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Smart Monitoring and Control of Bus Stand and Goods Transport System Activity using Cloud Computing

Kantilal Rane, Pradnya Vikhar, Bupendra Chaudhari

Abstract: ***This work focuses on the, implementation and validation of smart public transport system as well as goods transport system based on the application of GPS (Global Positioning System) technology, GSM (Global system for mobile communication) using Cloud computing. This system has been distributed into four modules as In-Bus/truck module, Bus/truck-stand module, cloud system and user mobile apps. After initialization of In-Bus/truck module, driver gets the information regarding to the platform availability on parking zone that are assigned to it. If the platform is vacant then driver needs to park the bus/truck at said position only. The drivers may get allotted or waiting parking platform's information through SMS or on Drivers app. The GSM integrated GPS technology can also be used to get the current location of vehicles and the available vacant seats or vacant space in truck. This information will be recorded automatically by the system. IOT module ESP12E NODEMCU is used for controlling and handling whole operations by collecting the data. This system will also guide the drivers and the bus/truck stand controller to control all vacant ports based on real time operation. One In-Bus/truck module (configured along ESP12E) needs to be installed into each vehicle to be monitored. One Bus/truck-stand module has to be installed in to each platform. Cloud system is needed to collect the whole data for big public/goods transport systems for automation of 1000s of vehicles at a time. ThingSpeak cloud is used and computing is performed by MATLAB computing. For late running, on-time running and before time running vehicles, messages are automatically sent regarding to its location and vacant seats/space. And will be displayed on rolling board on platform. Passenger/user may get the correct information by sending message on his mobile from anywhere through mobile app. Mobile app is developed to perform all the task of monitoring to passenger/user, and drivers.***

Index Terms- GPS, GSM, Bus/truck Stand (Platform) module, Bus/truck Side Module, ESP12E, IR Sensors

I. INTRODUCTION

Transport is one of the important needs of any country. The main problem about the transportation is the waiting time due to traffic jams.

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***** Correspondence Author
Kantilal P Rane*, Professor, KCES's COEIT, Jalgaon, Email: kantiprane@rediffmail.com
Pradnya Vikhar, Assistant Professor, KCES's COEIT, Jalgaon, Email: pradnyav123@gmail.com
Bupendra Chaudharu, Senior Lecturer, Government Polytechnic, Jalgaon, Email: bupendra_scorpion@rediffmail.com

The safety of all types of vehicles is a major concern so novel approach of vehicle tracking system ensures proper monitoring with their safety while travelling.
By doing comprehensive survey related to scope of bus/truck stand monitoring and control technologies available today in India, it is found that there is big scope to develop various types of applications and improvements for bus/truck stand monitoring and for it's controlling.

Vast works has been already reported in the field of bus/truck tracking system. But it is needed to co concentrated on some practical aspects like availability of parking zone, availability of reserved waiting zone for vehicle and awareness in public to use it. If the actual platform allotted for parking is not vacant then the driver will have to wait at waiting place or if both places are not available then drivers has to be prior intimated for speed control. Nowadays, most of the people are using mobile applications in their daily use so its today's need to work on such emerging topics. Driver app is also designed for getting message with voice assistance system during driving. Received message will be repeated until the driver simply clicks on mobile or until next message is received.

Whole operation of proposed system is performed with basis of four module 'In-Bus/truck module' (Bus/truck side module) and 'Bus/truck-stand module' (Platform side module), 'Cloud System' and 'Mobile apps'. It provides the access to real time information related to bus/truck schedules, arriving time and departure time etc through the display at bus/truck stands. Internet connectivity as well as self-service Short Messaging Service (SMS) is used for maintaining connectivity. Displaying vacant seats/space on platform in case of bus transport/truck transport truck respectively and displaying vacant platforms for bus/trucks inside the bus/truck-stand is performed by the proposed system. Number of present person in the bus or number of goods present in truck, their counting in bus/truck side and locating the vacant positions of the platforms on platform side can also be handled by the whole system.

Bus/truck tracking system is required to be installed in In-bus/truck module and bus/truck monitoring system has to be installed in bus/truck-stand module. Bus/truck stand monitoring system will display the status of number of bus/trucks likely to be approaching to bus/truck stand. Cloud computing module will collect the data about all the parking zones from Bus/truck stand module and corresponding resultant of computed data is provided to the bus/truck-stand module of asking bus/truck for handling 1000s of vehicles at a time. Good features of this system is that all the modules are configured and designed with GPS, GSM, ESP12E IOT modules and various sensors.

IR sensors are used to count the entered and exit person or goods in bus/truck.

It then saves the record for the communication to bus/truck-stand module and sends to cloud for further processing. With the help of that numbers, number of vacant seats or vacant space in the specific bus/truck can be reported at bus/truc-stand module. For counting the vacant seats, two IR pared sensors gives us the best result.

II. LITERATURE REVIEW

In 2008, a specific system was developed that involved some fundamental features of real-time monitoring for daily operations in Beijing bus Company that are realized in the BJ-BMS [1]. In 2010, integration of RFID and GIS was proposed. RFID based Identification was developed and monitoring system was also implemented based on the RFID. To monitor the movement and the positions of the campus bus, improved system was developed [2]. In 2011, GIS system was identified that analyzed and displayed geographic information. This work was targeted on the GIS application for identification of bus/truck detection. The intelligent monitoring system was also developed [3]. Again in 2011, moment of the bus was detected and monitored with the help of integration of RFID and combined sensing techniques like GIS, GPS, and GPRS. A decision algorithms based on ruled and new theoretical framework was developed for the becoming efficient system [4].

GPRS and Zig-Bee technology based supervisory system was developed in 2012. Efficiency of system was realized in intelligent transportation and bus monitoring [5]. In further work, the direction of the vehicle was monitored [6]. Dynamic vehicle monitoring and scheduling system based on Arc-GIS Server was also included in this work. The strong distance calculating ability of Arc-GIS technology was also discussed so that vehicle incoming time is calculate in advance, so the foreground of the system can manage and upload graphics and video information to accomplish monitoring and scheduling [7]. Message exchange was used to maintain accurate location of bus with minimal computation requirements in the work thereafter [8]. Data addition and calibration system for a new Flex Ray bus based on the high-speed and flexible USB interface was designed in latest work [9].

From the survey, it is concluded that, we may use various sensor based systems but the system based on reliable, cheaper, easily available system components with latest technology are to be considered.

III. METHODOLOGY

Proposed system is categorized in to four segments, out of which two main modules as Bus/truck Side module, Bus/truck-stand Side module are as shown in Fig 1 and Fig 2 respectively. In Bus/truck side module, GSM is integrated with GPS and IR sensors around IOT module. With the help of GPS, longitude and latitude of the Bus/truck can be recorded. Exact location of the bus/truck can be calculated from it. Counting the number of person entering and exiting or counting the goods space in the bus/truck respectively is performed using two IR pair sensor.

From user, the enquiry may be received for location and number of person present or vacant space in the bus/truck with the use of GSM module. If enquiry is received for the location of the bus/truck then it sends the correct location to the mobile number from which enquiry has been received. If enquiry is from many people then same will be sent to all. System constantly monitors the receiving SMS regarding to the bus/truck platform vacant status and shows the status on driver screen if enquiry is initially placed by driver for the same.

Main operations of In-Bus/truck Module are as follows.

1) Count the amount of space available in the truck using two IR pair sensors or continuously counts the number of persons entering and exiting in the bus using two IR pair sensors.
2) Continuously capture the location of moving bus/truck using GPS.
3) Receive the enquiry for location and number of person present or place available in the bus/truck respectively using SMS from GSM module.
4) If enquiry is for the location of the bus/truck then it sends the current location to the mobile number from which enquiry has been received.
5) If enquiry is for the number of person present or vacant space in the bus/truck then system sends the correct number of persons or vacant space details to the mobile number from which enquiry has been received (this mobile number may be of user or of Bus/truck-stand module).
6) If enquiry has been placed by driver for vacant platform, it collects the information by receiving SMS and/or through internet wifi about vacant status of bus/truck platform.
7) Display the status on driver screen on In-Bus/truck module.

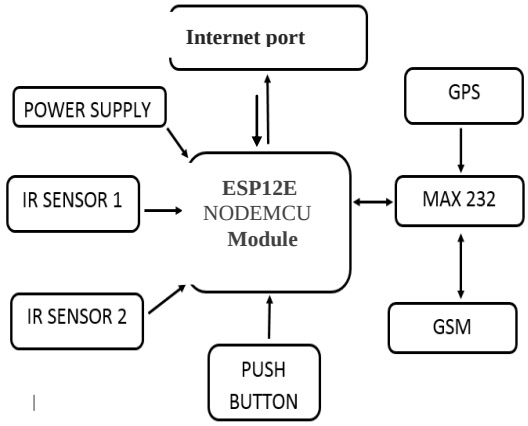

Fig 1: Block Diagram of In-Bus/truck Module

Bus/truck Platform Side Module is second part of the system, in which ESP12E NODEMCU-IOT model is used with GSM as well as two IR pair sensors for counting the vacant and un-vacant positions of the platforms. One Bus/truck Platform Side Modules have been installed at every platform for sensing the vacant position and then the control is given to the processor by wired network. Vacant platform information is stored on cloud. If enquiry is received by different drivers, GSM module has to send the vacant position status of platform assigned to the vehicle to the corresponding drivers those are registered with system by checking its status on cloud. Cloud system has the detailed schedule of all the vehicles running to the particular day.

On time vehicle, late vehicles and before time vehicles within the time of one hour are only considered for the assignment of free platforms.

For such vehicles, it assigns the free platforms and sends the information to Bus/truck-Stand Platform Side module for display and for sending to the enquiring driver through internet wifi. For other than such vehicles, if enquiry receives from driver, 'blank' information has to send back to driver module through GSM. If information is not received from cloud in any case specifically because of internet problem at the place of platform, information may be directly sent to of In-Bus/truck driver module through internet wifi so that vacant position may be displayed on of In-Bus/truck driver module.

Main operation of Bus/truck Platform Side Module is as follows.

1) Count the vacant and un-vacant positions of corresponding platforms.
2) Constantly send the vacant position and status of platform through internet to cloud.
3) Similarly all the modules have to send their vacant position to cloud through internet. Cloud updates the vacancy report.
4) If enquiry of vacant platform is received from driver through GSM, message is diverted to cloud through internet.
5) It analysis the inquiry vehicle number in schedule, if it is in its schedule limit of 1 hour then the assigned platform's status is send to Bus/truck-Stand Platform module.
6) It diverts the platform vacancy message to enquiring driver of In-Bus/truck Module.
7) In-Bus/truck Module displays it on its display.

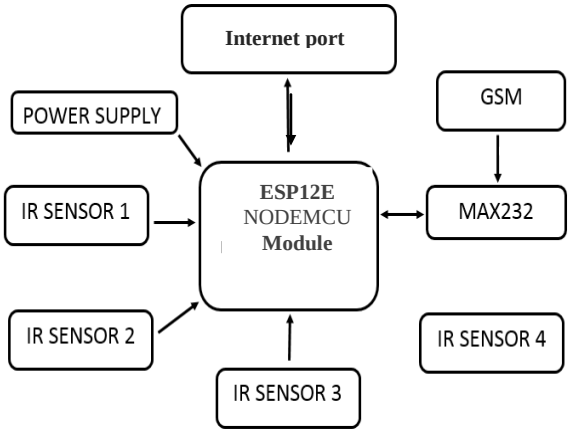

Fig 2: Bus/truck-Stand Platform Side

IR sensors: Long range Sharp 'Gp2Y0A21Yk0F, 2Y0A21 Sharp Ir Analog Distance Sensors' are used for sensing the entry or exit either passengers or goods. It may be arranged in such a way that it can identify the space available in truck.

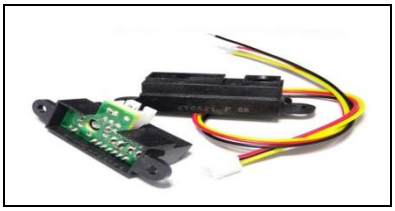

Fig 3: IR Sensors Used

GPS: The GPS module continuously transmits serial data through io pins. The latitude and longitude values of the location are contained in the GPGGA sentence in the form of NMEA format. To send data three signals are required to be interfaced which are named as RXD, TXD, and GND with ESP12E NODMCU.

GSM: The GSM module can send or receive SMS between the microcontroller and mobile phone. To communicate, three basic signals named as RXD, TXD, and GND are used. GSM modem is interfaced with NODEMCU for SMS control.

IR sensors: IR sensors are used for counting of the persons/space present in the bus/truck. It is also used for counting the vacant positions of the platform on Bus/truck platform side module.

CLOUD COMPUTING: If the volume of transportation is more (if more than 1000 vehicles), there will be more platforms and more data storage is required. And so the management of this system is becoming so complex. This problem will then become the big data problem. To overcome this problem, ThingSpeak cloud is used to effectively storage of 'Vacant Platforms Database' and it also may display the received data properly. On a single cloud, multiple city platform databases can be stored. All these databases can be easily modified using the ThingSpeak desktop through assigned different entry point. 'Database of All Day Schedule of All Vehicles' for different cities bus stands is designed on cloud. For real time computing the data, MATLAB interface with the ThingSprak cloud is used using code1 and code2. MATLAB code1 is having access to the 'Database of All Day Schedule of All Vehicles' for different cities bus stands. If enquiry is received by the particular vehicle, it is entered into the 'Enquiring Vehicle Database'. Its scheduled limit is 1st calculated by using MATLAB programming. Its enquiring station's platform vacant status is them analysed and the vacant platform is accordingly assigned to enquiring vehicle. 'Assigned Platform Database' is also maintained. The assigned message is then send to both the corresponding Bus/truck-station module and enquiring In-Bus/truck module through internet connectivity for further processing.

'User Enquiry Databases' are also managed on cloud. It is used by MATLAB code2 against enquiry of schedule/location/vacant seats or space from user. This enquiry has to be send through the corresponding BUS/truck-stand module.

According to the priority; the different databases are rearranged and assigned for processing through MATLAB codes. Two MATLAB codes are used for processing the two types of enquiries from users as 1st for vacant platform enquiry and 2nd for enquiry from user for asking schedule, for location and for vacant seats/space.

Algorithm for MATLAB code1 used for cloud computing specifically for vacant platform enquiry is as follows.

1) Get the enquiring vehicle number from platform enquiry database.
2) Search it weather it is available in registered numbers.
3) If it is not registered vehicle, rejects.
4) If it is registered vehicle, it searches it in its schedule database.
5) If its duration between scheduled time and arrival time is in limit of 1 hour,

then immediately checks for vacant platforms from asked station database.

6) It assigns the free platform to the enquiring vehicle and maintains assigned vehicle databases.
7) Sends the message of assignment to both the corresponding Bus/truck-station module and enquiring In-Bus/truck module through internet connectivity for further processing.
8) After receiving vacant status from different platforms from various cities, modifies both the vacant platform database and assigned platform database. Deletes the entry of enquiring vehicle number from platform enquiry database.
9) Repeats the step 1) to step 8) for next enquiry.

Algorithm for MATLAB code2 used for cloud computing specifically for enquiry from user for asking schedule, for location and for vacant seats/space is as follows.

1) Get the entry from user enquiry database1 for asking schedule, for location and for vacant seats/space.
2) Get the schedule of enquiring vehicle from 'Database of All Day Schedule of All Vehicles'.
3) Send the information to enquiring Bus/truck-stand module (in terms of enquiring user number, enquired vehicle number and its scheduled time).
4) Get the entry from user enquiry database2 for asking schedule, for location and for vacant seats/space by the entry of destination and current course.
5) Analyses the schedule from 'Database of All Day Schedule of All Vehicles' for recently scheduled two vehicles.
6) Get the schedule time of recently scheduled two vehicles.
7) Send the information to enquiring Bus/truck-stand module (in terms of enquiring user number, enquired vehicle numbers and its scheduled times).
8) Repeats the steps from 1) to 7) for new entries.

MOBILE APP FOR USERS: Android app is designed (using app inventor2) for users to send the enquiry by sending SMS to enquiry number of particular Bus/truck-stand module for asking location of particular bus/truck by vehicle number or by the destination of recently arriving vehicle like bus or truck going to destination say Mumbai at station Nagpur. This app sends the enquiry to the corresponding Bus/truck-stand module through SMS. Bus/truck-stand module diverts the enquiry to cloud by the entry to user enquiry databases by two ways as 1st through vehicle number (in terms of 'User Enquiry Database1' as enquiring phone number and enquired vehicle number) or through destination and source station code (in terms of 'User Enquiry Database2' as enquiring phone number and enquired station codes). Cloud computing MATLAB code2 updates the enquiry result database with the resent vehicle number or given vehicle number with its scheduled time and send the data to enquiring Bus/truck-stand module (in terms of enquiring user number, enquired vehicle number and its scheduled time). The Bus/truck-stand module sends the enquiry to the corresponding In-Bus/truck module for location and vacant seats/space. In-Bus/truck module replied the detailed data to Bus/truck-stand module. It diverts the information to user app.

IV. EXPERIMENTAL RESULTS

By using this system, waiting time of the passenger/goods transportation is well reduced as well as it helps to manage arrival and departure of bus/trucks by avoiding unwanted traffic jam. According to the priority the platform may be assigned to bus/trucks if want to access at a time.

In-Bus/truck Module: In-Bus/truck Module (Fig 4) counts the total number of passengers available or space available by using IR sensors. Counting the number of persons entered or exit in bus is possible by sensing the pulses from IR sensor. The space available in truck is also possible to identify by using distance measuring capability of IR sensors. Collected data from IR sensors are saved in data base in real time mode. If a message is received from bus/truck-stand module or from passenger regarding to the bus/truck location or vacant position/space in the bus/truck then the system will automatically replies to passenger/person through message. Also when driver needs information regarding to the vacant platform at the time of driving, In-bus/truck model sends the message to bus/truck-stand model. After receiving message from bus/truck-stand model, driver parks bus/truck in specified place and same information of bus/truck location is automatically announced by the system to the passengers or concerns.

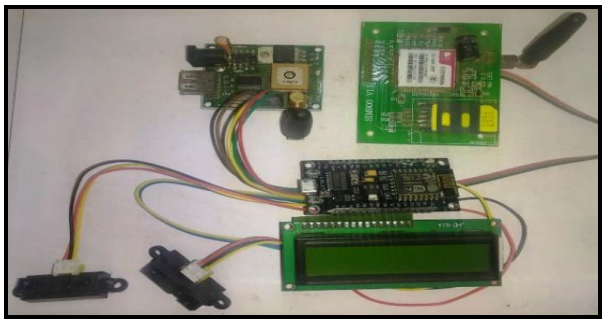

Fig 4: In-Bus/truck Module

Bus/truck-stand module: This module is shown in Fig 5. In this module, ESP2E module is interfaced with array of IR sensors and with GSM and power supply. Bus/truck-stand module counts the vacant platform number continuously in real time mode if the bus/truck stand module receives the message from the bus/truck driver or from in-bus/truck module then system will automatically replies to message received regarding vacant platform. Means the bus/truck stand module monitors the in bus/truck module. GPS module is also interfaced to this module to identify the location of various platforms.

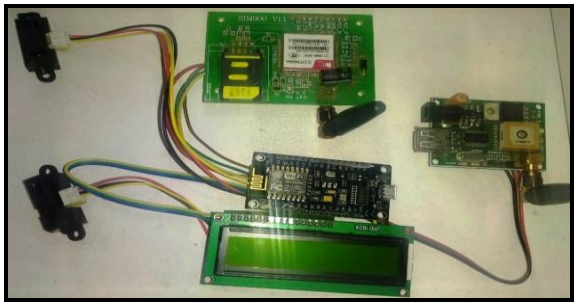

Fig 5: Bus/truck-stand Module

Initialization of the system is shown in Fig 6 when the power supply is switched on. The system will automatically collect the information regarding all the scheduled bus/truck's location through longitude and latitude.

It shows the message on 16*2 LCD display like "GSM modem connected "and "Bus/truck transport system". It also shows that "The system is initialized". And starts working and processing as per specified protocol.

Fig 6: Initialization of GSM & GPS

As shown in Fig 7, the passengers or vacant space are calculated and information is displayed on 16*2 LCD display. P shows the total number of passengers or vacant count available in bus/truck.

Fig 7: Display Number of passengers entered and exits or vacant space count

Fig 8 shows the enquiry message that passenger or user has to send in format like "MH 25 8031" to enquire the bus/truck details by using his mobile to enquiry phone. This enquiry message is sent from passenger or user to In-bus/truck module. By getting this message, the information corresponding to bus/truck number, bus/truck location and vacant seat/vacant space are reverted back. Similarly user can send enquiry through user app designed especially for android mobiles.

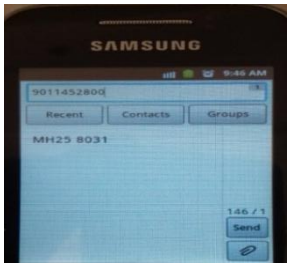

Fig 8: Enquiry sent by passenger/concern for bus/truck location & seat/space available in the bus/truck via phone

Fig 9 shows the received enquiry message for bus/truck location and vacant seat/space reading process and displays the message on 16*2 LCD display on display board.

Fig 9: System received inquiry about bus/truck location & seat/space available in the bus/truck

The system will automatically receive the message from concern person (Fig 9) and replies to enquiry message by sending back bus/truck location and vacant seat/space (Fig 10).

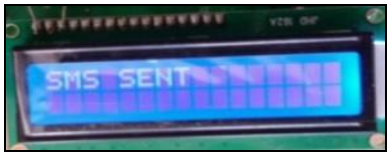

Fig 10: Sending reply for inquiry with bus/truck location & seat/space available

Fig 11 shows the message replied as a result of enquiry message. Reply message contains the bus/truck location, passenger/space count and Bus/truck Number.

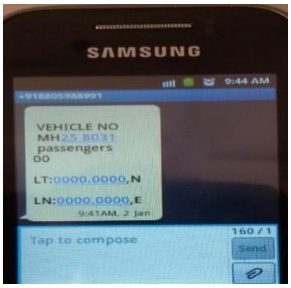

Fig 11: Reply containing bus/truck location & seat/space available

Driver has to press the PUSH button for the enquiry of vacant platform. After getting information regarding vacant platform, driver may park at located platform. System continuous collects the information of vacant platforms after receiving enquiry from the driver side module. After collecting information, bus/truck-stand module sends (Fig 12) the vacant platform information to In-bus/truck module.

Fig 12: Sending Platform status via GSM to In-bus/truck Module

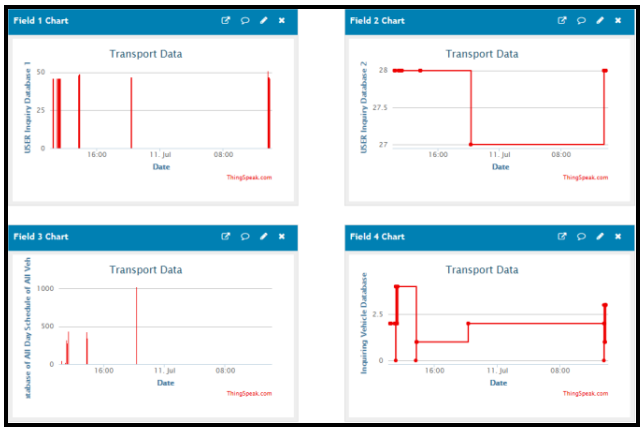

Fig 13: ThingSpeak databases

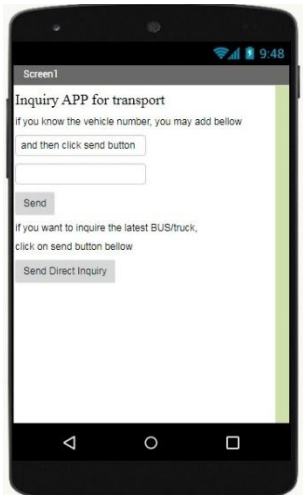

Fig 14. Mobile app for User

Fig 12 shows the process of sending a message to the in-bus/truck module which is nothing but the replay to the enquiry message about vacant platform. ThingSprak database for 'User Enquiry Database1' is shown in Fig 13. Front view of android app that is designed with App Inventor2 for user enquiry is shown in Fig 14.

V. CONCLUSION

Smart Monitoring and Control of Bus Stand and Transport System Activity is successfully implemented and tested. Bus/truck-stand module monitors the bus/truck stand traffic and reduces waiting time of passenger. Proposed system provides the information regarding real time location of bus/truck, longitude and latitude of bus/truck as well as available seats in the bus or vacant space in truck. This system also guides bus/truck stand management/controller by providing information regarding bus/truck location, vacant platform, and available seats/space in the bus/truck. Propose system is more efficient and cost effective and also possible to implement commercially. Tracking system is getting more important in large places and it is more suitable than other systems. It was successfully integrated and because of it, it is possible to track multiple bus/trucks anytime from anywhere. It has real time capability, this system has many advantages such as minimum operation costs, effective/ strong expandability and easy to use in vehicle tracking and bus/truck stand management.

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AUTHORS PROFILE

Dr. K.P.Rane, is presently working as a Professor and Principal in KCES's College of Engineering & Information Technology, Jalgaon. He has completed his Ph.D in 2015 from KBC North Maharashtra University, Jalgaon. He published 57 International papers and attended 24 National and International conferences. His area of research includes Networking, IoT, and Image Processing.

Dr. Pradnya A. Vikhar, is currently working as a Assistant Professor and Academic Dean in KCES's College of Engineering & Information Technology, Jalgaon. She has completed her Ph.D in 2018 from SSGB Amravati University, Amravati. Her research interests are Image Processing, Information Retrieval, and Soft Computing. She has published 20 papers in various recognized journals.

Dr. B. M. Chaudhari, is currently working as a Senior Lecturer in Government Polytechnic, Jalgaon. He has attended many National and International conferences and published 15 research papers.