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Enhancing Commuting Experience for Students and Faculty: A Transportation Kit

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***Abstract*—Students and faculty members of any college on a day-to-day basis use the buses provided by the college to commute. There is a lot of meticulous planning that goes into this. The data required for planning will surmount to decisions made such as how many buses should run today, the routes they need to take and have the buses reached the college premises. A kit has been developed in order to ease the work of the transportation department. Using this data collection will help in enhancing the experience of the passengers and also make the work of the transportation department easier. The two features that come in the transportation kit are: a license plate detection model to detect the number plate of buses and cars entering the college, which is developed using OCR and YOLOV7 model in machine learning and a bus tracking mobile application to track buses for students and faculty members, which is developed using Flutter and Firebase.**

Keywords— Students, Faculty, Transportation Kit, License Plate Detection, Bus-Tracking Application

I. Introduction

Rajalakshmi Engineering College has many great facilities especially like the transportation department. It provides transportation from home to college and vice versa every morning and evening. Two solutions were required namely number plate detection and real time tracking for students and user side (students and faculty). This is a tool kit consisting of two features developed and given as a package to the college. The first project consists of a license plate detection system where machine learning is used to develop a model and detect the license plate with accuracy and automate the system of registering buses which enter the premises of the college.

The second part of this project is the live tracking application. Students and faculties some days tend to miss their buses or in general want to plan when they can leave their houses depending on where the bus currently is. This is also useful for parents to track the buses to see if the student has reached college or vice versa. In conclusion, these two features together will definitely play a vital role in helping the transportation department and the many students and faculties who are using it.

II. Literature Survey

A. Object Detection Models

A paper was by Rantelobo, K., Indraswara, M. A., Sastra,N. P., Wiharta, D. M., Lami, H. F. J., &Kotta, H. Z. had the title “Monitoring Systems for Counting People using Raspberry Pi 3”. The objective of this study is to develop a monitoring system for population counting in a room using a visual sensor in a Wireless Sensor Network (WSN) environment. The system can determine the number ofpeople in the room from the image processing results and then send that information to the web [9].

A paper by T. A. A. H. Kusuma, K. Usman, and S. Saidah had the title “People counting for public transportations using you look once method”. This research is suggested so that the service operator can use image processing with the You Only Look Once (YOLO) method [15].

A paper by ZahraasalahDhaief Al-Mustansiriya had the title “People Counting Technology”. The proposed approach turns a color image into binary. The suggested method employs erosion and dilation methods to remove noise from the image, which may also contain noise. The technique relies on pre-existing packages to speed up development. Java is used to implement the suggested methodology [14].

A paper by Kasper-Eulaers, M., Hahn, N., Berger, S., Sebulonsen, T., Myrland, Ø.,&Kummervold, P. E. had the title “Detecting Heavy Goods Vehicles in Rest Areas in Winter Conditions Using YOLOv5”. You Only Look Once (YOLO)v5 can be used to detect heavy goods vehicles at rest areas during the winter. In order to determine whether the front cabin and the back are sufficient characteristics for heavy goods vehicle recognition, transfer learning was applied to YOLOv5 because these photos often contain a high number of overlaps and cut-offs of vehicles. The front cabin of heavy goods vehicles can be detected by the trained algorithm with a high degree of confidence [16].

A paper by Yonten, Jamtsho, PanomkhawnRiyamongkol, RattapoomWaranusast had the title “Real- time license plate detection for non-helmeted motorcyclists using YOLO”. The real-time LP detection for non-helmeted motorcyclists utilizing the real-time object detector YOLO (You Only Look Once) is presented in this work. A single convolutional neural network was used in the suggested method to automatically identify a non-helmeted motorcyclist's LP from the video stream. The false positive caused by the helmeted rider leaving the video frames was removed using the centroid tracking approach

and a horizontal reference line. 98.52% of all LPs were detected overall [17].

B. Object Detection Model with License Plate Reading

A paper by R.A. Lotufo, A.D. Morgan, A.S. Johnson had the title “Automatic number-plate recognition”. The study's goal is to create a computer vision-based automatic vehicle identification system that uses optical character recognition (OCR) methods to identify vehicles. Investigations on real- time automatic number-plate recognition and its application to other aspects of monitoring and controlling road traffic are part of the effort [1].

A paper by Arth, C., Limberger, F., &Bischof, H. had the title “Real-Time License Plate Recognition on an Embedded DSP-Platform”. The proposed system operates in real-time while processing a video stream on an embedded DSP platform. A region-based method is used to partition detected license plates into separate characters. Support vector classification is used to classify characters. A Kalman tracker is incorporated into the system to quicken the embedded device's detection process. Additionally, the classification accuracy is increased by combining the findings of successive frames' classification [3].

A paper by Silva, S. M., & Jung, C. R. had the title “Real-Time Brazilian License Plate Detection and Recognition Using Deep Convolutional Neural Networks”. 2017 30th SIBGRAPI Conference on Graphics, Patterns and Images. Deep Learning (DL) techniques have lately been used in the context of ALPR, as they have in other computer vision tasks, with a focus on country-specific license plates. In this study, a state-of-the-art Convolutional Neural Network architecture-based end-to-end DLALPR system for Brazilian license plates was suggested [7].

A paper by Qadri, M. T., & Asif, M. had the title “Automatic Number Plate Recognition System for Vehicle Identification Using Optical Character Recognition”. The goal is to create a successful automatic approved vehicle identification system that makes use of the license plate. The created system first recognises the car before taking a picture of it. Using image segmentation in an image, the region containing the vehicle number plate is extracted. Character recognition is done using an optical character recognition technique. The obtained data is then used to compare with the records in a database [13].

A paper by Laroca, R., Severo, E., Zanlorensi, L. A., Oliveira, L. S., Goncalves, G. R., Schwartz, W. R., & Menotti, D had the title “A Robust Real-Time Automatic License Plate Recognition Based on the YOLO Detector”. A two-stage method specifically for character segmentation and recognition using low-tech data augmentation techniques like reversed license plates (LPs) and flipped characters was created. The resulting ALPR method produced remarkable outcomes in two datasets. The trial versions of commercial solutions had recognition rates under 70% for the suggested dataset [10].

1) Drawbacks:

From all the Literature Surveys the following problems/gaps have been identified: -

The models which were used where of lower versions better versions have come up for example the version used is YOLOv7.Inference speed for the version YOLOv7 is 114 FPS as opposed to the comparable YOLOv5's 99 FPS, and YOLOv7 also achieves greater accuracy (higher AP by 3.9%). The YOLOv7 gets a 21 FPS faster inference speed than the YOLOv5 when compared to models of a comparable size. Accuracy can be improved with the collection of dataset being manipulated to suit our needs.

C. Bus-Tracking Application

A paper by Rahman, Mir SazzadurHaque, SM. HasanHafizul had the title “Location Based Service for the Mobile users using the GPS Technology”. Some of their mobile application developers created some LBS services using the LBS API offered by the cell operator. However, this is notavailable at the moment due to the platform's development of security. Consequently, the GSM network can provide a mobile user's location information [2].

A paper by Battin, P., &Markande, S. D. had the title “Location Based Reminder system using Google Maps”. Here it added a few permissions to allow the Android SDK to retrieve the user's location. This software runs flawlessly on Android Oreo, but other comparable apps won't. Google Maps directions: Get driving instructions from the app to the task location. Address Search: Use the place picker to look up addresses to add location reminders. Setting location reminders is now simple. Reusable reminders allow you to easily reset them without having to add them again and saves great effort [4].

A paper by Muhammad NurZakiJuhari and HasmahMansor had the title “IIUM Bus on Campus Monitoring System”. The goal of this project is to provide a low-cost, real-time campus monitoring system for IIUM buses. Students at IIUM must wait for the bus without knowing when it will arrive, which is a huge waste of time [5].

A paper by WillianMuliaMirandaa, Ricardo Tavares RibeirodeMendonçaa, AllefAndersondaSilvaa, André Márciode Lima Curvellob, FlávioLuís dos SantosdeSouzaa and Henrique JosédaSilvaa had the title “BusMe: Automatic Bus Localization System and Route Registration”. The solution unifies GPS transmitted data from buses to Android applications using Amazon AWS as the cloud backend. The terminal is a Raspberry PiTM that transmits data using an HSDPA module and a GPS receiver. It is put in the bus. The received data is plotted in real time using Google MapsTM in the Android application, enabling the user to see where his preferred bus is and even where it is on its journey [6].

A paper by Jisha, RC., Mathews M. P, Kini, S.P., Kumar, V, Harisankar, U V., &Shilpa, M. had the title “An Android Application for School Bus Tracking and Student Monitoring System”. The suggested technique offers a technical solution for the above issue, which occurs occasionally and necessitates pupils waiting a significantly longer period of time for their school bus to arrive. The

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system comprises an Android application with Internet access that communicates with a server. The system also offers authentication, attendance monitoring, and vehicle tracking. Using this Android app, parents may monitor the bus's movements at all times [8].

A paper by S.Sabareesh, S.Sibicharavarthi, K.Vishnu, N. Mohammed Illiyas and K. Naveen Durai had the title “Location-Based Bus Tracking Application Using Android”. The main goal of this article is to gather GPS data and transfer it to a Firebase server, from which an Android application will retrieve it and display the bus' real-time location on a Google Map that is included into the Android application [11].

A paper by S., Islam, T., Olanrewaju, R. F., & Binyamin,A. A. had the title “A Cloud-Based Bus Tracking System Based on Internet-of-Things Technology”. In order to save time, energy, and human involvement, a cloud-based bus tracking system based on IoT is proposed in this study. The precise location and arrival time of the bus can be recorded dynamically using a mobile application. Additionally, by paying online, customers can purchase tickets without standing in line and reserve the available seats [12].

A paper by BadghainyaAnchal, MaripallyLokesh, MohdSaleem, UmamaMahreen, Ramesh Alladi, had the title “Smart Bus Tracking Application using IOT”. Building a mobile application for real-time bus tracking is the paper's main goal. The system offers the necessary data, including the driver's contact information, the route specifics, the average waiting time, and the anticipated arrival time. The flutter framework is used to create the mobile application, and a real-time firebase database integrated with a Node MCU is also used [18].

A paper by N AyushUbale and DrMohdTajammul had the title “efficient model for automated school bus safety and security using iot and cloud”. This study proposes an SMS- based method for parents to monitor their children's school bus location. An RFID and GSM-based system is used to authenticate the student's identity and count the number of students in the bus. Parents receive SMS notifications about their children's location, and a visual studio application installed in the AWS cloud controls the system. [19].

A paper by Sourav Kumar, ShreyashMoundekar, MansingRathod and RupeshParmar and the title “Location-Based Bus Tracking Application Using Android”. An application that overcomes the shortcomings of the public transportation system was proposed. It gathers the necessary information, and using it, the bus is traced. Passengers can access these details at any time in real time [20].

1) Drawbacks:

From all the Literature Surveys the following problems/gaps have been identified: -

This system developed using Flutter instead of native Java as Flutter supports Cross-platform development (Android and IOS), It has higher development speed it supports multiple platform which require only a single code base, the cost of development is reduced and the amount of resources and libraries are much higher compared to Java [21-23]. The database used for this system is google firebase. This database service is much preferred compared to other database providers because the learning curve for other database services such as AWS Amplify and Microsoft Azure SQL as a whole are actually steeper, since there are a number of things that are quite difficult to implement [24- 26]. Old version of Google Maps API causes the accuracy of location to be low and the app does not work when the phone enters sleep mode, the distance between two geo locations have been calculated manually, only one bus is able to be tracked and the cost of Amazon AWS and usage of IoT are expensive.

2) Common Deficiencies:

From all the Literature Surveys the following problems/gaps have been identified: -

A better model can be used for object detection. Accuracy can be improved with more dataset which is manipulated to our needs and for the bus-tracking application, mostly IOT is used along with old location frameworks. Hence they tend to not be user-friendly. IoT is comparatively expensive and data handling via IoT is difficult.

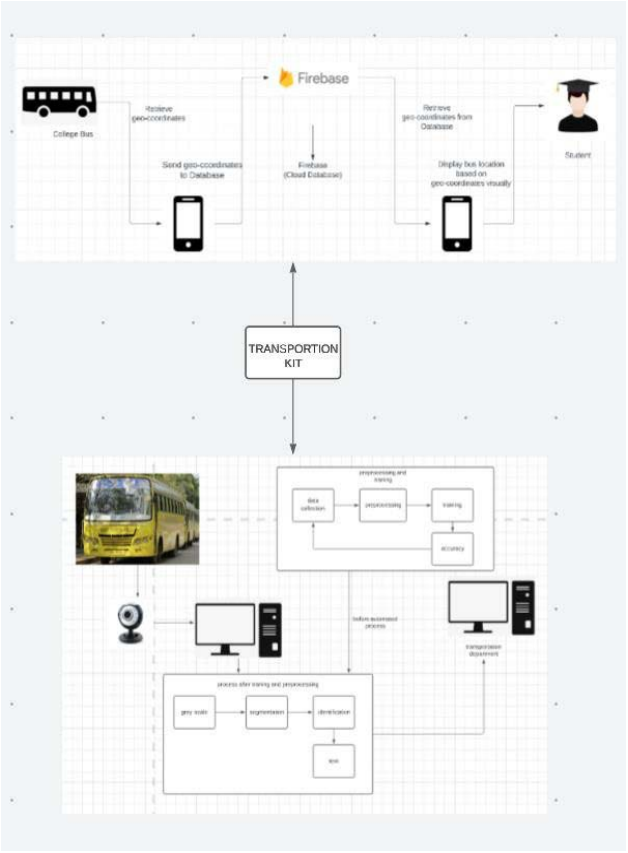

Fig. 1. Transportation Kit System Architecture

A. License Plate Detection and Recognition

The system that is proposed is to make the detection model using the yolo (you only look once algorithm). Many projects use the 5th version to make their projects but now there is version 7 which is superior to its predecessor, hence

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for the detection model the yolov6 or yolov7 algorithm will be used. For the Optical Character Recognition algorithm, a simple algorithm can be written which will pair properly with the object detection model being used. For better efficiency Theos AI tool is used to train test and split. Using the same tool, we can label our dataset. Once the dataset is labeled it is trained using YOLOv7 algorithm. It is then paired with OCR code to read the letters that is present inside the detected license plate.

III. Proposed Work

This section provides the proposed methods for the three projects in the kit respectively.

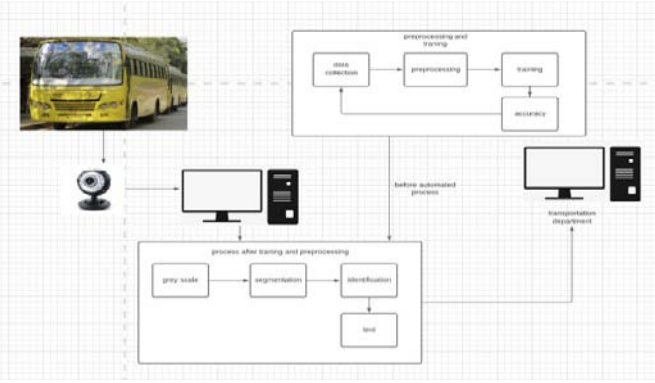

Fig. 2. License Plate Detection and Recognition System Architecture

The dataset will consist of multiple images and videos since it is only the license plate of the buses which needs to be extracted. The dataset can be manipulated to suit our needs and ultimately improve accuracy.

B. Bus Tracking Application

The proposed system for the bus-tracking system is a mobile application. With this application students and faculties will be able to find the location of their respective buses with ease in a short period of time. The only requirement needed to use the application is a mobile device with active internet connection and feature to access the location.

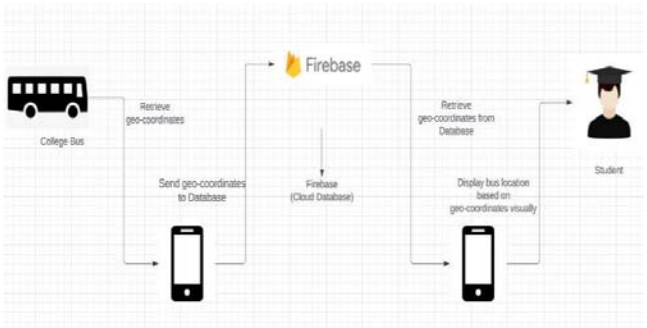

Fig. 3. System architecture for bus-tracking application

As mentioned above, the technologies used here are Flutter to build the mobile application and Google Firebase to play the role of the database. Two applications are developed using Flutter (Driver App and Student App). Once the driver logs into the application using the credentials provided by the Transportation Department, the bus number mapped to that particular account gets retrieved into the application. The driver will then be able to start streaming his location by clicking the 'Start' button. That location stream is sent to the Firebase database along with the bus number. In the student application, the student can log into the application using their college mail and start tracking their bus live by selecting the bus number.

Firebase makes this job easy as it is accurate with data and has an immutable class called 'GeoPoint' in-built which allows to easily work with location coordinates. On the other hand, Flutter provides smooth functioning of the mobile application with a clean user interface [27-30]. The proposed system helps combat the problems/gaps in the existing system using the following methods - New version of Google Maps along with geolocation package is used in Flutter which has a lot of in-built algorithms which enhances the time complexity and user efficiency, there is no limit to the number of buses to be tracked and only Firebase is used as the database and two apps (Driver App and End-User App) are being used, thus eliminating the need of IOT devices and thereby reducing costs.

IV. Results and Discussion

Based on the comparison and differentiation performed with the existing systems mentioned above, some of the advantages of the proposed system are:

a) *Recognition of model :*Our model is able to regognize the licence plate and is able to read the plate with a confidence of 60-70%.

Fig. 4. Object detection and recognition result

b) *Bus tracking driver app:* In this application the driver can start/stop streaming his live location.

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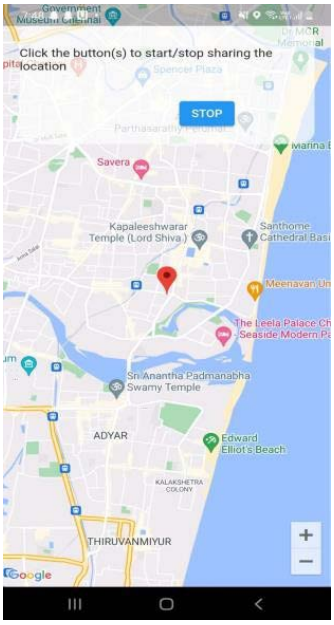

Fig. 5. Bus tracking driver app

c) Bus tracking student app: In this application the students can select their respective bus number and start tracking their bus live location.

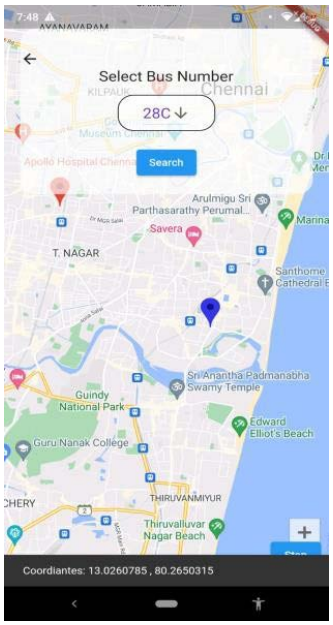

Fig. 6. Bus tracking student app

d) *Firebase database:* Due to its accuracy with data and built-in immutable class named "GeoPoint," Firebase makes this task simple by enabling simple working with geographic locations.

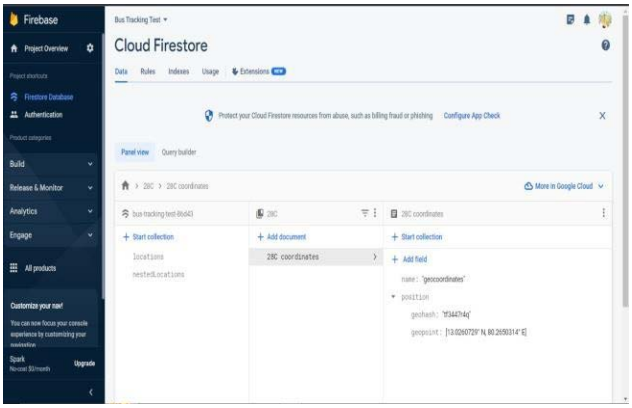

Fig. 7. Bus tracking firebase database

V. Future Endeavor, Scope And Conclusion

In this paper, the main objective is to ease the work of the transportation department by providing them with easy-to- access products which helps them in managing their resources efficiently. In conclusion, these three kits together will definitely play a vital role in helping the transportation department and the many students and faculties who are using it.

Future modification can only be made with feedback from the user side for example the plate detection system can only be tuned better after seeing the accuracy it has generated after detecting the bus's number plate. Similarly for other models future works and enhancements can be made purely based on user feedback.

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