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Active Bus Tracking & Bus Recommendation System using IoT & Machine Learning

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Abstract – *Currently, buses are an important part of the public transport system. Traveling by the bus is an option but in most cases the chance of a bus getting delayed is high, this can be of various reasons like heavy traffic, engine problems, etc. The objective of this project is to provide the real-time locations, routes of travel, also recommending bus to a particular destination and best travel options, that ensures available bus routes, available buses to a destination, provide bus timing to reach the bus stop and required time to reach the destination. IoT is used to provide real-time bus location and machine learning to build recommendation engine. The recommendation based on most scored, reviewed, budget, travel comments, similar travels. Cloud-based database is used for storing and manipulating the data. Database stores the location along with the update time. Updating time and location can be used to calculate the time taken to travel and average speed. If the bus is not running on that day, the proper indication is displayed along with the location and the timing of the next bus through the route will be given. Machine learning server uses data in the database to recommend the best route to travel and creates a model for future use. The user interface provided by using an android application. This proposed system saves time and increases the work efficiency of end-users because it reduces the user's efforts to traveling for work and avoids the wastage of waiting time for the bus.*

Key Words: Machine Learning, Internet of Things (IoT), Recommendation Engine, NodeMCU, Global Positioning System (GPS), Android Application

1. INTRODUCTION

The public transportation system plays a major role in daily routine. Sometimes there are lots of problems arising because of the lack of information about the availability of buses in a route at a time. Lots of technologies can be applied to transportation systems, especially in buses, but they don't run according to the predefined timetable as described due to traffic jams, breakdown, engine problems, etc. The bus corporations provide bus timetables on the websites, but such bus timetables are usually static and provide only very limited information to the user. This project focuses to solve problems facing every people in the public transportation system. This information will help people in making better traveling decisions. Here explaining an IoT based bus tracking system, deals with NodeMCU which serves as the central controller acting as the brain of the system, by using GPS (Global Positioning System), the geographic location of a vehicle can be determined, and the related information can be transmitted to a remotely located server. This will locate the position of bus in google maps through track requests. Machine learning is used for route recommendation systems, which provide an available path and available buses to a destination. The user uses an android application to access the service. The user selects the travel destination. The app processes the data by accessing the database and shows the available transport options to the destination at that specified time. The recommendation engine builds by using content-based filtering and collaborative filtering algorithm. A cloud-hosted database is used for storing and manipulating the real-time data and normal data (user information, Bus details), which enables the fast and efficient use of the application.

2. LITERATURE SURVEY

A system described in [1], aims in automating the services of the system that can provide the real-time tracking experience of the public transport buses. The RFID (Radio Frequency Identification) tags placed inside buses and RFID readers will be placed at every bus stop. Arduino act as the controller for this system. GSM (Global System for Mobile communication) module will send the tracking messages to authorized persons for continuous monitoring. GPS (Global Positioning System) is used to track the location of the buses. Users will get the details of the bus as notifications in their mobiles through IoT. The inputs from RFID readers are updated continuously to Arduino for processing the data. After processing, the data is sent to the cloud which serves as the interface between the user and the system.

The designed in-vehicle device [2] works using GPS and GSM/GPRS (General Packet Radio Service) technology. The hardware part is embedded inside a vehicle whose position is to be determined and tracked in real-time. A microcontroller is employed to manage the GPS and GSM/GPRS modules. The GSM/GPRS module helps to transmit and update the vehicle location to a database. A smartphone application is employed for continuously monitoring the vehicle location. The Google Maps API (Application Programming Interface) is helping to display the vehicle on the map.

In this system [3], the position of the bus is gathered by embedding GPS on the bus and the location of the bus is sent

by GPRS service provided by GSM networks or by SMS or using RFID. The GPS device is enabled on the tracking device and this information is distributed to a centralized controller or directly to the bus stops using RF receivers. People can get the details using LEDs that connected at bus stops, or by SMS, or using a web application or an Android application.

The system in [4], the development of a vehicle tracker using the GPS and GSM modem is done with the aim of enabling users to locate their vehicles with ease and in a convenient manner. That paper explains the development of the vehicle tracking system's hardware prototype. The system will utilize GPS to obtain a vehicle's position coordinate and transmit it using a GSM modem to the user's phone through the network. The u-blox NEO-6Q GPS receiver module, u-blox LEON-GIOO GSM module, and Arduino Uno microcontroller are the hardware component of this system.

The tracking system in [5] is using the integration of GPS, GSM, and RFID. There is a need for accurate estimation of Bus location. Here using a novel approach for location estimation called B-T-S (Bust Tracking System) based on adaptive location estimation method and GPS approach. The evaluation of the approach is done using java simulation tool by considering both simulation and real-time analysis.

In system [6], the aim is to find out the location of the college bus using GPS and GSM by a message request from the user's mobile phone and without using the internet at the user's end. Users can know the location of the bus by sending an SMS.

The system described in [7], requires passive RFID tags holding the bus code to be placed at the buses and low-frequency RFID readers to be placed in bus stops which are approximately 20 km aside from each other. Any stops within two bus stop having RFID readers are overlooked because the time of arrival of buses at these stops is predicted by approximation.

This system [8] will enable the tracking device to induce the bus locations through GPS, which can then be passed to the centralized control system by using GSM module, then send to the bus stop and displayed on the GLCD as per the request of the passenger

In the system [9], a novel framework based on Ambient Intelligence (AmI) is explained to attain the traveller's requirement. This system evaluates the problems of users in the transportation system and studying the situation and providing recommendations to the passenger discretely. This system is evaluated on a micro-platform to testify its supportability in the real-time mobile computing context.
The Bus information system (BIS) [10] provides useful information to users that needed in cities. One type of information that BIS provides is how to get from the starting bus stop to the destination bus stop.

The system in [11] uses a GPS module that is attached to the Arduino system inside the bus. The satellite information is received by it and then the position information like latitude and longitude are determined by it. This system uses the GSM module to communicate & transmit data on the server. By using GPS, the location of a vehicle can be determined, and the related information can be transmitted to a remotely located server.

3. ARCHITECTURE OF THE PROPOSED SYSTEM

The Active Bus Tracking and Bus Recommendation system consists of four modules, hardware, user application, cloud-hosted database, and Machine Learning (ML) processing server. These four components work together to give a user-friendly application. Fig-1 shows the overall architecture of the system.

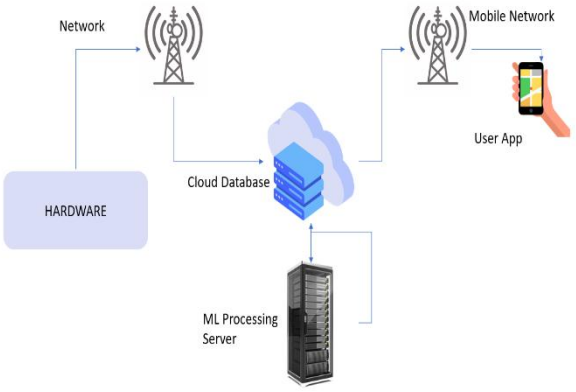

Fig -1: Architecture of the proposed system

The hardware components integrated inside the bus by providing power from bus and a battery source. The system uses internet service to communicate and update data on the server and later to the real-time database. The server receives the data and stores it to the database and provides the data as input to the machine learning model to crate suggestions to the user for better travel options. The user interface is provided with an android application which gives the user access over the service provide with a smartphone.

4. METHODOLOGY

This system is using Internet of Things (IoT) and Machine Learning to get the data over the internet and building a recommendation system. In IoT, all devices are connected in a network by using internet service for transmitting data. Affordable and reliable devices and sensors are making IoT possible for more developments. IoT development boards, also known as prototyping boards, are hardware platforms that are widely used to build prototypes of developer's ideas. Here using an IoT board for building the hardware portion. These boards can save you from a lot of repetitive tasks and

processes. A Recommender System refers to a system that can predict the future preference of a set of items for a user and recommend the top items. Machine learning is used for a route recommendation system, which provides an available path and available buses to a destination. The outcome of the project gives to the user through a very simple, effective, and friendly android application.

4.1. Hardware of the System

This system has hardware that needed to be attached inside the bus. This hardware module consists of NodeMCU/ESP8266 [12], u-blox Neo 6M GPS Module [13], Power Supply. The MCU based vehicle tracking system designed here is an IoT device; it is basically a System on Chip (SoC). Hardware is designed by the interfacing GPS (Global Positioning System) module to the NodeMCU. GPS module is used to get the geographical coordinates of the location. By using GPS, the geographic location of a vehicle can be determined, and the related information can be transmitted to a remotely located server. GPS module gives output in a standard string format, called NMEA (National Marine Electronics Association). It provides output with default 9600 Baud rate serially on TX pin. This NMEA string output contains different parameters separated by commas like longitude, latitude, altitude, time etc. The Fig-2 shows the hardware component of the system.

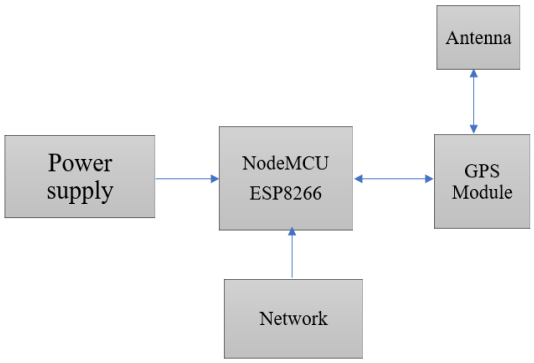

Fig -2: Hardware components

The NodeMCU is a programmable IoT Device and it has an in-built Wi-Fi Module. After integrating the component into the bus, it is required to provide internet to start the data transfer between the NodeMCU and server. The data from the NodeMCU includes the latitude and longitude of the bus with time-stamp, it easily updated to the real-time database with the help of internet.

4.2. Software of the System

The software of the system consists of user app, machine learning processing server and cloud-hosted database. The user uses an android application to access all the functionality of the system. The Fig-3 shows software components of the system.

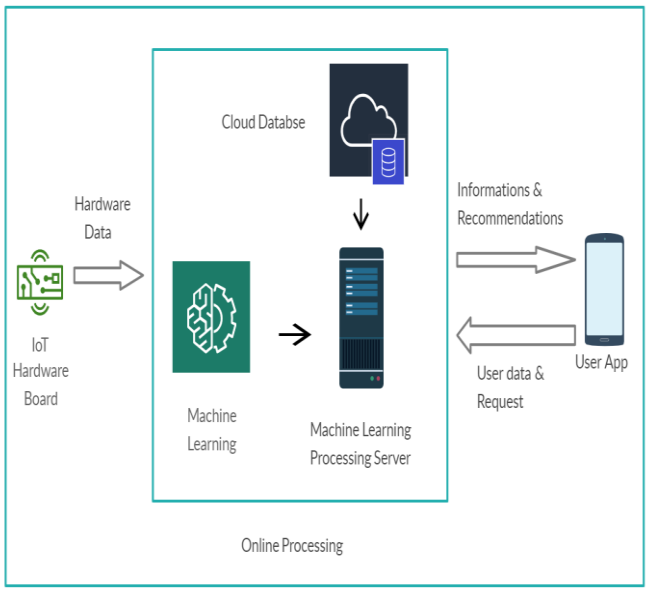

Fig -3: Software components

Google map API is integrated with an android application which will ensure visualization of the bus on the map. Initially user selects the travel destination. App processes the data by accessing the database and shows the available transport options to the destination at that specified time. The data will be sorted based on the arriving time at the user location. The android application initially asks the user to register with the application; these details are stored in the cloud database. The admin enters all the bus details and required location details to the database. This information is required for machine learning processing. For real time operations we are using firebase database [14], it is real-time cloud-hosted NoSQL database used as a mobile and web app development platform that provides developers with tools and services to help them develop high quality app. The Realtime Database is really a big JSON object that the developers can manage in real-time. The firebase storing two types of data, the normal data which include user data and bus details, and real-time data which is updating from NodeMCU board through internet.

4.3. Machine Learning Recommendation Engine

The recommendation engine [15] is built by using Machine Learning. Machine Learning provides a system with the ability to automatically learn and improve from experience without being explicitly programmed. These models are trained with common data of various users and data from the details of the bus. This creates a user-friendly environment for the convenience of the user. ML model is continuously training with the user data for user-friendly results. The machine learning algorithm runs on the server-

side and collects the data from the database and learns and develops from the data.

Candidate generation is the first stage of recommendation. There are two methods used here for candidate generation, they are Content-based filtering [16] and Collaborative filtering [17]. In content-based, recommendations can be based on the content of previously liked items with the content of unseen items and recommending similar ones. That is the system recommending route and bus would analyze the buses a user likes to find out what they have in common in terms of content, i.e. distance, rating, bus ticket. This information will constitute the user's preferences, which are used to find the bus and route with a high degree of similarity to the liked ones. The model can capture the specific interests of a user and can recommend items. Collaborative filtering is a technique that can filter out items that a user might like based on reactions by similar users. It works by searching a large group of people and finding a smaller set of users with tastes like a user. It looks at the items they like and combines them to create a ranked list of suggestions. Recommendation engine build by using popularity and segmentation of users. The recommendation providing to the app user based on most scored, reviewed, budget, travel comments, similar travels.

Both content-based and collaborative filtering algorithms map each item and each query to an embedding vector in common embedding space, the embedding space is low dimensional. Similar items, such as the route that are usually used by the same user, end up close together in the embedding space. The "closeness" is described by similarity measure. Cosine, dot product, Euclidean distance are common modes of similarity measurement methods. Here mostly using cosine similarity method. The similarity is a number bounded between 0 and 1 that tells us how much the two vectors are similar. After finding the cosine similarity each travel option will be scored according to the similarity and sorted using these data. Whenever the user is searching for a travel option these data are used to show recommendations to the user.

5. RESULT AND DISCUSSION

The user uses an android application to access the service. The location information such as latitude and longitude are updating to firebase database in real-time manner. The database relates to the server and real-time location of the bus is visible in google map in user application. To update the real-time location the system needs internet connectivity, the app also provides some suggestions by using local cache even if the user is offline.

The app helps the user to get the real-time locations, routes of travel, also app recommending bus to a particular destination and providing best travel options, which ensures available bus routes, available buses to a destination, provide bus timing to reach the bus stop and required time to reach the destination. The user can choose best travel option based on budget, shortest path. User can get most believable bus to a destination based on the reviews and rating. User can check the comments also for their convenience.

When the user request for a route by giving starting point and destination point, the system provides all route in google map to that destination with the proper indication of bus route. When select that route giving a list of bus names with arrival time, also that list categorized based on different travel option. Further information and tracking option are providing when the user select a bus. Also helps to select best travel decision, while it is a long route and providing recommendation about chain service bus. This system is very helpful to the passengers. The system believable, robust, also have good performance.

6. CONCLUSION

Active Bus Tracking and Path Recommendation system using IoT and Machine Learning is very helpful for passengers. IoT based Public bus transport tracking system is an advanced method that can locate and track the buses. Machine learning helped the app to suggest the best available travel options for the clients. The success of the tracking system lies in providing an easy interface to the user via an Android application to the user. The system is effective where the Internet is accessible. This system saves time and increases the work efficiency of end-users because it reduces the user's efforts to traveling for work and avoids the wastage of waiting time for the bus. It is beneficial to vehicles that follow a specific traveling route daily. Machine-Learning based recommendation systems for navigational information will improve the reliability of the public transport system.
Further enhancements like breakdown alert and over-speeding alert can be made into the system. The integration of a security alert system will help to register complaints to nearby police stations; it will enable women safety while traveling. The use of video cameras to this system would take this system to the next level in the field of security. It will help to observe the crimes that happen nowadays which is suffered by people. This would prove a breakthrough in reducing crime rates

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