E-Rickshaws Management for Small Scale Farmers using Big Data-Apache Spark

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Abstract: E-Rickshaw provides environment friendly, in-expensive, time-effective, suitable mode of transportation and plays a vital role in transportation in cities. E-Rickshaw lacks regularization, frequency and management, which increases the burden on the E-Rickshaw management system. Paper aims at developing a real-time RFID based E-Rickshaw Management System for small scale farmers, which focuses on scheduling the e-rickshaw according to passenger demand in a real time environment. The main focus of this system is to evolve user friendly, flexible and convenient E-Rickshaw management system for small scale farmers that would cater the needs of vegetables and fruits and reduce the traffic congestion in the city. This Real Time-Based System is helpful, precise, secure and flexible. The system will use Global Positioning System (GPS) and Radio Frequency Identification Tags (RFID) to get the location of E-Rickshaw and information about passengers and drivers. The system will be working on Real Time with a merged function of RFID and GPS which will sustain the detailed information about farmers and E-Rickshaw.

Keywords: E-Rickshaws, Big Data, Small Farmers, Apache-Spark, Apache Hadoop, Smart cities.

1. Introduction

A Smart City is an urban area in which different types of electronic sensors are used for collecting the data which perceive the useful data to manage the strength, resources and services effectively. Effectiveness of a city depends on the potency of it's transport system's facilities. The Government had taken the initiative for the Smart cities and made a plan for unplanned areas and produce walkable localities to decrease blockage, pollution and raise the wealth to encourage interactions and ensure the security (Smartcities.gov.in, 2019), (Albino, V., Berardi et al, 2015) and (Arduino Microcontroller 2013 'Smart Cities Mission' was launched by the Union Government to upgrade the lives of the public. Most of the people are moving or relocating towards cities that increase the demand for better conditions like electricity supply, digitization, sanitation, economical housing, feasible environment, better governance, IT connectivity and safe transport. In India, On June 25th 2015 our Prime minister Honorable Narendra Modi has initiated the “100 Smart Cities Mission”. With the aim of 100 Smart Cities and the increasing urban area's population, the framework of public transport and rural strength require development and further investment (Smart cities mission, 2018). In the Smart Cities Mission, Indian Government already reserved 50,802 crore INR (US$ 7.6 bn) for this project with an advance budget of 48,000 crore INR (US$ 7.2 bn) to make use of evolving first 20 Smart Cities. It is found that energy consumed by E-Rickshaw is more efficient than other motorized 3-wheelers, hence it should be the preferred transportation ( Khan, Ejaz Ahmed, and Mohammed Quaddus, 2020). Hence if the small farmer would be able to sell their crops in smart cities then they will be able to earn more profit and live a much-pleased life and this system will provide a solution to this problem of the management system.

1.1. Challenges of Smart City faced by Farmers

Transportation plays an important role in the Smart Cities. In India the Central Government and the State Government had taken many actions towards the growth and betterment of Transportation Sector i.e. Smart fuel Vehicles (like hybrid and electric) and smart technology (like anti-locking braking system, smart cards, real time parking management system and crash testing etc.) has been promoted (granthornton.in, 2016) and ( Kallas, S., & Yates, J. 2009). In Smart cities there is a need to improve transportation as Transportation in Smart Cities should be reliable, sanitized, secure and economical ways for moving from point A to point B. Even the small scale farmers do not have much money so they cannot afford their own vehicle to sell the crops in cities where they could earn more profit, so there arises an problem for these farmers to sell their crops in the market at reasonable price to earn more profit, which could provide a better opportunity to these farmers to live a better / healthy lifestyle (Dev, S. Mahendra, 2012). Some challenges are to be discussed here for implementing the smart transportation in Smart cities for small scale farmers/passengers include:

1.1.1 Optimization

On a daily basis, a large amount of data is generated which require optimization for maximizing the effectiveness in Smart cities.

1.1.2 Integration

It's required to integrate many smart systems to work together for smooth functioning, because of the big and complicated nature of smart systems, they need a host of different systems and administration protocols that are modified for various services.
1.1.3 Analytics

Enhancement based on the data initiated by Smart Cities; we need to compute output for the system. While doing analytics, challenges occur because of the scale and capacity of data generated, as well as the kind of analysis required.

1.1.4 Prediction

Using predictive analytics to better the functioning of the smart system and upgrade the lives of people is a big task.

1.1.5 Mobility

It's a big task to innovate resources for effective transport i.e. which is both economic and eco-friendly.

Where a decreasing blockage, pollution and accidents is one of the major challenges for all Smart Cities. The causes for blockage of vehicles in most of the cases is not only an absence in measurement of road infrastructure but it is also caused due to management issues.

1.2. Logic behind choosing Smart Transportation problem

E-Rickshaw provides a low-cost mobility (wri-india.org, 2019). It comes up with the demand-responsive service to the travelers (farmers). As they don't follow any fixed path, the route is identified by the driver who is driving it, which may be short or long or may have traffic congestion. In some cases, they bring door to door service and they can easily work in areas where any traditional means of transport can't work. Which overcomes this problem but at the same time a lot of e-rickshaws running on the road which are not even registered with the RTO (Jawaid, M. F., & Khan, et al 2015). And there is no control over their numbers which leads to traffic congestion in the city. As currently there is no management system for E-Rickshaw, there is a need for Scheduling of E-Rickshaws. So, this Management System for E-Rickshaws determines the no. of E-Rickshaws running in a particular area. This problem could be solved with Big Data (Shoro, A. G., & Soomro, T. R., 2015) (vivomente.com, 2016).

2. Major Connectivity Problems in Smart Cities

Due to the rising urbanization, more and more Smart Cities are being made. One of the reasons the farmers are not able to sell their crops at a good price is because of a lack of transportation. Transportation should be eco-friendly, for which E-Rickshaw, plays an important role. But as of now, there is no management system for it, which causes a lot of traffic congestion and lack of regularization this creates a necessity to solve this problem.

3. Components used in E-Rickshaws Management to Find the Transport Solution

3.1. WIFI

WIFI is also spelled as Wi-Fi and stands for Wireless Fidelity (WiFi on medium.com, 2020). The WIFI system is released by the Institute of Electrical and Electronic Engineers (IEEE) in the year 1997 and it uses 802.11 developed standards. It is a local area wireless technology. Electric devices transfer the data or connect to the Internet using ISM radio bands. The WLAN organization and a remote access point are used to connect the Electronic gadgets with the Web. Electronic devices like Computers and other devices communicate over a wireless network with the help of the Wi-Fi (Thakare, S., Bhagat, et al, 2018). Hot-spot (passageway) has a range of around 20 meter inside and more noteworthy scope outside. Hot-spot inclusion can be compared as small as a solitary stay stands with the divider that square radio waves, or as giant as covering the square kilometers. The Wi-Fi generally utilizes the 5 gigahertz SHF ISM radio groups and 2.4 gigahertz UHF. There are four connections (PWR, TX, RX, GND) that have been used by the Wi-Fi for creating wireless data connections. Ethernet is the suitable example for explaining that the Wi-Fi is defenseless, against any assault other than wired associations.

![Figure 1. Wi-Fi Module](image)

3.2. GPS

GPS is spelled as Global Positioning System. It is also known as Navigation System with Time and Ranging (NAVSTAR) GPS, which is a satellite-based system that uses the ground station and satellites to compute its position on earth and to measure. For the accuracy purpose the GPS receivers are used to receive the data from at least 4 satellites (electronicwings.com, 2019). GPS receivers are based on trilateration or triangulation. Smart phones, Cabs, Fleet management are the applications of the GPS receiver. The GPS module consists of 14 channel tracking and powerful 10Hz update rate. It consists of two serial ports, SPI and UART interfaces, high sensitivity and 28mA operating current. After the power is removed, to support the fast restart there is the need to connect those interfaces with the super capacitor or with an external battery to the board. It contains the even pads on the
bottom of the board for the 0.2F super capacitor, which help to keep the board hot start-able for up to 7 hours without power (Spark Fun Electronics. 2013) (McMullen, G. G., Hayden, et al 2007) and (IEETimes, 2010).

### 3.3. RFID TAG

Radio-frequency identification (RFID) tag contains a very small radio transponder, a radio receiver and a transmitter. When it is provoked by an electromagnetic interrogation pulse from a nearly located RFID reader doubly, the tag mediates digital data conventionally an identifying inventory number, to the reader in return. It is one of the arrangements to Automate Identification and Data Capture (AIDC) (Wayback Machine, 2016). Alternate name of RFID is proximity integrated circuit card, the transponder which can be activated actively or passively whereas a single transponder comprises an antenna, microchip and a battery (for active tags only). Size of chip devolves on the size of antenna and form devolves on the frequency used by the tag. Active tags incorporate on board power sources while the passive one is inductively energized with the help of Radio signals produced by RFID reader. Active tags can work in truancy of the reader and records the reading of sensors to perform calculations on them while the passive tags can operate only when the reader is present there. Some tags involve rewritable memory that varies only in size according to the requirement of applications. The Unique Identification (ID) of every object is stored in the Microchip and this unique ID works as a serial number stored within RFID memory. Range of RFID depends on their frequencies, and the frequency ranges are: - Low Frequency (30-500 MHz), High Frequency (10-15 GHz) and Ultra High Frequency (2.4-2.5 GHz). These frequency ranges are used to determine various (Douglass, M., 2006) other performance attributes and resistance to interference.

### 3.4. RFID CARD READER

Radio Frequency Identification Reader (RFID Reader) is a gadget that collects information from an RFID tag which is later on used to track each and every object. Information stored inside a tag to a reader is transferred with the help of radio waves. RFID tag should always be in the range of RFID Reader and it ranges from 3 to 300 feet, in order to be read. The RFID technology permits various items to be scanned rapidly and quick identification of a specific product. Frequency ranges from low frequencies of 125 to 134kHz and 140 to 148.5KHz to high frequencies of 850 to 950 MHz and 2.4 to 2.5 GHz. RFID reader is designed to be used with standard carrier frequency of 125 kHz. It also intends to transmit 125 kHz carrier signals constantly with the help of an antenna. This unit comprises intrinsic or extrinsic antenna facilities communication with Read-Only transponders type UNIQUE or TK5530 via air interface while the tag data is transferred to the host systems via wired communication interface with the help of a protocol. Another name for RFID Reader is Proximity Coupling Device (PCD) which reads the data through tag antennas at a particular frequency. Passive tag readers give rise to a radio signal so that it can get powered and transmit a signal that is readable only by the reader. Now, Reader translates the received information and passes it on to the forwarded systems via wired or wireless. A reader is able to read the information from multiple frequency-based tags.

### 3.5. ARDUINO UNO MICROCONTROLLER

ARDUINO UNO contains a second Microcontroller to handle all USB communications. It is a microcontroller board based on the ATmega328 and contains 14 digital input and output pins, where six of them can be utilized as Pulse Width Modulation outputs, USB connection, 16 MHz ceramic resonator, 6 analog inputs, reset button along with a power jack. Arduino Uno supports microcontroller, by easily connecting to a computer system using USB cable or activating it by AC to DC adapter or battery to initiate (i.e, an external power supply 9-V battery). The power source (battery) is
chosen as spontaneous and the board will run on the external supply of 6V -20V. The ATmega328 includes 32KB (where 0.5KB is utilized for the boot loader), and it makes use of 1kB EEPROM (EEPROM library can be used to read and write it) and 2KB SRAM.

4. Working Procedure

This System will provide the management of e-rickshaws in real time by addressing the two main features i.e, Scheduling and Analytics, with the help of Global Positioning System [GPS] and Radio Frequency Identification [RFID] Card. Along with that Safety for farmers could be ensured.

When a farmer travel by the e-rickshaw the they first have to tuck the RFID Card and RFID Reader fetch the location from card and mark his entry location of farmer, which will be saved into the Database and also GPS tracking device will connected to the e-rickshaw to determine the location of e-rickshaw. RFID Module will help to find the location from where the journey begins to where the journey ends.

Wi-Fi then sends the location to the database, where Real Time analysis will be done using Apache Spark. This analysis would be used to manage the frequency of e-rickshaw according to demand. When the farmer reaches the destination, then it tucks the RFID Card and marks the end location of the farmer, which will be updated in the database.

Once the farmer had tucked his card, RFID Card Reader kept the serial number of cards that can help to fetch the details of the farmer to improve the decision making and analytic process. The whole system is helpful for the managing e-rickshaw requirement and along with that safety of passengers could be ensured, which depicts the journey of farmers in an efficient manner.
Our management system is going to provide the system for the farmers and passengers to use the e-rickshaws services towards the betterment. The most important part of the system includes the Radio Frequency Identification Detection (RFID) Card and RFID Reader, they both plays a major role in the system, as shown in the flowchart, when the passenger starts his/her journey they have to carry their RFID Card, which they have to tuck in the E-Rickshaw while entering in the E-Rickshaw, once the card is tuck the RFID Reader reads that the card is been tucked or not, if the card is not tucked then the user again have to tucked, otherwise it will send him back to the tucked in part, once the card is been tucked successfully and been read by the RFID Reader then by using the Global Positioning System (GPS), the initial location of the farmer or we can say that passenger and the E-Rickshaw is been stored in the database for further collecting the information if needed, the information that has been stored in the database includes the passenger detail or farmer details, the initial location where the RFID Card is tucked by the passenger, and it contains the whole details of E-Rickshaw like the owner details and others. Once the destination of the passenger or farmer reached, they have to tuck the card again so that their final destination is also stored in the database for future requirement and analysis purpose, this process is repeated many times and helps the passenger to be tracked and manage the E-Rickshaw services.

5. Result and Discussions

The output for the E-Rickshaw management system which shows how the system is working and the outputs looks like, below are some snapshots of the code, RFID reader, GPS and website and all the snapshots of the website which is the part of the management system for analysis purposes. The snapshots/outputs are as follows:

5.1. Code
Figure 8. Code for Arduino Uno.

Figure 9. Output for Authorized Access

Figure 10. Output for RFID Reader.

Figure 11. Output for GPS Tracking Location

GPS Location, RFID Card number will be sent to the database using Wi-Fi. Which will be used for Analytics.

5.2. Output

Approximate the card you’ve chosen to give access and you’ll see:
Figure 12. Analysis of E-Rickshaws Management System.

Figure 11. Shows the analytic data for E-Rickshaws in form of counters that helps in the Management Process and decision making by determine the number of E-Rickshaws, Drivers, Users and Passengers.

Figure 13. Map shows the demand of E-Rickshaws in a particular area

Map shows the analysis for demand of E-Rickshaws in which

- Denotes high demand.
- Denotes moderate demand.
- Denotes less demand area in a particular area.

6. Comparison

| Parameter | Traditional System | ERMS for Smart Cities |
|-----------|--------------------|-----------------------|
| Latency   | High latency computation as compared to ERMS for Smart Cities. | Low latency computation. |
| Usage     | It does Batch Processing with a large volume of data. | It processes real-time data, for real-time events, like analyzing the demand of e-rickshaws. |
| Process   | This system processes the data in Batch | It processes the data in streams/ interactively. |
| Ease of Use | This system has a complex model which needs to handle low-level APIs. | External scheduler is not needed, as In-memory computation. |
| Scheduler | External scheduler is needed. | * It provides real time location. |
|           |                     | * It is a data analytics engine. |

7. Future Scope

Not only is this definition of ERMS restricted to farmers, it can also be applied to allow certain additions to the scheme, such as it can be used for
students going to schools or colleges or for passengers who had to travel late night because of their work, especially women. As most of the students going to school or college use public transport to reach their college or school because they find it comparatively cheaper than school buses or cars, but it is very unsafe at the same time, what if these students use this system so that their protection is ensured with this method as parents can monitor their location, record timings, start point and end point of their child. Similarly, passengers who need to travel in the mid-night or late-night feel insecure, particularly women, and their families are also concerned about them.

As we have seen two examples that how ERMS is helpful for other people and this system has website for end-user which may not be that handy for end-user in every-situation, so we can develop a mobile application for end-user which would be easily accessible and convenient for all the users, as website may not be accessible everywhere.

If we can develop a mobile application for this system which can have following features:

- Location Tracking using GPS.
- The Starting point (from where passengers took the e-rickshaw) and destination of the passenger is noted.
- Details of the e-rickshaw and e-rickshaw driver (like name, phone no., e-rickshaw no.) can be displayed on APP.

Apart from Mobile App, we can work on how to optimize the ways for wireless charging and reduce the charging time period for E-Rickshaw without doing much changes in the cost of the E-Rickshaw (i.e the cost should remain cheap and affordable) (Vaka, Ravikiran, and Ritesh Kumar Keshri, 2020).

8. Conclusion

In today's time, everyone is in a hurry. Although many cities identify the benefits of public transport in minimizing pollution and congestion and E-Rickshaw being Environment friendly, cheap, time-effective, convenient means of transportation and plays a vital role in transportation for farmers, this management system will significantly contribute towards a bigger picture. This information helps people in having a smooth and comfortable travel. Real-time location of the E-Rickshaw is used to analyze the demand of E-Rickshaw in the particular area which can easily help in identifying all the areas which have high, moderate or low demand using real-time data. Real-time data will capture the number of farmers travelling from their farm to the vegetable market, number of users and no. of E-Rickshaw running on road and this information will be continuously monitored on a web portal, connected to the database. ERMS for Smart Cities helps in providing a better management for the farmers and reduce traffic congestion, helping farmers with hazel free travel. As our Government is promoting Eco-friendly mode of transportation adding a greater number of Eco-friendly vehicles, arising the need of managing these vehicles and the huge volume of data it generates. Our E-Rickshaw Management System, for Small Scale Farmers will provide a solution for this need, from our proposed services.

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