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ADVANCED AUTOMATED INTELLIGENT TRANSPORT SERVICE WITH IOT INTEGRATED IN SMART CITY

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ABSTRACT

The technological outburst has rendered any individual to achieve an hassle free, unambiguous, methodical system for reaching any destination, a necessity. With the advent of technology, the Internet has become accessible to everyone and daily process has become more complicated. This requires an omnipresent, powerful, process oriented, error free transport system for the Indian roads, so that citizens can safely process the ticket, and get an assured seat in the bus. This environmental friendly use of technology, reduces human intervention to the limit redundancy, such that each stop or destination is selected by the user, full refund system for wrong booking, hassle free journey, an and assurance that tourists will reach their destination securely without boarding the wrong transport. This theoretical paper discusses the use of wireless technology, smart bust stands, and state of the art process oriented case management for each booking and the mechanics of such a solution and its security. The purpose of the paper is to discuss the various components required and the technology used to collate the arrangement, using the existing technology to create anexcellent experience for the administrative staff and the public. This arrangement can be used for any other public transport system thus increasing the flexibility. The basic use of GPS tracking system, wireless technology, where passengers will get a bar coded token which is unique to the start and destination code and hence while swiping to catch the bus, will automatically stop the passenger and alert them. The security of

the modules has also been covered here. This system orients to use the IoT as a soul of the vehicle to collate with various sensors for a smart operation. The basic setup will not only enhance the transport system but will also become a crucial part of building a smart city.

KEYWORDS: Women Safety, Automated public Transport, Uses of Wireless Communication, Smart bus stand, Advanced transport booking, Smart City, IOT.

INTRODUCTION

In the modern era, the fast pace of life has made it a necessity to change the way the mobility and transportation system is dealt with.[1] Improving the public transport system in the urban area is of special concern as many concepts of smart cities are already gaining a progressive leap in the present times. Pollution reduction, green communication, enhanced and automated, intelligent transportation system has thus now become a necessity that government bodies should enact upon. Currently there is no specific data on how many people travel in one specific route, unpredictable count of passengers boarding from and to a bus stop, no statically data on which area needs more frequency of buses, no environmental friendly organized tickets distribution (most of the tickets being paper token, it is highly inconvenient and deplete the tree population, accumulate excess litter) general public not accustomed to the cities may board the wrong bus and this leads to inconvenience., this Intelligent transport system, customizes the need for a bus conductor to book tickets for the users, minimizes the use of paper by substituting it with bar coded tokens getting generated by the bus stand ticket booking counter at the bus stop, recharging the bus card, which acts like a credit and debit card, authenticating the user each time the user logs in and makes a booking, wireless transmission of the data about the booking to the driver, thus enabling the calculation of the stop time at each bus stand, passengers can swipe the token at the small bar code reader and get on board. The embedded IoT chip will help in tracking the sensors on board which will not only make the system intelligent but intelligent. The wireless technology enables each vehicle to send/receive signal to and from the bus stand and to the smart traffic signals. There is a scope for intra vehicular communication which will be discussed in the short. The data collected during the process, needs to be analyzed and efficient systems build out of it, this requires data capture, data analysis and the data storage which might possibly pull in big data analytics in future. The facility of online police and the administration staff has the capacity to moniter and communicate with the vehicle on the fly, hence making it interactive and secure.

Theoritical Design

Smart Bus

These centralised A.C. buses have automatic slide open and shut doors with approach sensor giving the maximum safety for the passengers and on screen display and announcement for the next stop and the approximate distance left to cover it. The bus will be specially designed with lower base and retractable stands for passenger to get onboard, to facilitate public on wheel chairs as well, leaving a minimum width of 8ft' cross 6ft' single door entry for the passengers to enter and exit. The display board outside the bus will facilitate the number, start and end location for easier identification. The bus can be tracked with GPS by the traffic police as well as the information of its arrival can be projected on a screen at the respective bus stops.[2] The number of passengers will vary from the bus size and has been kept a flexible parameter allowing building any size as per requirement. The A.C units are built in the front considering the basic aerodynamics, while the entrance slide doors are placed at the middle section enabling enough space on either side for the passengers to move. The bus seats will be allocated based on the travelling distance avoiding rush. Separate bus lanes on the left of each road are allocated for easy traffic movement, including the crossroad signals. The bus driver is elevated such that there is a comfortable shoulder positioning, as well as elevated seats, double glass protection for the window panes in the front with a camera installed at the back of the bus giving the driver the rear view and the back view as well, the front panel will contain, apart from the standard panel, a display board dynamically displaying the number maximum number of passengers boarding from each stop and the maximum stop time. The Smart Bus uses the latest Raspberry Pi 3 model with built in Wifi which helps it to connect it to the terminals, the on board Bluetooth has not been utilized yet, but could be used to fetch immediate data by the driver. The bus stands are secured Wi-Fi hotspots and as soon as the busses are within the range, the smart bus can pick up the data analytics required for it and process efficiently. Token reader in the form of bar code detectors are installed adjacent to the sliding door and the token has to be read in order to get in. The token code will contain bar code following the general standards representing the source and the destination current data of travel and an encryption key generated from use name. Before getting down from the bus, every passenger will deposit the token upon which the slide doors will open and for every thirty tokens the bus will, on analysis of whether the bus stops require tokens, dispose the used tokens to the token recycling unit, installed in each bus stop. Once the token is placed into the token disposal unit, a simple bar code eraser will erase the existing bar code and prepare the token for the next use, thus reducing the use of paper as token. The Bus has its own GPS: GPS

NEO-6M Module, DS1307 RTC, for time and date updates since the unit is not always connected to the internet, there could be the use of GSM Surfstick in case the WiFi signals go weak, but this device is kept optional now seeking to the cost of the overall bus. The segment display in the bus for the various destinations can be connected onboard as well. MAX7219 LED Matrix, will be available and each light can indicate the driver for various purposes: they are available in red and green lights and they can display various digits as programmed by the control unit. Since the security is under question we have kept keypad connected to the Raspberry module which is typically 3x4/4x4 number pad which allows the driver to enter the code to start the system on. This can be read directly by Raspberry Pi. BMP180 Barometer can e used to read aloud the weather condition. This is a futuristic idea to include it in the weather reporting in the bus stand as well.[5]

Bus Terminus and Autmoated Ticket Vending Machine

Will be a secured Wi-Fi hot spot where the buses will be displayed in a standard LCD Display screens, displaying the time of arrival and the bus number along with the exact location. Bus tickets can be booked at the Automated Ticket Vending Machine (ATVM) and buses can be monitored by the application. The bus booking machine will be simple where the passengers swipe their bus card and after authentication, need to select the destination, and the card which was earlier recharged with fixed amount of money, automatically calculates the destination charge for the travel and subtracts and amount from the user's card. The charging of the card is done at the stop as well, in which an individual will transfer it from his/her bank account. If a person needs an emergency travel then he can do it through a credit limit on the card, next time he pays for a journey, it clears the debt first and then books for the location. Each time a passenger books a ticket a seat gets allotted to him on the first come first serve basis and in case the booking is full, he is automatically moved to the next slot, provided any passengers are not evacuating at that stop. The ATVM uses a simple screen flow where the user is authenticated first, and then taken trough screens depending on the transaction, and then once the destination is booked, generates a token containing a unique bar code printed on it. This bar code, will be similar to the SISAC barcode.[3]

Example

Table 1: Representation of the new bar code on the token, followed by an arbitrary picture showing the formation of the full bar code.

Section	Field Size in digit	Data contained in each section
The unique key (random number generator)	5 digits	e.g user name Aileen: 55291
Date of Journey	7 digits	e.g 09051989
Source	3 digits	e.g ABC bus stand unique code 1234
Destination	3 digits	e.g BCD bus stand unique code 2345

552910 905198912342345

The Token for the future can include the alarm system and since the bar code has already been generated along with the destination code, there could be a temporary storage made in the token to read the destination code and when the destination arrives, receive a signal from the bus an alarm could be put on alerting the passenger to get down in case he is visually disabled, or in any case misses the announcement or the board display.

The ATVM processes each request as a case, uniquely capturing the data and sending it online via the Internet to the backend database repository where the administrator uses certain data to see the number of people boarding the bus at a particular time, the popular destination, the silent hours monitoring an can keep the security high by analyzing the data. This is where we can be futuristic and use the big data analytics come into place. The data needs to be securely stored and processed, because the strategy for controlling the traffic and the passengers is what is going to give the smart city and efficient outlook. The unique software installed and the algorithm followed.

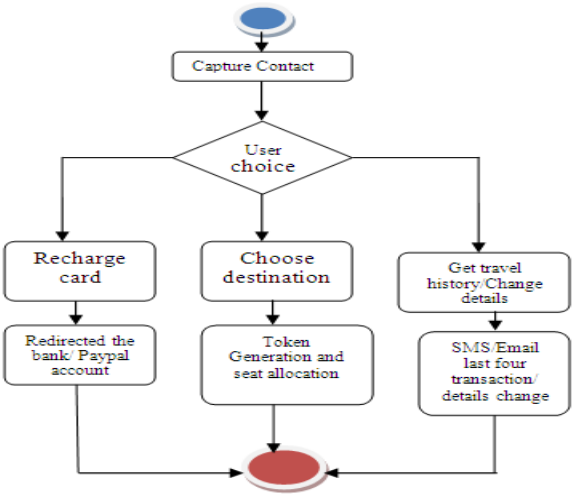

Figure 1: The simple flowchart to describe the processes and the outcome of the ATVM.

The steps for the ATVM are as follows:

1. The user authentication is done when the card is swiped in as each customer has a unique identification code, in this case the pin, which needs to be entered as well, to increase security.
2. After authentication each user is directed to three options, on the display screen and they select one of them to proceed, by pressing enter.
3. In case the user selects Destination, first the data of the user, the data of the journey the source of the user (i.e the ATVM location) and the destination code together is concatenated and send to the bar code generator where the token is finally generated from the outlet.
4. In case the user selects Recharge card, the user is redirected to the PayPal or nt banking account where the money can be transferred to the card. In case the user is short of money, there is a option of borrowing money for the travel destination up to 10 travel after which the card will not go ahead until the user pays of the dues. Since this will be any government initiative, the user will be recorded an tax will be charged in case the due is not cleared with 3 months work period, so that the association do not lose out the money.
5. In case the user needs to know the travel history, his logs can be generated up to 5 travel history at a time. This is in place to reduce the load on the server as well as reduce the fetching time for each request. The receiver will get n SMS with the details and an email, in case the user provides an email id when he is registering for the first time.
6. There will be an unit connecting from Token Recycling unit to the ATVM, where fresh tokens will be generated, as and when required.
7. In case there is an unpredictable rush and all the tokens are used up, there will be backup tokens kept inside the Token recycling unit, and that will have to be consumed. In that case an alarm signal will be relayed back to the administrators stating the capacity of the bus stand should be improved.
8. The Bus terminus will have solar panels installed which will be used along with electricity side by side, and in case of a black out , the transaction will be solely be from the battery charged by the solar unit, as a backup.
9. The ATVM will alert the user in case the upcoming bus accommodation is not possible and the user will be taken into the next slot. In case there are seat available and the bus is within few second range, the alert will be shown that there will be a stop time of x

minutes and hence in case the booking is not possible within that time, the user will be shifted to the next slot.

10. The wireless hot spot is a secured one, as soon as the bus is within range, the Wi-Fi on the smart bus searches for the signal, and prompts a connection, where the bus conductor only has to press authenticate, and provide his digital signature or thumb impression which will be verified at the back end, as the database will be loaded with the names and the digital data for each user working for the concern, and the software installed in the Smart bus, retrieves the password, which was previously fed into the system, and connects the nearby signal.

This security system has been kept in place so for security of the huge data being collected and processed, and to reduce the load on the channel. This needs to be done once and at certain intervals as the system time outs after one hour of the journey.

The Bus Card

The Bus Card functions similar to the normal ATM cards.[5] The dimension of Bus cards is same as the ATM 85.60 mm × 53.98 mm (3.370 in × 2.125 in), and the pin needs to be entered from the pin pad at the ATVM , then the authentication of the user is complete. The Bus functions like a normal credit card, but unlike them it depends on the number of transaction rather than the credit limit. The physical card will contain a logo, just like any ATM cards, bearing the sign of Government of India, an EMV card, and a specific card number unique to each user. The card will contain information about the user, whether the user is below the poverty line and thus will be availing some discounts, the emergency contact person and personal details that will show up on the screen each time the user wants to make any transaction. The back of the card will contain the signature and the magnetic stripe. This is a life time card and once the user is registered, she will not have to be re-registered even if the card is not used for a long period of time. This will avoid duplicity and this card will be a unique identification to the user. Children above six will need to have their own cards, which they can maintain for their lifetime. This can prevent fraud and certainly can track criminals using the card to travel to specific destinations. Since there is no other way the person can commute in public, he has to go through the online process to get the token and hence can be tracked rapidly.

Mobile Tracking System and the Online Police

The GPS of the Smart Bus will always be on with the help of Raspberry Pi GPS Tracker[6] which basically acts as a location tracker, hence tracing of the bus will become easy. This will help the police track the vehicle and keep it under control, reduce accidents, by sending alert messages directly to the administration as well as the bus via Radio frequency broadcasting, and immediately check the vehicle. There will also be a rely of information to the individual bus stands, about the schedule of the bus, with bus number, time and kilometer left to reach the bus stop displaying on the LCD screen at the bus stops. Any mishaps will fall under the jurisdiction of the local area. The smart city has to include smart traffic control systems which have to process the information received and relay information accurately. Tracking the vehicles using the GPS could give partial control and give a sense of virtual communication. The algorithm for processing th information such as speed limit breaking or offensive actions taken by the bus driver could be prevented by using a smart and intelligent traffic control module with its own algorithm:

1. Receive the information from the individual bus/vehicle; check the date and time for travel and the number of passenger information
2. Collect the history of the travel and check the number of causality caused by the driver. If the driver has no causality then simply send an acknowledgement message to driver. The signal goes via the fm transmitter and is received by the bus.
3. In case the causality is present, categorize the causality based on the severity. The most severe being accident, the majority types can be predefined in different cases based on their severity by the authority and depending on the decision o the software, either the driver would be given a warning or the driver will be tackled with law.
4. If step 4 determined the automated message gets generated with the action taken and credit score of the driver is added or subtracted based on the case.
5. End the process with adding the history with the details for further processing.

This rough design for the software at the administrative end can be observed for short throughput time and fast decision management and vehicles can be managed in a systematic manner without the redundant intervention of the public or the police hassle in the traffic time.

Integrated Smart City Design

The Online bus booking system along with the bus design takes us to the next generation of traffic control system. The advent of car to car communication is already under the way and what could be really helpful to building the smart city is the development of smart traffic control posts[7] with webcams and inbuilt wifi kit, which will detect the number of vehicles on each side of the street and in case it is safe to go, will give a green signal, unlike now where we have to wait under an automated timer, even if there is no traffic onboard. The traffic signal post can communicate with the administrators and the bus or the nearby vehicle about the speed limit, any alert messages (old age home nearby, horn slow please), could alert the buses of the weather and the road skidding condition, on the other hand can act as an online traffic police, and communicate any road block, accidents, vehicle crossing signals along with the picture sent across. This information once received by the administrators could be utilized for further processing. This eliminates the need of traffic police, bfor further processing. This eliminates the need of traffic police, by automating its job. The intelligent bus along with The ATVM and the traffic signal will be a bigger part of the Smart City design.

Algorithm and calculation

The algorithm for the ATVM is explained as follows:

Step 1: Authenticate the user through the user pin and the card swiped at the system,

Step 2: If the user is authentic then proceed to the Home screen displaying the user essentials otherwise go to Step 6..

Step 2: In case the user proceeds for the destination booking, the system retrieves user id, the source code, and the destination code.

Step 3: The system check the standard time of arrival of the bus and in case the user is too close, to the approach time, is alerted that in case the transaction process takes longer time, she will be given the next booking slot.

Step 4: In case there are no allocated seat available, then the slot is allocated for next available slot.

Step 4: The processing unit generates a unique random number generator specific user, and then concatenates the entire string and sends it to the bar code generator.

Step 5: Show booking Confirmation screen along with seat number,

Step 6: SMS alert is send across to the user, about the details.

The Algorithm for the card reader at the Smart Bus

Step 1: Bar code reader reads the bar code and verifies it has all 18 keys,

Step 2: It ignores the first 5 digits and extracts the rest.

Step 3: Match the next 7 digits of the date field to see if it matches the current date, In case the validation fails go to Step 6.

Step 4: The next three digits are verified to the current stop, and the next 3 digits are verified against the Next stops, in case the destination is not matched, go to Step 6.

Step 5: The passenger is allowed inside. In case anything fails go to Step 6

Step 6: Alert the user via sending the SMS as t where exactly the validation failed

The Calculation of the stop time

The passengers need to board the bus an in case token need to be recycled from the bus to the token vending machine, this action require some time to be spent near each bus stop, but that certainly cannot be arbitrary, so each bus stop has a grace period of 30 seconds: Tgrace

In case there are tokens that need to be recycled then the time for that is token delivery to the token recycle centre is 30 seconds: Ttoken

Each passengers is given roughly 15 seconds to board the bus which includes, token bar code verification: Tpassenger

So the total wait time for the bus at each stand is

Ttotal = Tgrace + (Tpassenger x Number of) Passengers (1)

Note the maximum bus capacity is also a variable parameter and there is a maximum seating arrangement which has been kept a variable which needs to be accommodated into the calculation. This has been done purposely done to keep the size of the bus a future decision. The stop time is then displayed on the screen in front of the driver. In case the driver exceeds the stop time then an alert goes via the Wi-Fi signal back to the administrator, and this gets distributed to all the subsequent bus stops as well. For a well regulated Smart city design the buses should run on time. The online police could take this data into consideration and process it further or simply alert the user.

Future Possibilities

1. The bus stop will be GPS enabled.
2. The Bus stop will have outlets for charging mobile, and will have free Wi-Fi.

3. The Bus stop can be retracted and carried off to a different location and reinstalled there.
4. Interactive voice guiding the user in case visually impaired and using the digital speech reorganization to identify user and process the instruction by the ATVM.
5. The Bus stop will be able to fully function on Solar Energy.
6. The IVRS support for bus booking as well, where the passenger just have to come an collect the token.
7. Mobile Application to Geo-locate the bus, study the bus timing, book Bus tickets and secure the seat.
8. Interactive display screen where the passenger can choose the buses they want to see, and the reports will be displayed as well, along with the weather condition.
9. Alarm systems for generated tokens.

CONCLUSION

The Smart City design needs an efficient traffic control design so tht anything can reach to market on time and resources are always available. This brings in the design of the advanced automated intelligent transport system which can e built into a smart city design. It includes the latest raspberry Pi 3 model for the sensor utilization and on board work on the bus control panel. Overall keeping the futuristic idea in mind we can always leap ahead and design this effective transport system for hassle free public experience.

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