Smart Traffic & Parking Management using IoT

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Abstract— **The world is moving very fast and it has to keep moving this way for continuous development. But modern transport is failing to provide smooth transportation system to the citizens. Excessive traffic jams lead to delays in reaching workplace or home, wastage of fuel, wear and tear on vehicles or even a road rage by the stressed and frustrated motorists. Very often we see people standing in a long queue for toll tax collection. Parking is also an extra headache to the vehicle owners. With the help of Internet of Things we have proposed a remedy to all these problems and to make the vision of a Smart City true. We have proposed an algorithm to control traffic congestion and the smart parking system. We have also discussed smart toll tax collection using Internet of things. The implementation of our proposed method is inexpensive.**

Keywords—Wireless Sensor Network; IBM's Watson; ANPR; RFID; LPN-(Licence Plate Number)

I. INTRODUCTION

The Internet of Things is a tool for humanity, which has proved its worth in almost everything that we use in our daily life. It has improved the efficiency of all those applications where it is used. With rapid growth of Wireless Sensor Networks (WSN), it has become the key source to the development of IoTs. We have used the IoT in making transportation smarter. We have developed an algorithm that will help control traffic congestion. The implementation of our proposal is inexpensive and asks for very little infrastructure. We have also suggested a smart method called SPAS (Smart Parking Allocation System) which will help a vehicle's owner get a parking space in a few seconds. They won't have to roam the entire area in search of a parking space anymore. We have designed a toll tax collection system on busy highways, which will allow the vehicles to pay toll tax without halting. We have first discussed traffic congestion control then about advance parking management and thereafter about Toll Tax collection. We have discussed all of these proposed methods in details in later sections.

II. SMART TRAFFIC CONGESTION CONTROL

The idea is to use a central server called STCCS [1] (Smart Traffic Congestion Control System) which will keep track of the data of the traffic density of various roads in the city. The vehicle will make a request to the STCCS for the best route available to a particular destination. Upon receiving the data, the central server analyzes the best possible routes the car can take to reach its destination and sends back the best possible route as a recommendation along with other routes with data of each of their traffic density. Now which route an user will take among the ones shown to him/her is his/her own choice. For real time processing of the data of traffic density, we can deploy IBM's Watson [2]. Watson will be placed on one corner of the road which can analyze how many cars enter and leave the road. It will keep sending the central server the traffic density from time to time. In this way the database of traffic density gets updated and is ready to be sent to the vehicle for possible routes and recommendation.

Here we propose Dijkstra's shortest path algorithm [3] for finding the route as per the user's request:

```
Step 1: function_Dijkstra(Graph G, Source S){
for each vertex v in Graph:  //Initialization
 if (traffic_density < thresholdvalue) /*condition to check if road is congested or not*/
 dist[v]:= infinity      /* initial distance from source to vertex v is set */
 previous[v] = undefined
        // Initially prev[vertex] is not defined
 dist[source]  = 0
   // Distance from source to itself
 Q  = the set of all nodes in Graph
// all nodes in the graph are unoptimized - thus are in Q
}
Step 2: while Q is not empty:      // main loop
Step 3: u: = node in Q with smallest dist[ ]
Step 4: Remove u from Q
Step 5: for each neighbor v of u:  // where v has not yet been removed from Q.
Step 6: alt: = dist[u] + dist_between(u,v)
Step 7: if alt < dist[v]
//alt represents the alternate route
Step 8:dist[v]:= alt
//if alternate route is shorter or of less cost than it is selected
Step 9: previous[v]:= u
Step 10: return previous[ ]
Step 11: Else: function_Dijkstra(Graph, sourcecurrent path)
/*i.e. to apply the algorithm again excluding the current path from the graph*/
```

Here we introduce a graph where the current vertex is represented by v. We apply the algorithm to a path only if traffic is low; otherwise we remove the possibility of choosing that path and apply the algorithm again on the remaining graph.

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III. SMART PARKING & SPACE ALLOTMENT

In most of the metropolitan cities, people call it a lucky day if they find a parking lot easily. Most of them keep roaming hither and thither in search of vacant parking places and somehow manages one after some tedious efforts. There is no certain mechanism available to determine an available parking space and hence they wander all around to search for a parking space. We have come up with an idea which will reduce the headache of searching a parking area with the help of Internet of Things. We are proposing a technique which will help park a car at ease with the help of various WSN (Wireless Sensor Networks) that will provide real time data analysis. In our paper we have suggested a method which will alert the driver about available parking spaces in a nearby area after the STCCS receives a request for a parking space. Our proposed method will provide a shortest path to the driver to the parking space. Instead of traversing all the area in search of a parking space, now in one request the driver can get a parking space in a matter of seconds.

Proposition

There will be a central monitoring system which can communicate with all vehicles and vice-versa. We call this Smart Parking Allocation Centre [4] (SPAC). The SPAC has data from all the parking places in the city. It monitors the no of occupied spaces and available spaces in real time. The driver of the vehicle will make a request to the SPAC to provide a parking space. The request data contains the exact position of the vehicle with the help of GPS (Global Positioning System). Now the SPAC will look on all the available parking space nearest to the position of vehicle. As soon as the SPAC finds one in its Database it will send a message to the driver stating his parking allotment number. The SPAC will also provide the shortest path to the parking area. Thus the SPAC will help car to park in least of time.

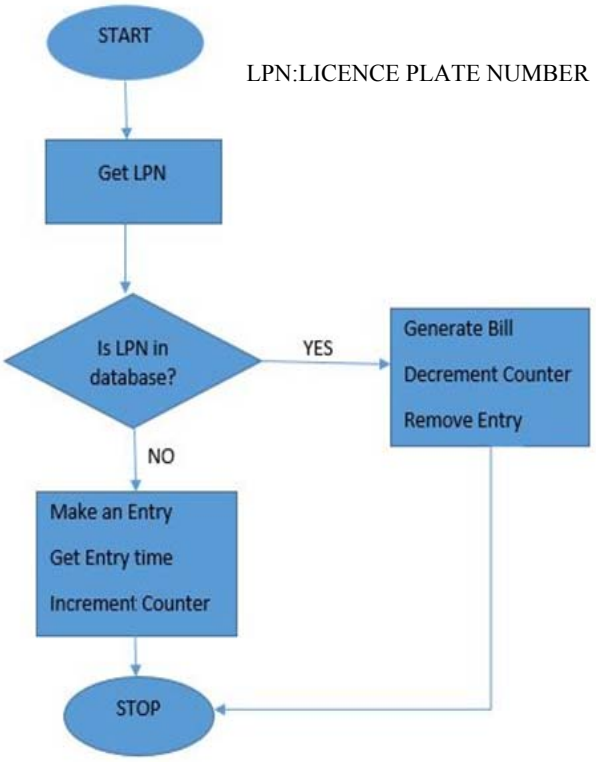
All the parking spaces have WSN which can communicate with SPAC and can share data with it. As soon as a car enters the parking space, the Licence Plate Number (LPN) of the car is recognised with the help of ANPR [5] (Automatic Number Plate Recognition) technology which takes the image of the Licence Plate and sends it to the system. With the help of optical character recognition it gets the Licence Number which then sends it to the database of the SPAC. When the car leaves, it again sends the data to the SPAC, which checks for the entry of this vehicle in its database and generates an e-statement of the total bill for the driver of the car. The SPAC will maintain an electronic payment system which will automatically deduct the amount from the Credit Card of the car owner or it will use a wallet, like PayTm wallet, for payments. Thus reducing time and making things more organised.

Working of SPAC

All the parking spaces will have WSN installed and they will be continuously communicating with the SPAC. SPAC will maintain a separate database for all the parking spaces. The SPAC maintains a counter for all the occupied space in the parking area. Whenever a vehicle enters the parking area, the ANPR system will detect the Licence Plate Number and will send it to the database of SPAC. Now, the SPAC will check in its database for any entries with this plate number. If it finds one then a counter for occupied space will be decremented by one and an e-statement of the billing amount will be sent to the driver and if it doesn't find the plate number then it will make an entry for the vehicle. The database also maintains a column for entry and exit time of the vehicle which will help to generate the billing.

Once the driver of vehicle makes a request, the SPAC will check in its database for all the parking spaces near to the vehicle. It can easily determine the shortest parking space with the help of GPS and hence will tell the driver and provide the shortest path as well.

FLOWCHART FOR PARKING SPACE ALLOTMENT



LPN:LICENCE PLATE NUMBER

IV. SMART TOLL TAX COLLECTION USING IOT

All vehicles have to stand in a long queue to pay the toll tax on highways. Sometimes the queue is so long that vehicles have to wait for quite long. The current Toll Tax Collection system is completely human operated. Every vehicle on the highway must halt and then one traffic officer notes the Vehicle's Licence Plate Number. The officer then generates the billing amount and the driver pays. While this happens, all other vehicles standing behind wait and watch for their turn to come. We have come up with a Smart Toll Tax Collection System (STTCS) which will allow a hassle-free payment and

smooth travelling without waiting to pay the Toll Tax or the gate to open.

Smart Toll Tax Collection System

The System uses a minimal infrastructure to implement this technology. The system will use an ANPR (Automated Number Plate Recognition) technique to collect the basic information of the vehicle when passing through the highway. A primary thing has to be done by all vehicle owners, that is to keep a clean number plate and to link their email ids and Credit Card with the Licence Plate Number. The ANPR system uses a wide angle camera used to capture images of the number plates of the vehicles passing through the highway. ANPR system uses optical character recognition technique to identify the Licence Plate of every vehicle. It then passes the information to the main STTCS where the system matches the Licence Plate number in its database to collect the information about Credit Cards and owner. The system deducts the balance from the owner's account and sends an e-statement of the billing amount to the owner's email id. This entire process of generating the billing, payment and verifying the Licence Plate from the database approximately takes 250 milliseconds.

Recent works on Toll Tax and our proposed method

Many recent works on smart Toll Tax collection uses RFID (Radio Frequency Identification) technique to get details about the owner and Licence Plate of the vehicle. But the implementation of this system is too expensive compared to our proposed method. The RFID [6] technique uses radio waves to search for a common tag on all vehicles to identify them. The RFID tag which has to be placed on all vehicles contains an integrated circuit and antenna. Installation of these tags and RFID readers on cars and arcs of Toll is more expensive compared to ANPR system.

An ANPR system has many advantages over RFID such as easy installation, simplicity of communication and reduced cost due to less circuitry and wiring.

An ANPR system offers a recognition rate between 95 and 98%. ANPR equipments are able to recognise the number plate of vehicles driving up to 200 km/hr.

The Dubai police uses ANPR system to monitor vehicles and in patrol cars.

What if someone doesn't have Licence Plates?

The paper also discusses a method to sort out an issue if someone doesn't have licence plate on the car and tries to escape from the STTCS. A motion sensor will be installed on the arcs of the Toll Tax collection gate along with the camera of the ANPR equipment. This motion sensor detects any kind of movement via the gate. The system continuously monitors the status of the Motion Sensor and the optical character recognition of the ANPR. If the motion sensor detects a movement of car and the camera is unable to get any Licence Number of the vehicle then alerts nearby Traffic Police. The STTCS will capture an image of the car instantly and will send it to the nearest Traffic Control Police Headquarter and alerting all the nearby Traffic Police Officers giving the details of the car. Thus the system removes any kind of fraud. Our paper also suggests a way for catching those culprits who use wrong number plates. The ANPR recognises the Licence Plate Number and if it doesn't match with the available database then that vehicle will be detained by the Traffic Control Police.

V. CONCLUSION

As a project of smart city concept many technologies are running but they haven't proved themselves that efficient or they have proved to be very expensive to implement. But the idea we have proposed in our paper is very easy to implement and much less expensive than the existing ones. This paper will help researchers to start working in a new direction instead of improvising the older methods to ameliorate the transportation system.

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