Smart Parking System using M2M communication in IoT

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Abstract: -The parking space problem can be turned 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 2050.[18]

The idea of creating smart city is now possible with an emergence of 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 Things (IoT) [17] started with the identity communication devices. The devices could be tracked, controlled or monitor using remote computers connected through Internet.

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

The coming a newera of computing technology, called as the Internet of Things (IoT) which contains data from mobile devices, sensors, and other Internet-connected objects. [19]. 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. [20]. 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 available parking spaces in a particular geographic area. This process is real-time to place vehicles at available positions. It involves real-time data collection using low-cost sensors and mobile-phone-enabled automated payment systems that allows people to reserve parking in advance [9].

The importance of smart parking is:
1. Accurately sense and predict spot/vehicle occupancy in real-time.
2. Guides residents and visitors to available parking spot.
3. Optimize Parking Space Usage.
4. Simplifies the parking experience and adds value for parking stakeholders, such as merchants and drivers.
5. Helps the free flow of traffic in the city leveraging IoT technology.
6. Enables intelligent decisions using data, including real-time status applications and historical analytics reports.
7. It’s creating a better urban environment by reducing the emission of CO2 and other 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 IR Sensors**
5. **Vehicle Detection Using RFID**
6. **Cloud-Based Server**
7. **Shortest Path using A* Algorithms**
8. **RaspberryPi3**

1. **Mobile Application:** The Android App is developed and installed in the user's mobile.
   The user will follow the steps for booking the particular slot of the system. Install the Smart Parking System in the mobile device. Message or notification will be given to the user after booking.

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 one is allowing the user to search for the space for parking. Then the user can decide the parking slot and park the vehicle.

3. **Light Emitting Diode (LED) Indicator:** It is used to indicate that which parking slot 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 indicates that the slot is not available for parking.

4. **Slot Detection Using IR Sensors:** 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.

5. **Proximity Access Control System Using RFID:** The RFID tags are put on vehicles to take down the in-out time of the vehicle based on that cost for parking is decided. The cloud system used to store the data from each sensor on a daily basis, thus cloud provides unlimited storage capacity, which is low in cost and easy to use for door and gate entry system. It has on-demand storage capacity.

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.

7. **Shortest Path using A* Algorithms:** A* algorithms (A star) is a combination of ‘branch and bound’ and ‘best search’ methods combined with the dynamic programming principal. It is used to determine the order in which the search visits nodes in the tree. The heuristic function for the node N is:

   \[ f(N) = g(N) + h(N) \]

   Where, \( g(N) \) 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.

   \[ f'(n) = g(n) + h'(n) \]

   This is the current estimated shortest path. \( f(n) \) is the true shortest path which is not discovered until the A* algorithm is finished.

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

1. Create a search graph \( G \), consisting solely of the start node, \( n_0 \). Put \( n_0 \) 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 \( n_0 \) 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.
8. 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.
9. 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.)

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 computer which is of credit card sized with is most efficient board [34]. Raspberry piboard contains System on a Chip (SoC), it is a method of grouping all the useful electronics to run on the individual 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].
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.

Figure -5: Flow Chart of
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 implemented tracking 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 prevents traffic congestion. This work is further extended as smart car parking system with automatic billing system also fully automated system using multilayer parking method. Safety measures such as vehicle no. tracing, driver face-recogni ion.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 in consumption of fuel, it reduces traffic congestion in cities and cloud used for storing the information which is collected from the sensors. It also benefits interns of lowering operating costs and increases revenues and facility value. We outlined the agenda of this ongoing work to enable value-added services around parking to both end consumers and parking service providers. Parking space owners profit from the new services by a more economic use of their parking space, which is represented as an economic resource in the parking management system.

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