Smart Parking System using M2M communication in IoT

[1]Om Prakash Yadav, [2]Dr. R.P. Singh,
[1]Asst. Professor, [2]Research director, Vice Chancellor, SSSUTMS
[1]Aurora Degree & P.G. College Chikkadpally, Hyderabad, India
[2]Sehore, M.P

Abstract: -The parking space problem can be turn into a new opportunity brought by the recent trends to meet the world's connected continuum. There are so many vehicles in the world and the number of vehicles is increasing rapidly. The people are facing problems on parking vehicles in parking slots in a city. The Smart Parking System involves use of Mobile Application, Wi-Fi , LED Indicator, Slot Detection Using IR Sensors , Vehicle Detection Using RFID ,Cloud Database , Shortest Path using A* Algorithms, RaspberryPI3.The Smart Parking System would enable vehicle occupancy, monitoring and managing of available parking space in real-time that reducing human effort and cost. This paper makes easy for the user to find automatically a free space at the low cost and it will save time and fuel. The whole system is based on M2M communication in IoT. The android application in mobile is also provided to the user to check the availability of free space for parking and book that slot accordingly. The shortest paths, sets of paths with the shortest distance between a single initial (source) point and all other destination points, as well as between all pairs of points, are to be found. It will also calculate the duration of time and amount to pay.

Keywords:Internet of Things (IoT), A * (Star) algorithm; Vehicles, RFID, M2M.

Introduction: The parking management market size is expected to grow from USD 3.39 billion in 2018 to USD 5.15 billion by 2023, at a Compound Annual Growth Rate (CAGR) of 8.7% during the forecast period. The major driver for the parking management market is expected to be the growing focus on seamless traffic flow and reduction in fuel consumption and increasing motor vehicle sales. Worldwide vehicle production has increased from 84.2 million in 2012 to 90.8 million in 2015. Furthermore since 2012, with a growth of 8.6%, total passenger car production increased to 68.5 million in 2015. [14]. According to a report Smart Parking could result in saving 2, 20,000 gallons of fuels till 2030 and approx. 3, 00,00,000 gallonsof fuels by

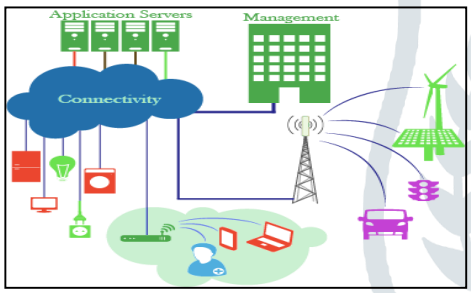


Figure-1. Connectivity between different devices in IoT environment.

The Coming a newera of computing technology, called as the Internet of Things (**IoT**) which is also known as Machine to Machine(M2M), Machine to Infrastructure(MTI), Machine to Environment (MTE), Internet of Everything, Internet of Intelligent Things, Intelligent Systems [20]. The concept of Internet of thing(IoT)[18] started with the identity communication devices. The devices could be tracked, controlled or monitor using remote computers connected through Internet.

The idea of creating smart city is now possible with an emergence of IoT[17]

Internet of Things =Physical object + Controller, sensor and Actuators + Internet

India is a historical country filled with beauty, serenity and is well known as "Incredible India". There are so many vehicles in the world, especially in India. One in three households in India owns a two-wheeler.

The IoT is the network of physical objects accessed through the internet, as defined by technology analysts and visionaries. These objects contain embedded technology to interact the internal states or the external environment.[29].Smart parking management systems of parking facilities will get cars off the street and into parking spaces sooner thus contributing to congestion control in highly congested urban areas. This system can help alleviate some of the pain by more efficiently using existing parking spaces and by making the process of finding a parking space quicker and less frustrating [25].

It is defined as the things present in the physical world or in an environment are attached with sensors or with any embedded systems and made connected to network via wired or wireless connections [21/24]. These connected devises are called as smart devices or smart objects. It is connecting any two machines, machine to human and vice-versa etc.This communication is called as M2M communication.

The M2M communication is developing by the various standardization bodies such as Open Mobile Alliance (OMA) European Telecommunication Standards Institute (ETSI), Institute of Electrical and Electronic Engineers (IEEE), 3rd. Generation Partnership Project (3GPP) organization have performed some activities on M-M communication [31]. Some important benefits of IoT includes 1) tracking behavior; 2) enhanced situational awareness; 3) sensor driven decision analytics; 4) instantaneous control and response etc.

Smart Traffic Service: The Smart traffic services include smart parking services to prevent illegal parking and facilitate convenient parking, citizen participation-oriented illegal parking prevention services, and smart safe crosswalk services.[8] Smart parking refers to the construction of a platform that enables real-time checking of available space and parking prices in areas that require parking and facilitation of reservation/payment
through Web and mobile connections.[19]

The Smart Parking Systems obtain information about availableparking spaces in a particular geographic area. This process isreal-time to place vehicles at available positions. It involvesreal-time data collection using low-cost sensors andmobile-phone-enabled automated payment systems thatallows people to reserve parking in advance [9].
The importance of smart parking is:

1. Accurately sense and predict spot/vehicle occupancy inreal-time.
2. Guides residents and visitors to available parking spot.
3. Optimize Parking Space Usage.
4. Simplifies the parking experience and adds value forparking stakeholders, such as merchants and drivers.
5. Helps the free flow of traffic in the city leveraging IoTtechnology.
6. Enables intelligent decisions using data, including real–time status applications and historical analytics reports.
7. It's creating betterurban environment by reducing the emission of CO2 andother pollutants.

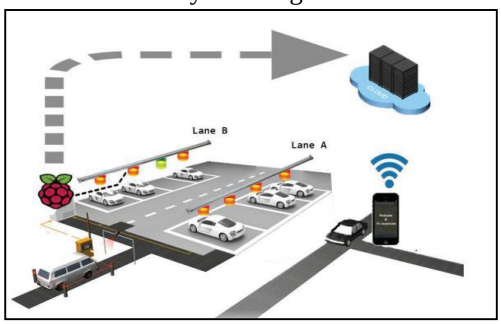


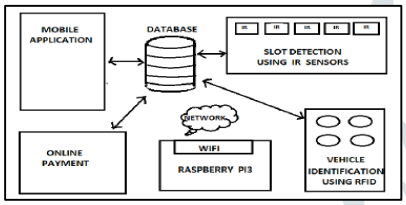
Figure-2. Smart Car Parking System Layout

Proposed Work

Architecture Description: The architecture mainly consists of the following components:-

1. Mobile Application
2. Wi-Fi
3. LED Indicator
4. Slot Detection Using IRSensors
5. Vehicle Detection UsingRFID
6. Cloud-Based Server
7. Shortest Path using A* Algorithms.
8. RaspberryPI3

Figure- 3.Architecture of Smart Parking System using M2M communication in IoT



1. **Mobile Application**:The Android App is developed and installed in the users mobile.
The user will follow the steps for booking the particular slot of that system. Install the Smart Parking System in the mobile device.Message or notification will be given to the user after booking. [5]
2. **Wi-Fi:**The Wi-Fi internet connection is used. An Android Application has two methods to create a link. The first one is using IP address of the Wi-Fi module directly coded into the app for initial testing. The second is it allows the user to search for the space for parking. Then the user can decide the parking slot and park the vehicle.[15]
3. **Light Emitting Diode (LED) Indicator:**It is use to indicate that which parkingslot is available. If the LED light is on means that slot is free for parking. Once car is parked at the slot the light will be off which indicate that the slot is not available for parking. [15]
4. **Slot Detection Using IRSensors**:Infra-Red (IR) sensors are used to detect the objects and obstacles in front of sensors. In this system, when the vehicle comes in the parking slot, sensors keeps transmitting modulated infrared light and detect the vehicle.[16]
5. **Proximity Access Control System UsingRFID:**TheRFID tags are put on vehicles to take down the in-out timeof the vehicle based on that cost for parking is decided.The cloud system used to store the data from eachsensor on a daily basis, thus cloud provides unlimitedstorage capacity, which is low in cost and easy to use for door and gate entry system. it has ondemandstorage capacity [13/23]
6. **Cloud-Based Server:** This is a Web entity that stores the resource information provided by local units located at each car park. The system allows a driver to search and find information on parking spaces from each car park without the need to directly access the local server node by directly accessing the cloud-based server.[3]
7. **Shortest Path using A* Algorithms**[4]**:**A* algorithms (A star) is a combination of 'branch and bound' and 'best search' methods combined with the dynamic programming principal. It is use a heuristic value or evaluation function; denoted b f(x) to determine the order in which the search visits nodes in the tree. The heuristic function for the node N is

$$f(N)=g(N) + h(N)$$

Whereg(N) is the total distance it has taken to get from the starting position to the current location. h(N) is the estimated distance from the current position to the goal destination/state. A heuristic function is used to create this estimate on how far away it will take to reach the goal state.

f'(n) is the sum of g(n) and h'(n). This is the current estimated shortest path. f(n) is the true shortest path which is not discovered until the A* algorithm is finished.

A* Algorithms: By Nils Nilsson [1].

1. Create a search graph G, consisting solely of the start node, n_o. Put n_o on a list called OPEN.
2. Create a list called CLOSED that is initially empty.
3. If OPEN is empty, exit with failure.
4. Select the first node on OPEN, remove it from OPEN, and put it on CLOSED. Called this node n.
5. If n is a goal node, exit successfully with the solution obtained by tracing a path along the pointers from n to n_o in G. (The pointers define a search tree and are established in Step 7.)
6. Expand node n, generating the set M, of its successors that are not already ancestors of n in G. Install these members of M as successors of n in G.
7. Establish a pointer to n from each of those members of M that were not already in G (i.e., not already on either OPEN or CLOSED). Add these members of M to OPEN. For each member, m, of M that was already on OPEN or CLOSED, redirect its pointer to n if the best path to m found so far is through n. For each member of M already on CLOSED, redirect the pointers of each of its descendants in G so that they point backward along the best paths found so far to these descendants.
8. Reorder the list OPEN in order of increasing f values. (Ties among minimal f values are resolved in favor of the deepest node in the search tree.)
9. Go to Step 3.

8. **RaspberryPI3:** The microcontroller which is used to implement our parking system and it is attached with raspberry pi camera.[2]Raspberry pi 3 model B is a single board computerwhich is of credit card sized with is most efficient board [34]. Raspberry piboard contains System on a Chip (SoC),it is amethod of grouping all the useful electronics to run on theindividual chip.

Implementation:

This paper "**Smart Parking System using M2M communication in IoT"** is mainly intended to monitor the status of parking slot. The controlling device of the whole system is a Microcontroller, Wi-Fi module; IR sensors are interfaced to the Microcontroller. IR sensors are fed as input to the Microcontroller. The Microcontroller processes this data and transmits over Wi-Fi, which will be received from mobile [10]. The user who wants to park the vehicle is connected to the Wi-Fi network of that particular parking application.

The IR sensors send the status to the microcontroller where the data processing is done. The microcontroller sends information to the webpage about the status of the slot to the user using IOT. This way the user can easily find a parking slot without any congestion and in less time. [11/12/22].

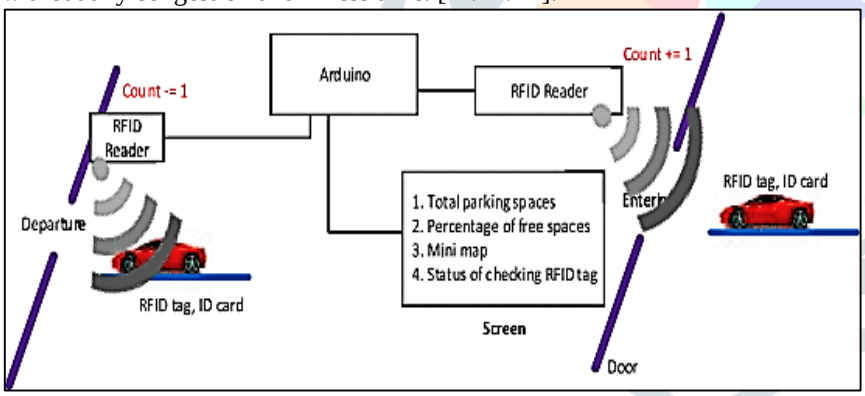


Figure -4. Implementation of Smart Parking System

The transitions indicate the flow of the data between the database and the rest of the components. The user has to register first time through the mobile application which indeed stores his information onto the server. After registering into the parking system his user has the privilege to go into the application and checkout for a free parking space available and then he can actually go and park his car there.

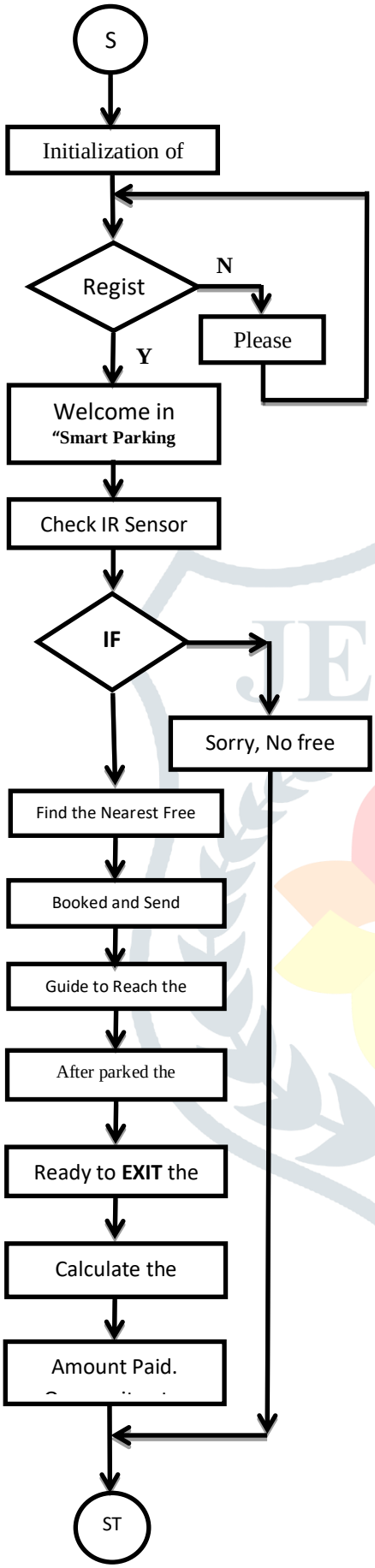


Figure -5: Flow Chart of

The application is updated the data to server; each time when the car is detected on the parking slot with the help of IR sensors. IR sensors are responsible to detect if a particular slot contains car or not[27]. Vehicle identification is done with the help of RFID tags which are present on each car which in deed helps us in calculating the amount to be paid by each user separately.

Before generating the parking bill, IR sensors and RFID tags work together to know which vehicle is being parked and depending on the time and the amount the corresponding bill is generated[28].

Raspberry PI3 is a processor which performs all of the above functions through the use of Internet. Payment of the parking bill is done through online banking which will be done using the mobile application[30]. All of the data generated above is stored and retrieved from the database. The tracking system is an integration of several modern embedded and communication technologies.

To provide location and time information anywhere on earth, Global Positioning System (GPS) is commonly used as a space-based global navigation satellite system[32]. The location information provided by us GPS systems can be visualized using Google Earth technology. The implementedtracking system can be used to monitor various parameters related to safety, emergency services and engine stall.

Conclusion:

The smart parking system based on IoT concept has been implemented using various sensor circuitry and cloud server. It is an efficient system for car parking which prevails traffic congestion. This work is further extended as smart car parking system with automatic billing systemalso fully automated system using multilayer parking method. Safety measures such as vehicle no. tracing, driver face-recognition.Using the same IR sensor circuit we can detect the vehicles that are parked in the no parking area and prevent the vehicles from flaunting the traffic laws.

Using IoT in a smart parking system it helps in reduction inconsumption of fuel, it reduces traffic congestion in citiesand cloud used for storing the information which is collectedfrom the sensors. It also benefits interms of lowering operating costs and increases revenues andfacility value. We outlined the agendaof this on-going work to enable value-added services around parking to both end consumersandparking service providers. Parking space owners profit from the new services by a more economic use of theirparking space, which is represented as an economic resource in the parking management system.

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