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Public transportation optimization

Abstract— New application and businesses are created continuously with the help of technology through the internet. IoT(Internet of Things) can assist in integration of communication, control and information processing across various transportation systems. In public transportation, there is lack of real time information. The public transit usage can be improved if real time information of the vehicle such as the seating availability, current location and time taken to reach the destination are provided with easier access. It would also be helpful for the passengers to find alternate choices depending on their circumstances. As excessive long waiting often discourage the travelers and makes them reluctant to take buses. A smart information system has been proposed where the travelers get prior information about current location, next location of bus and crowd level inside the bus. This system is designed using ARDUINO UNO, IR Sensor and GPS Module. An Intelligent Transport System (ITS) removes the barriers for public transport usage and creates the positive impact about the bus journey.

1. INTRODUCTION

Public transport is a service available on sharing basis for the benefit of general public. It includes city buses, trolleybuses, trams, passenger trains, ferries and rapid transit like metro and subways. Unlike transportation modes like carpooling, rickshaws and taxis, this system encompasses an entirety of strangers.

The main reason why the people choose public transportation over other modes of transport are its subsidized rates, environment-friendly attributes and easy accessibility. Firstly, public transport is very economical allowing a large population to have access to it. Using a bus or a train to commute is comparatively cheaper than using a private car. If people have their own car, they have to spend a lot of money on fuel, car servicing, repairs, and insurance. There are many discounts available for some individuals, like students and senior citizens who choose public transport as their transportation option to get to work or to school. Secondly, public transport can preserve the environment by reducing the amount of pollution. With an increase in the use of public transportation, there will be a reasonable dip in the number of private vehicles on the road, therefore, improving the environment and in addition, solving the traffic congestion issue[10].

Furthermore, public transportation has good accessibility in big cities, making it easier to travel to any part of the city, making buses a favorable option. It provides personal mobility and freedom for people. Taking into consideration the other aspects of public transportation, there are some downsides to this service as well. Public transportation, by its very nature, is far more time consuming than any other mode of transportation. Most trains and buses run in accordance with a scheduled timetable. However, these time schedules are seldom followed. There is always an uncertainty regarding the arrival of a bus. Often, buses break down causing further problem to commuters. Another pitfall we see is that public transportation often lacks organization. Commuters are often confused with regards to bus routes and bus stops. Even if the buses are running on time,

signal [18] [20].

In public transportation, there is lack of information about the arrival time. Along with the uncertainty in time, there is also an apprehension regarding the capacity of a bus. Even if the passenger is aware about the arrival time of the bus, they do not know how many additional people can be accommodated inside the bus. The information will be half-baked and hence of no use. Thus, determining capacity of any given bus is equally important to the arrival time estimation. Thus, the system will eradicate the uncertainty in arrival time that commuters face every day and prove to be of great assistance in planning their journeys well in advance. As excessive long waiting often discourage the travelers and makes them reluctant to take buses.

With regard to all the problems mentioned above, the simple knowledge of bus related information can solve a number of discrepancies related to public transportation. For instance, the time of arrival and departure of each bus, a comprehensive list of bus-stops, etc. can prove to be very beneficial.

The opportunities to improve existing public bus transportation by embedding advanced technology into real time transport system is provided by internet of things. Internet of things is inter-networking of physical devices with electronics and network connectivity that control these objects to collect and exchange data. IoT is not only used to sense the information but also to interact with the physical

II. RELATED WORK

An automatic system for low-cost, real-time transit tracking, mapping and arrival time prediction is presented .Several number of step is used to produce trip direction .Easy tracking System consists of data collection unit in each bus .Using batch processing and online-processing route[1]-[5] is predicted and stops are located.

Two information services are provided by Urban Bus Navigation for passengers crowd aware route recommendation and Micro-Navigation .First one collect the information about crowd in the bus and suggest less crowded bus .Second one, through mobile app it provide real time information to the passengers[11].

Arrival time prediction system has three major components 1) sharing Users (passengers inside the bus): By using mobile phones and various sensors to report cellular signals to backend server. 2) Querying users (persons outside the bus): will ask for the arrival time for certain route using mobile

phones.3) Backend Server: collects information from sharing users and process those information to predict arrival time .There is no GPS or other devices is used to acquire current location. Drawback of this system is at least one user on bus willing to report bus status [20].

Idea behind the crowd density estimation [18] is WLAN devices are used to send the probe request periodically and detects the nearby access point. WLAN device is kept in monitoring mode, to receive probe requests. Each vehicle has a mobile device to track the location of the vehicle. The amounts of logged probe requests are limited to one request per MAC address per second. Using this number of passengers has been estimated. By using built-in GPS device position of the vehicle is located .Number of passengers and GPS location is sent to central server and it is associated with the segment of current route of vehicle.

RFID tags are used to detect the objects and EPC is used to link data. Short range wireless RFIDs are used at entry and exit path to calculate vacant seats in bus. Details about location are provided through GPS Device and Details are refreshed for every one minute.3G/4G protocols are used for the freshness of data. In IOTA app, source and destination is given as input and the output will be number of buses in ascending order arriving at the original stop, the total number of time taken to complete the journey and shortest walking distance to reach the destination .And pop-up screen will appear when particular bus route is selected, and information about number of vacant seats and next bus in ascending order is provided. This bus application [13] is currently used in Bangalore.

III. PROPOSED SYSTEM

In this paper we present the smart information system shown in figure 1 which will allow the travelers to take alternative transport choice by providing information about location of the bus and crowd level inside the bus.

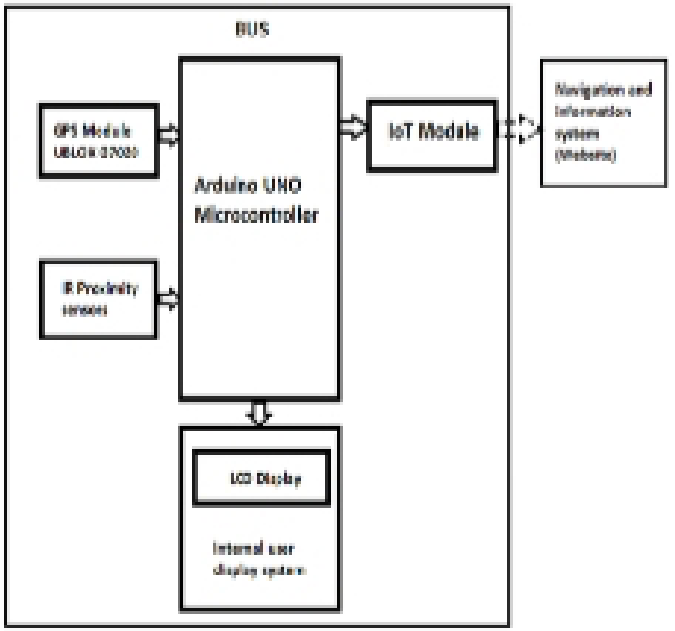

Figure 1. Block Diagram of the Smart Information System

The vital components of smart information system are micro-controller, IR proximity sensor, GPS Module, IoT Module. Inside the bus, GPS module and four IR proximity sensors are used. Two IR sensors are kept at entry path and another two kept at exit path. IR Proximity Sensor is used to count the number of persons inside the bus. GPS Module is used to find the latitude and longitude of current location of the bus. Information from sensors and GPS module is sent to Controller and via IoT module information will be displayed in webpage. IoT Module is used to establish

IV. SYSTEM IMPLEMENTATION

The Embedded device in the bus collects the information of bus related to its location and time and gives out the information about arrival time, current location and vacant seats available in the bus, for this purpose Arduino Uno is used.

4.1. Crowd density estimation

Our approach utilizes an infrared sensor which is an electronic device, that emits IR rays in order to sense some aspects or objects around it's the surroundings. This sensor measures the IR radiation which considering the infrared spectrum, where all the objects radiate some form of thermal radiations. These kinds of radiations are invisible to our eyes that can be detected by an IR sensor. The emitter is called as IR LED (Light Emitting Diode) and the detector is an IR photodiode which senses the IR light of the same wavelength as that emits the IR LED. When IR ray falls on the photodiode, the resistances and these output voltages of the IR receiver change in magnitude.

This sensor is used to detect any human crossing entrance and exit path of the bus. These signals are processed by our embedded system. The bi-directional counter is used which senses the human hindrance and increments the counter each time, when Infrared signal is cutoff at the entrance. This embedded system also receives the signal from the exit points which is used to decrement the counter. This counter provides us real time estimation of density of people who are inside the bus.

For crowd density estimation, four infrared sensors are used. Two infrared sensors (IR1&IR2) are fixed at entrance and another two infrared sensors (IR3&IR4) are fixed at exit path. Because, in urban bus people may use both the entrance and exit to enter and leave the bus. The bi-directional counter is used which senses the human hindrance and increments the counter by 1 when infrared signal of the IR1 is cutoff and then the infrared signal of the IR2 is cutoff. The counter gets decremented by 1 if infrared signal of the IR2 is cutoff and then the infrared signal of the IR1 is cutoff. Similarly, at exit path the counter gets incremented by 1 when infrared signal of the IR3 is cutoff and then the infrared signal of the IR4 is cutoff. The counter gets decremented by 1 if infrared signal of the IR4 is cutoff and then the infrared signal of the IR3 is cutoff. This provides us real time estimation of density of people who are inside the bus. The flowchart for the operation of bidirectional counter at entrance is shown in the figure 2.The operation of bidirectional counter at exit path is same as the counter at entrance path.

Figure 2. Flowchart for Crowd Density Estimation

4.2. Bus location prediction

To detect current location of vehicle GPS is used to interpret the coordinates of the vehicle. A microcontroller embedded with GPS is used to track the location of the bus. A GPS navigation device or GPS receiver is used for vehicle navigation. It is the device that is capable of receiving information from GPS Satellites and then to accurately calculate its geographical location. It can retrieve from the GPS System Location and Time information in all-weather conditions, anywhere on earth. A GPS reception requires an unobstructed line of sight to 4 or more GPS satellites.

The location details such as latitude and longitude are received through GPS module through the embedded system. The system is programmed with a route map which enables us to identify the location. The entire route's is latitude and longitudes are stored in the system with corresponding stops that need to be taken. When the bus is moving the GPS module stays active and sends the tracking data to the controller. The controllers compress the real time data with logged in data to identify the current location and the stops. When the vehicle reaches the stop the system automatically detect the corresponding and displays the stop information to the users.

For location prediction, GPS Module is used. In our project, we have taken five fixed stops. They are Stop1: SRIT Parking, STOP2: SRIT Entrance, STOP3: Pachapalayam, STOP4: Chettipalayam, STOP5:Perur.First the latitude and longitude readings of the above 5 places are noted and then those values are fed into program. When the bus moves the GPS module which is kept inside the bus sends the latitude and longitude of the current location of the bus.

Arduino compares those values with the already available values and display the name of the current location if the values match or else simply displays latitude and longitude of that place. The flowchart for the bus location identification when the bus moves from SRIT Parking to Perur is shown below in the figure 3.The procedure remains same when the bus starts from Perur and ends in SRIT Parking. But, the small modification should be done to display next location and arrival time.

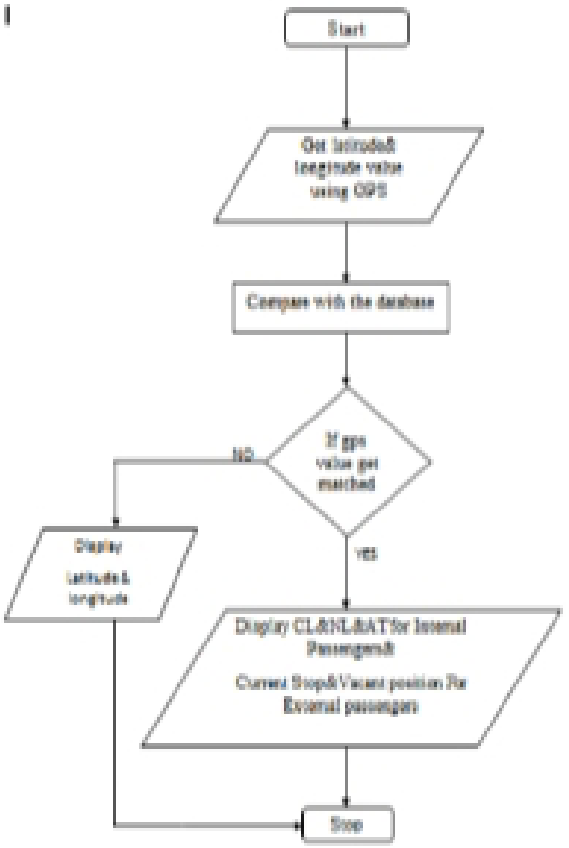

Figure 3. Flowchart for Bus location Prediction

4.3. IoT module

To establish the communication between urban bus and passenger's smartphone IoT Module is used. If we use Bluetooth it will provide only short range communication, so we are using IoT module.The Internet of Things (IoT) is internetworking of physical devices with electronics and network connectivity that control these objects to collect and exchange the data. IoT is not only used to sense the information but also to interact with the physical network.SIM800C is used here for the transmission of data and it is a complete quad-band GSM solution, which can be embedded in the customer applications. These modules are the sub-system of the internet-of –everything hardware. It Supports quad-band of 1900MHz and it can transmit voice, SMS and data information with low power consumption. It can smoothly fit into slim and compact demands of customer design.

V. RESULTS AND DISCUSSION

The system provides real time information about arrival time of the bus, crowd density and transmits information of bus. All these help public about the occupancy status and upcoming buses which enables them to take better decision which in turn helps in crowd management this information also helps bus operators, to analyze patterns in public transportation usage in different routes, based on which they can provide extra service.

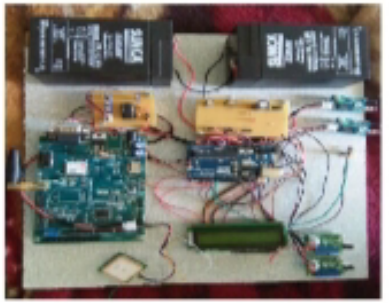

Figure 4 Final prototype of the proposed system

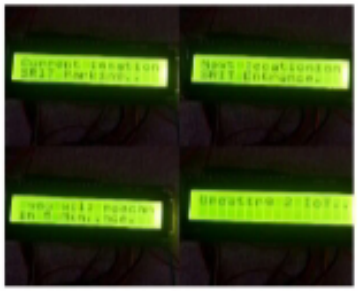

Figure 5 Information displayed in LCD at SRIT Parking

By using the smart information system, the public bus usage can be improved and so private modes of transportation get reduced. It will play vital role in controlling traffic congestion and pollution .This system is created and developed using simple and cost-efficient components. It can be easily installed inside the bus because of its small size.

We have tested our project in all the five stops that we have taken as reference location. All the other units in the system, including sensors, GPS module and power unit are tested and are found to be in working condition. The outputs taken at SRIT Parking when the bus moves in forward direction i.e., SRIT Parking to Perur is shown in the figure 4 and figure 5.For Internal passengers the current location is displayed as "SRIT Entrance", the next location is displayed as "SRIT parking" and the time taken to reach SRIT is displayed as "5 Minutes" in LCD Display .

For External Passengers, the information will be displayed in the webpage www.iotclouddata.com/project/305/iotview.php as shown in the figure 6.The maximum capacity of the bus is fixed as 55 in our proposed model. Difference between the maximum seating availability of the bus and the number of passengers inside the bus is displayed as vacant position for external passing.

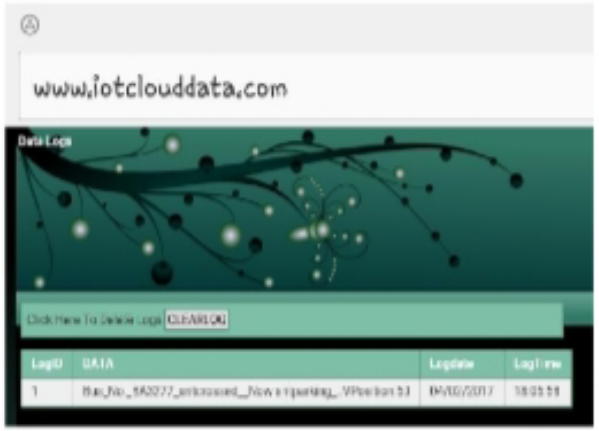

Figure 6 Information displayed in Webpage at SRIT Parking

Fig.15. Update Location response

Once a driver card interrupt is detected the driver's credentials are validated, and the trip ID is returned as shown in Fig. 16.

Fig.16. Driver authentication

Fig. 17 shows, when a user boards the vehicle and swipes their card, their info is validated; if valid, their reservation's status changes to "boarded" and their pickup time is updated.

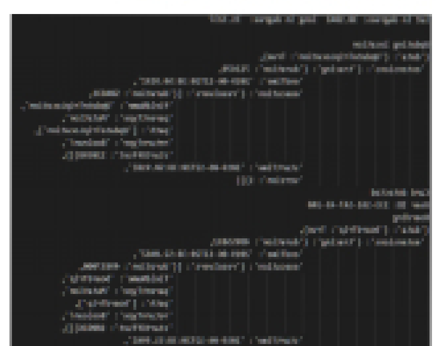

Fig.17. User Boarding