesn't cancel their ticket even after they decide not to travel. In present situation, the seat allocation for the travelers is mostly done through online but when it comes to the vacant seats, the ticket checker has to allocate it manually. The system purpose is to verify whether all booked seats are occupied or not using sensors, and it automatically sends the signal to centralized server and make enable that particular seat for fresh booking. So that, the passengers who planned for travel by last minute can able to book ticket through online from the upcoming boarding stations.

Keywords: Seat vacancies, IoT Technology, IR sensors, Node MCU ESP8266, Vehicle seats.

I. INTRODUCTION

Decent may change but every human love to travel all round the world. From the beginning of planning, booking tickets and to sharing an experience of travelling in the digital media plays a main platform. Digitalization makes a huge trend and it provides a massive change for the human to handle day to day utilizes. The travel industry is one among the top five sectors which are brought higher level by changes via digitization. The combination of digital world and IoT technologies creates a huge impact. Internet of Things is the network of physical device used to interconnect the world without any human interactions. IoT devices immerse with electronic sensors, software, actuators, gadgets, appliances and machines to transform a data from one place to other via internet. Using Artificial intelligence and machine learning algorithms in IoT devices used to build the system for the processing with intelligent and sovereignty according to the

input. Smart home devices, smart cities, smart educational appliances, Industrial manufacturing, and Medical equipment's are some IoT implements. Every field prefer for the IoT concept all because of the easy processing techniques. Maximum numbers of IoT devices are compact, powerful, cost-constrained microcontroller. In data privacy and network bandwidth experience the IoT endpoint satisfies the user's expectation. In this paper, system is design to reuse the manual checking of vacant seats in travel buses. When it comes to seats without passengers or even after booking and ticket cancellation, there may be a seat left vacant.

IoT technologised sensor helps to gather the information about the vacant seats using one of the sensors fond of with Node MCU and GPS modules which refresh the centralized server with signals to open ticket booking for an upcoming boarding bus terminus. The main purpose is to solve the problem of seat allocation for the vacant seats in a travel bus using IoT devices.

II. BASIC METHODOLOGY

i) Hardware Techniques:

IoT hardware techniques are used with the mixture of devices like sensors, microcontroller, bridges etc. The physical devices are the main head which makes an IoT technology to deal in real time. The functions of the device to control, monitor, analyze, communicate and detect a surrounding and make an output as a digital signal from analog signal. All the information gathered are stored in local storages of the devices and further it can be transfer to other storage like database, third party system using some kind of interactions via internet connection which are integrated with the device board, switches, and chips.

a) Microcontroller in IoT:

Microcontrollers are the tiny computers which are built into the IoT devices to provide them a brain. They contain a single integrated circuit with a more computer processors, memory and programmable input/output peripherals.

Node MCU ESP8266

Node Microcontroller unit is an open source software embedded language which are used as a development kit written in the embedded language like Lua which is light weighted, it can be written in C also. Now-a-days most of the IoT products are developed with the help of Node Microcontroller Unit. The environment is built with an inexpensive System-on-a-chips called ESP8266 along with the Wi-Fi,4MB flash memory, 80MHz clock speed, 11 digital Input/output pins and 1 analog Input pin, ADC range 0-3.3v. It's also has a voltage regulator and USB interface.

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The transformation of the data from device to the requirement is interact via internet connection to enable this board are written with arduino programming language. The whole processing, controlling, monitoring, analyzing and whatever the data consider as input are communicated through 2 UART pins. On board switches there is a Led indicator which is connected to the D0 pin. The board also consists Chip Enable pin, Rest and Wake pin.
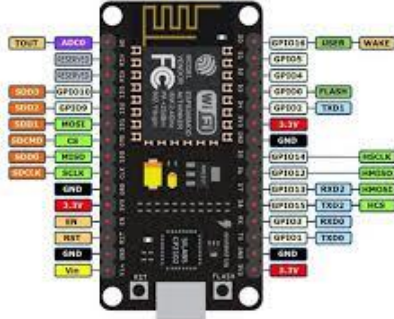

Figure (a)Hardware structure of the Node MCU ESP8266

b) Sensor:

Sensor is a physical device used to sense the environment. It can detect and response to the some type of input to get the output. It collects the data and converts into an electronic data. The output of the sensor detected values is displayed as the human readable data. Let see an example to understand the sensor easily. To detect the objects for automatic doors, the infrared sensors are used.

Infrared Sensor:

Infrared Radiation is the main radiation that comes from the electromagnetic spectrum that having a longer wavelength than a visible microwaves. It required only less power. It can be able to detect a radiation from 8 um to 14 um which is nearly to the range of detecting the human body. PIR sensor is the passive infrared radiation sensor or pyro electronic sensor are used for the motion detector. The motion can be measured as a velocity, direction, displacement, acceleration and time. It is more effective and accurate even in the movement. The output is converted into the digital form according to the user need.

Figure (b) Passive Infrared Radiation Sensor

c) GPS module:

Global Positioning System is used to track a location of an object on Earth in real time. An object integrated with GPS tracking chips. It has 24 active satellite, they use microwaves to collect the information in three dimensions and calculate the position of an object. When the active satellite fails they use Global Navigation Satellite system. The Combination of IoT technology and GPS are the recent trends in every field. IoT devices collect the required data of the user need in a real time with the attachment of the GPS, it provide a geographical location of the hardware device. It makes a

smart devices to perform a valid capabilities to achieve goals which are previously lack due the location variation. In this system NEO 6m Global positioning system is integrated with a microcontroller with an antenna, on board memory chips to calculate a location.

Figure (c)NEO 6m GPS module

ii) Software Module:

Role of the software module in IoT is to collect the data from the hardware devices. They are used as an intermediate platform for communicate between an IoT devices and Centralized database with the help of data server. To increase the memory storage and processing power of the hardware device, the values are slotted and transfer it. Operating a softwaremodule with languages like c, c#, java etc integrated with predefined IoT devices to enable some sufficient process and allow having more effective purpose.

a) Slim Framework:

Powerful web appliances and Rest api's are created with the help of PHP micro frame are called Slim framework. Micro frames are great to create a smaller application with minimal in design. Slim consists of multiple features like client-side HTTP caching, session, URL routing, cookies. When theRepresentational State Transfer Application Program Interface url called a respective api the information transfer between the network. Slim framework works as a transmitter to get a HTTP responds for a specific HTTP request. Its responds time is faster among other frameworks. PSR7 request objects from a slim app routes and middleware's are receive the HTTP request by web server.

b) Arduino Programming:

Arduino Programming is a hardware programming language used to written in the different arduino board circuit chip executed in the Arduino Integrated Development Environment for processing. Arduino broke the micro controller into more accessible package. Sketch is known as a new terminology arduino program. To startup an arduino board the setup () function is called default when sketch is started. Most of the micro controller built up with arduino board for the feasible usage.

iii) Database Module:

The module used to store the collected data in the organized form is called database. Computer database typically contains a data records or files which consists of the entire details about the data.

All the data formed are saved in the structured format organized in rows and columns with reliable connections.

When it comes to the structured form it's always very convenient for the specific user to read/write access their data in database management. The information stored in the relational database are easy to access, modulate, and modify. Relational database are setup with a pre-defined categories. Each set of data stored as a table with a minimum of one column related with same category of rows. It prefers the Structured Query Language interface for the application and user programs. They are extends easily for the new data adding and the modification of the existing data without any extra requirements.

III. METHODOLOGY

The process of the proposed system contains hardware device built in with some software technologies. Node microcontroller and IR sensors are the hardware devices mounted with the Wi-Fi technologies for data transmission. The IR sensors are interconnected with the node microcontroller for the sensing work. The input data for IR sensor are detected by receiving the infrared radiation that transmits the IR light towards an object. Neo 6m Gps device is used to collect the geographical location of a place in latitude and longitude values. Here, when a person book a seat it request for the passenger boarding point and store the geographical location in a cloud server with the default vacancy status of the seat as reserved. Every seat has individual IR sensor which are connected with NodeMCU. For every 5 minutes, NodeMCU sends the data (latitude, longitude, seat no, vehicle id and status) to the cloud. On the travel date, the IR sensor verifies whether any passenger is occupying their booked seat or not. When the booked passenger occupied his seat then the seat vacancy status will remain the same. Also the system will not change the vacancy status when the vehicle's current location is at 10 km distance radius from the passenger's boarding point. The system calculates the distance radius between the particular passenger's boarding point and the current location of the vehicle.

Formula for Distance Radius calculation

$dr = \sin(lat1) * \sin(lat2) + \cos(lat1) * \cos(lat2) * \cos(theta)$

where,

\ dr = Distance Radius
   theta = lon1 - lon2;
   lat1 = latitude value of boarding point of the passenger
   lon1 = longitude value of boarding point of the passenger
   lat2 = latitude value of the current place of the vehicle
\ lon2 = longitude value of the current place of the vehicle

If the seat is vacant by calling the API Uri-1, it sends the IR sensor data to the cloud server by NodeMCU with the current latitude and longitude values of the vehicle. If the distance radius exceeds 10 kms of the particular passenger's boarding point, it will check for the status and the system updates the vacancy status of the particular seat. Otherwise it will not make any changes. The same procedures are executed for all the seats which are connected with the sensors. They are referred with the unique seat numbers.
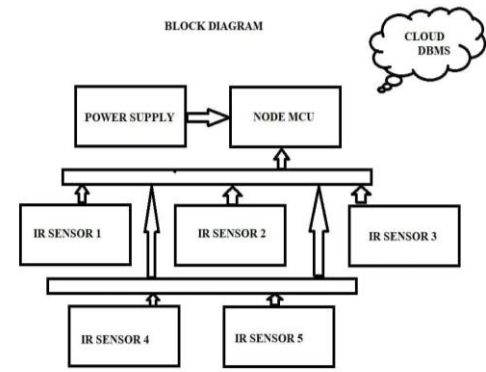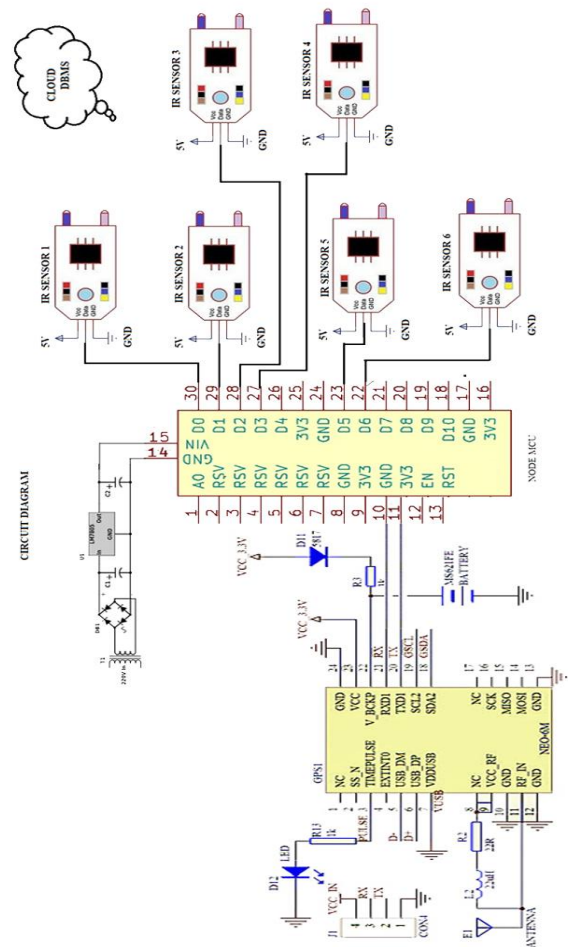

Figure (d)Block structure of Node IR

Circuit Diagram

Circuit diagram (a) Node MCU with power supply

The system is organized together with sensor, node microcontroller to check the vacancy of the seats in the Omni-buses. The input values detected using the hardware devices which are transferred to the cloud database via internet. The software module that collected all the information's about the process undertaken in the Omni-buses related to the seats are stored and retrieves instantly to the required websites for seats booking.

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All collected data can be uploaded and updated in the required database with the help of internet. The hardware device Node mcu board is combined with Wi-Fi access point through the USB port with USB-TTL which directly allows flashing so that the transformation of the input values can be easily done. LUA programming language is used in centralized database while receiving the data from the ESP8266 Wi-Fi module. The digital and analog pins in the microcontroller are used to detect the input and output values.There is an individual pin number for all analog and digital pins. The power supply for the Node MCU ESP8266 is also supplied. To get the latitude and longitude value of the location, NEO 6m Global Positioning system is highly recommended. Especially for the indoor applications, integrated and communication with the micro-controller's on-board memory chip, patch antenna and backup battery by UART which are connected through analog pins is used to detect the location.IR sensors divide and work it process. IR transmitter which transmits the IR light to an object to sense and it receives IR light from the same object via IR receiver to get the input. Multiple numbers of IR sensors are connected with Node MCU ESP8266's digital pins.In figure no, IR Sensors are connected with digital pins D0, D1, D2, D3, D5, and D6 respectively. All the IR sensors are works as same as the above procedure.

3.1 Rest API Module:

BaseURI:http://myliveprojectdemo.com/seatdetection/v1/check/seats

The implemented proposed work can be used with this base uri.The value transformation in the uri is used with help of parameters. It named which stores the value of the data which are required.

API Uri - I:

All the collected data will be transformed from the hardware to the database through API Uri-1 automatically whenever the request is called.The parameter vehicleid it is useful in the state of reference when the status of the seat availability is changes according to the particular vehicle. To get a particular detail about the seat they use unique seat numbers. Availability of the seat vacancy is denoted as 0(Empty) and 1(Occupied). Boarding latitude and longitude gives the exact geographical location of the bus boarding point.

Table Structure of the proposed system

S.No	Parameter	Description
1	Id	Unique id of the particular booking
2	Vehicle_Id	Unique id of vehicle
3	Travelling_Date	Travelling Date of the ticket booked
4	Seat_no	Unique number of seats in the vehicle
5	Availability	Seat vacancy status (0 – Empty, 1 – Occupied)
6	Boarding_Latitude	Latitude of the bus boarding
7	Boarding_Longitude	Longitude of the bus boarding

Table (a)

IV. RESULT ANALYSIS

The result of the simulated model is checked in different vehicle routes within reasonable distances. The vacancies of the seats are detected using the combination of NodeMCU and IR sensors. The microcontroller calls the API Uri to collect the data and transferred to the cloud server. The time duration for the data to reach the server takes minimum of 2 seconds. If the time exceeds more than 30 seconds, it is considered to be failure and it automatically insists the hardware to do the process again. Due to the computer network congestions data fails to reach its destinations. The network congestion may affect the quality of service in network range. Because this model is depends on different locations, which means the result is taken in dynamic areas the computer network plays a vital role. The following graph is used to describe the results progress in the network clearly.
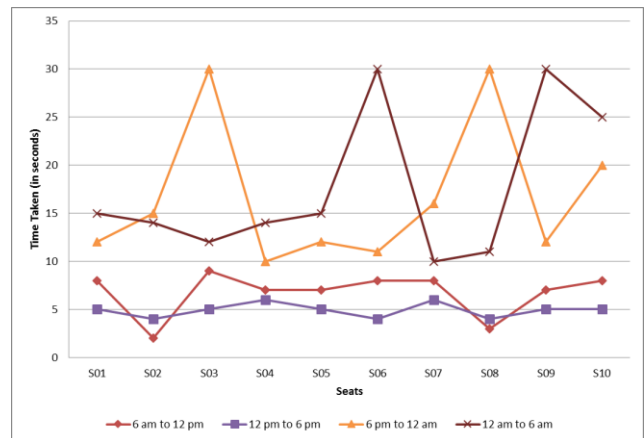

Chart (a) Time Analysis of Seat Vacancy Detection (taken only 10 sample values in each time period)

The graph represents the analysis of the time duration taken to send the detected values of seat vacancies from the hardware devices to the cloud server. The result is taken in the basics of different time slap of 24 hours a day and separated as 4 shifts, so that it can be neatly describes the minimum and maximum duration of the data transmission through the network. In-between the time of shift 3 and shift 4 the transmission rate of network traffic is higher and it leads to the poor quality of service. The maximum duration is took place because of the network congestion. The duration is evaluated in seconds.

V. CONCLUSION

IoT technology is used in better way to find the innovations in the existing systems. It improves the need of essentials in every field. In long distance travel, IoT system helps to increase the efficiency and effective process on every need of the user. Digitalization of seat vacancy checking in the vehicles is also a kind of development in this fast growing world. The Proposed system is designed to detect the seat vacancies in the vehicles using the sensors mounted with some IoT devices.

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This model tested in different routes to get the time progress of the data transmission in different time intervals. This system gives the better seat allocation strategies for the last time passenger.

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