UniScan

NPR & Facial Recognition System for University.

Content

01. Proposed System Problem Statement

System: UniScan (Number Plate and Facial Recognition System for a University)

Our proposed system UniScan allows providing multiple automated solutions according to the problems arise in a university in case of detecting, recognizing and monitoring people and their vehicles real time. According to the system, there is a network of interconnected high definition cameras around the university to capture records of faces and number plates around university premises. Outputs from those cameras are processed using a specific image processing approach and recognized by a Machine learning inspired Self Train Convolutional Neural Network. System manages a database to maintain all the data used in the system. Following are the major requirements that should be satisfied by the system in aspect of user.

1. Registering members and vehicles of the university by their face and number plate snapshots respectively.

2. Identify members and vehicles inside the university by face and number plate captures from high definition cameras.

3. Distinguish members and vehicles of the university as insiders and outsiders to the university.

4. Generate real time location maps for members and vehicles inside the university which are accessed and controlled by the admin of the university.

5. Locate current location of a vehicle by the vehicle owner using the UniScan mobile app.

6. Share current location of a member to other members of the university by the UniScan mobile app.

7. Share vehicle live location by vehicle owner to other members of the university by the UniScan mobile app.

8. Location map instances of the system should be able to recover by checkpoint file system in case of an emergency.

9. Extension of Face Recognition System can be able to use in case of marking attendance for lectures in the university.

10. System should categorize vehicles as legally allowed and legally not allowed, and allowance of entering to the university for illegal vehicles should be restricted by the system.

02. Requirements

Functional Requirements

Face data of any member of the university should be registered on the database when registering them to the university.

Facial snapshots of student's, academic staff members & nonacademic staff members should be taken at the registration level and those will be stored in a large data base.

Vehicle Number Plate data of any member of the university should be registered on the database whenever they are owned to members of the university.

Student's, academic staff member's & nonacademic staff members may have vehicles that they have been tried to enter to the university at day to day activities. So, same as to the persons, vehicle number plate should be registered at the administrative with several snapshots and some other information (like original owners) and those data will store in a separate data base.

System should detect and recognize any human face inside the university.

There will be a CCTV camera system around the university area and those CCTV camera will be placed with the same distance (like 100m). Using that CCTV system the main system can be taken different detection results help of a trained model and next system will recognize that detection results of a student, academic staff member and non-academic staff member using another trained model. Same procedure will be applied for an unauthorized person like visitors.

System should detect and recognize number plates of any vehicle inside the university.

Using same CCTV camera system the main system will take several snapshots of a vehicle that near to particular CCTV camera and comparing stored information in the data base and current snapshots, the system will recognize the vehicle using two models trained for detection and recognition.

System should be able to distinguish faces of members of the university and faces of outsiders of the university respectively.

System will able to identify the faces separately base on the information which are in the data base and comparing them with the current snapshots taken by CCTV cameras of persons help of that two trained models for detection and recognition. If the taken snapshots are not matched with stored data, system will identify that person as an outsider of the university.

System should be able to distinguish number plates of members of the university and number plates of outsiders of the university respectively.

System will able to identify the vehicles separately base on the information which are in the data base and comparing them with the current snapshots taken by CCTV cameras of vehicles help of that two trained models for detection and recognition. If the taken snapshots are not matched with stored data, system will identify that vehicle as an outside vehicles of the university.

System should record all the recognized face and number plate data on a particular database such that it should generate real time live location maps for humans and vehicles available inside the university by considering their face data and number plate data respectively. (Admin)

This can be done by only the admin. Same as to the technology behind the radar object detection or other real time maps this system will help to generate a live location maps for humans and vehicles available inside the university.

Let's assume there will be CCTV camera placed at **A point** and there is person or a vehicle at that particular point. If that object has detected and recognized at the CCTV **point B**, that means that identified person or vehicle has moved to the **point B** from **point A.**

System should maintain a checkpoint module which is capable to restore a specific instance of the live location map (vehicle or human) correspond to a specific date and time. (Admin)

This requirement also can be done by only the admin. System will store the data about each and every CCTV points as records. This will help to find out past instances of the live map of a human or a vehicle for a selected date and time.

Most of the time this will help where a situation about robbery, fights etc. to gather evidences.

Vehicle owners can be able to monitor locations (inside university) of their vehicles real time using a specific mobile app.

As an solution to be known about vehicles, owners can be have a mobile app and using it they will have the ability to know where is the vehicle at a given date and time. It can be named as a benefit such that when the owner need to give his vehicle to the trustworthy person to use, owner can monitor the vehicle locations.

An extension of Face Recognition System should be able to use in case of marking attendance of students to their lectures. In the end of each lecture, the lecturer should be able to get attendance sheet of students and all the attendant records are recorded in the database also.

As an enhanced requirement of a Face Recognition System can be introduced a marking attendance of students to the lectures help of two trained modals of detection and recognition. When the students come into the lecture, they need to face for a camera and it will identify each and every student separately and attendance will mark in a database. If the lecture wants to get attendance as a hardcopy he can have a printed document.

Students are able to share their locations + their vehicles locations (inside university) with their friends using a specific mobile app.

As a solution to be known about places, students can use this mobile app. They can their also can share their live locations and the students vehicle location with their friend. This will very useful for newly enrolled students to share useful locations among the friends.

System is able to recognize legally invalid vehicle by it's number plate and such vehicles are not allowed to use inside the university. A summarized report about non authorized vehicles will be generated by the admin of the university. Legal allowance of vehicles are checked by getting support of a police database.

There can be vehicles that have recognized as illegal vehicles when the driver has done traffic violations. University will be a most suitable place to hide those kind of vehicles. Administration can be received a list of illegal vehicle's number plates from the regional police station. If entered that kind of a vehicle into the university premises administration can recognize those vehicle quickly and list down of those kind of vehicles.

Non - Functional Requirements

Usability

Usability refers to how easy it is for users to understand and use the system. This includes the design and layout of the user interface, the simplicity of the user flow, and the clarity of the instructions and documentation.

Scalability

Scalability refers to the ability of the system to handle a large number of users and a high volume of data without performance degradation. This is important if the system is expected to grow in usage or if it needs to handle a lot of data.

Security

Security refers to the measures in place to protect user data and prevent unauthorized access to the system. This includes measures such as user authentication, data encryption, and secure communication channels.

Reliability

Reliability refers to the availability and functioning of the system at all times. This includes the ability of the system to recover from failures and errors, and the frequency and duration of downtimes.

Performance

Performance refers to the speed and efficiency of the system, as well as the number of errors and delays that occur. A system with good performance will be responsive and efficient, with minimal delays or errors.

Compatibility

Compatibility refers to the ability of the system to work with the university's existing systems and infrastructure. This includes compatibility with different hardware and software platforms, as well as the ability to integrate with other systems.

Maintainability

Maintainability refers to the ease of maintaining and updating the system. A system that is easy to maintain will require less time and resources to keep up-to-date and functioning well.

Internationalization

Internationalization refers to the ability of the system to support multiple languages and regions. This includes support for different languages and cultural conventions, as well as the ability to handle different currencies and measurement systems.

Customizability

Customizability refers to the ability of the system to be customized and configured to meet the specific needs of the university. This might include the ability to modify the user interface, add or remove features, or change the way the system operates.

03. Stakeholders

Stakeholders of a system are the entities who are interested on that particular system.

Stakeholders of our current system are:

   1. Member

      1.1. Admin

      1.2. Lecturer

      1.3. Student

   2. Outsider of the University

   3. Sri Lanka Police

1. Member: A member of a university can be recognized as Admin, Lecturer and Student respectively. All the members are eligible to track location of their vehicles real time.

Common functions of a Member:

   1. Register in to the system by providing face and vehicle data.

   2. Share live location of a member or a vehicle with another member.

   3. Access shared live locations which were sent by other members.

   4. Access real time location of the member's vehicle via a mobile application.

Admin: A kind of member which stands for system administrative activities.

Functions of Admin:

   1. Verify a registration done by a member.

   2. Access and control real time location map (member and vehicle) of the University.

   3. Generate a summarized report about not allowed vehicles inside the university.

Functions of Lecturer:

   1. Generate attendance sheet for the lecture.

2. Outsider of the University: Entities who are using the system as outsiders from the University.

Functions of outsider of the University:

   1. Access real time location map (member and vehicle) of the University.

3. Sri Lanka Police: Sri Lanka police API to get identified with illegal vehicles inside the University.

Functions of Sri Lanka Police:

   1. Identify and get information about legally not allowed vehicles (insiders and outsiders of the University) by a specific API (Application Programming Interface) contract.
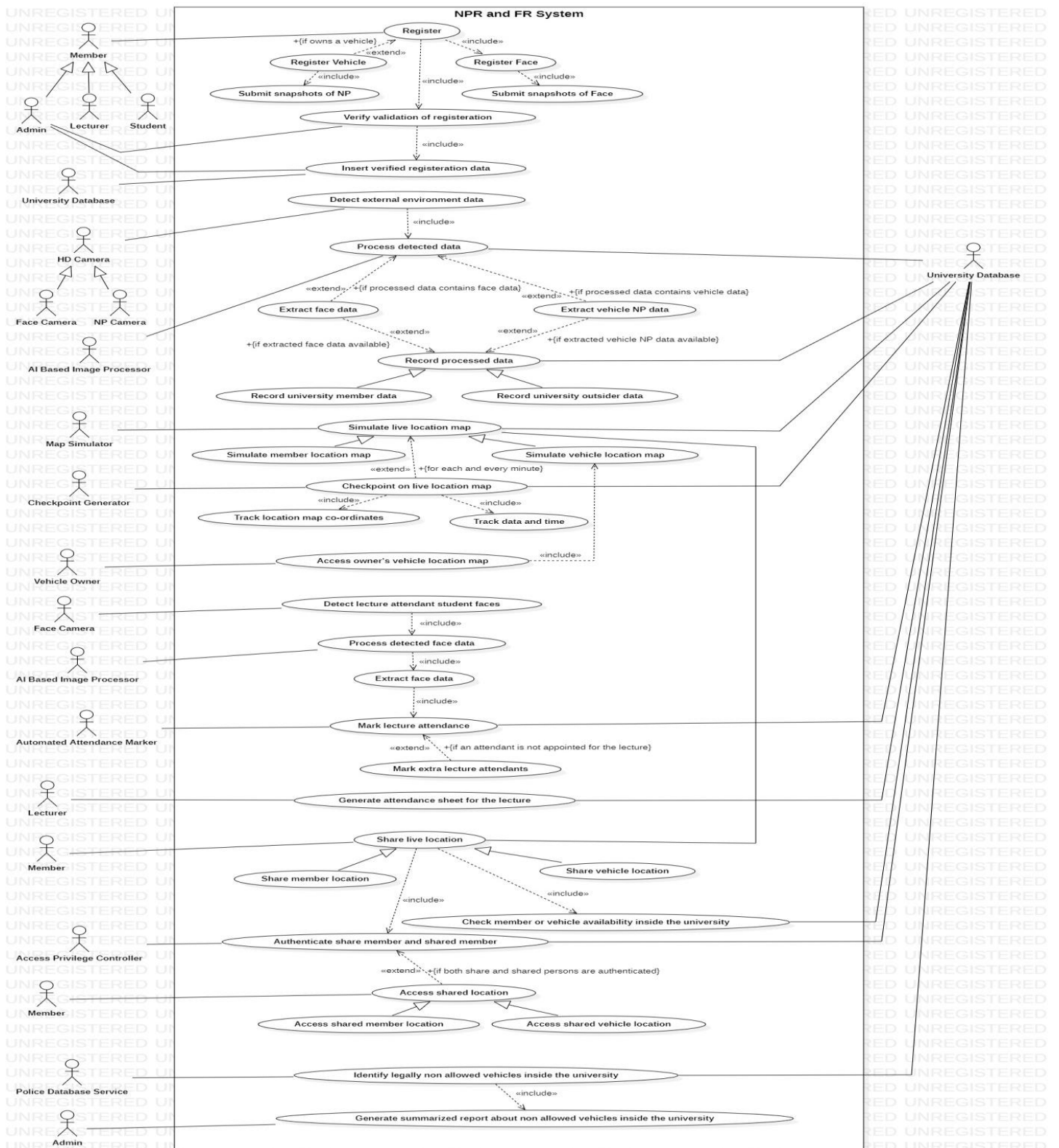
04.Diagrams

i. Use Case Diagram.

  a. For what use case diagram?

Use Case diagrams are used to identify functional requirements, system boundary (how system is distinguished from the external environment) and to showcase the stakeholders along with their connection towards the system.
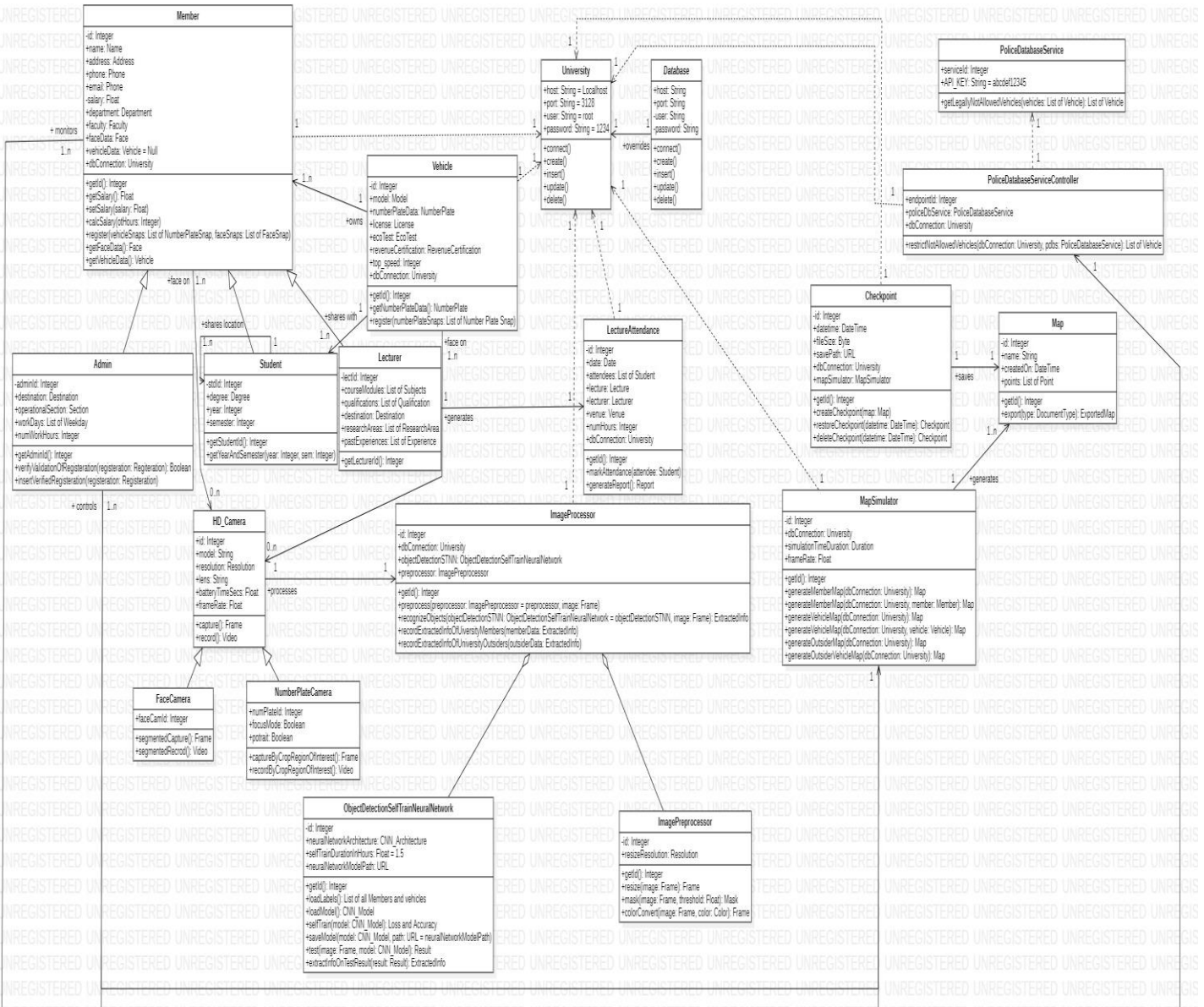
  b. Figure 01.

ii. Class Diagram.

a. For what class diagram?

Class diagrams are used to map the components to the class before programming. We use class diagrams to easily map the attributes and methods to the classes. Finally we can do coding to the system with the help of the class diagram.

b. Figure 02.

05. Technologies used for UniScan

We are going to implement our system in 2 major stages. They are,

               1) Front end development
               2) Backend development

1) Front End Development:

- We mainly use HTML, CSS, Bootstrap Languages and Javascript with ReactJS framework . The concept we are using here is Reuse Component Development concept which is the software engineering practice of creating new software applications from existing components, rather than designing and building them from scratch.

- Then we use ReactJS Native framework to develop UniScan mobile app which can be used to find student and vehicle locations real time.

- React is a library for creating modular user interfaces. It promotes the development of reusable UI components that display data that varies over time. React is frequently used as the V in MVC. React separates the DOM from you, resulting in a simpler programming approach and improved speed. React may also be used to render on the server with Node and to power native apps with React Native. React uses one-way reactive data flow, which eliminates boilerplate and makes reasoning easier than conventional data binding.

2) Backend Development:

- In this development stage we mainly use Flask framework under Python language. We use MySQL database to store our data and which is hosted in a MYSQL server.

- The Flask framework is a software architecture that comprises tools and frameworks for quickly and efficiently developing a web application. Flask is a Python micro framework which was created by Armin Ronacher.

- MySQL is a relational database management system that is an open source (RDBMS). It is built on Structured Query Language (SQL), which is a programming language used to manage databases and execute CRUD activities such as create, read, etc., update, and delete.

- A MySQL server is a MySQL instance that stores and processes data. This component is in charge of processing incoming MySQL client queries and manipulating database tables. It is also in charge of receiving database connections from MySQL clients.

- OpenCV library (Open Computer Vision) is used to process the images which are recorded in cameras.

- OpenCV is an acronym that stands for open-source computer vision. It was created to offer a standardized architecture for computer vision operations and the application of system behavior in financial products. It primarily focuses on image processing, facial recognition, video recording, search, and object disclosure. OpenCV was designed to do a variety of tasks such as face recognition and detection, human task analysis in movies, object identification, recording camera motions, monitoring moving objects, and merging pictures to generate a high-resolution image for the accurate scenario.

- Object Detection Self Train Nerural Network (Object DSTNN) is implemented customising Tensorflow object API framework along with the Tensorflow, Keras, Scikit-Learn, Matplotlib, Numpy libraries.

- TensorFlow is a free and open-source framework for developing Machine Learning applications. It is a symbolic math toolkit that employs dataflow and differentiable programming to handle various tasks related to deep neural network training and inference.

- Keras is a Python-based open-source high-level Neural Network framework that can operate on Theano, TensorFlow, or CNTK.

- Scikit-learn is one of GitHub's most popular machine learning libraries. Scikit-learn is mostly developed in Python and heavily relies on NumPy for high-performance linear algebra and array operations.

- Matplotlib is a fantastic Python visualization package for 2D displays of arrays. Matplotlib is a multi-platform data visualization package based on NumPy arrays that is intended to operate with the larger SciPy stack.

- NumPy is a Python library for working with arrays. It also provides functions for working with linear algebra, fourier transforms, and matrices.

- Again we are going to use OpenCV library to implement the Map Simulator. Also we are using this OpenCV library to get real time records from High Definition Cameras.

- We use PyTesseract library (which comes under the framework of Tesseract) to identify and extract digits and numbers of number plates of the vehicles.

- Then to print the attendance sheet for the lecturer, we are going to use OpenPyXL library in Python.

- The OpenPyXL module in Python is used to work with spreadsheet files without requiring third-party Microsoft application software. We may manipulate spreadsheet without having to launch the application by utilizing this plugin.

- It is used to conduct excel activities such as reading data from an excel file or writing data to an excel file, drawing charts, accessing an excel sheet, renaming the sheet, modifying (adding and removing) the sheet, formatting, styling the sheet, and any other job. OpenPyXL is a highly efficient tool for handling these jobs for you.

- As we have previously mentioned in our report that the lecturers can get the summarized report of the students' attendance count and Matplotlib, Seaborn and Numpy libraries are used to generate the attendance sheet summary.

- When in implementing the Police database API contract, the Request library is used which is a Python in built library.

06. Future Maintenance and Evolution of UniScan

System maintenance can be introduced as continuing a system until phase out by correcting errors and adding new functionalities when needed because the environmental change is inevitable. Under maintenance part, system can be implemented for correcting errors, to enhance the accuracy, safety and efficiency. This maintenance can be done using major three perspectives.

01. Corrective Maintenance.
(Correct existing errors in the code.)

Examples:
- We have introduced two mobile apps for students and vehicle owners to share their locations. If those mobile apps faced to any error like logging error, sharing location, displaying wrong readings, the developers should able to correct those kind of errors using existing code.
- There are CCTV cameras in the university area. If one of CCTV has occurred an internal circuit damage, CCTV service providers will come and fixed those errors under corrective maintenance.

02. Addictiveness Maintenance.
(Maintains the system when it deploys to new environment.)

Examples:
- Let's assume our whole data base has created base on **MySQL**. But, with the time or, if there is a need to enhance that data base into **MongoDB** nosql data base it should be applicable for to that. So, the introduced system develop like that under addictiveness maintenance.
- CCTV cameras perform a major role in this system. So, when the day is rainy or sunny, day or night, CCTV camera readings cannot be changed. Therefore, to maintain the system continuously, it betters to choose most comfortable cameras for any kind of environmental change.
- If the request amount is greater than the outputs of the system, definitely there can be generate a server traffic. So, when system has been developed, developers should consider about the capacity of the system. Then, the implemented system can be used in any kind of an environment whether it has a lot of requirements or not.

03. Perfective Maintenance.
(Changing the system according to new functionalities.)

Example:
- Go through the several years, users may have new requirements to add for the purposed system. As an example, after two or three years administrative wants to recognize the vehicles and categorize those vehicles according to its type. Developers will agree and add this requirement to the system, but it should not affect to the previous working system.

07. Team Members

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W.W.M.H.Chamuditha	UWU/IIT/20/059

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