
Opening:

Hello everyone, We are here today to present our project:
"Application of Autonomous Vehicle Patrol and Image Recognition Technology in Smart Campus Management." Our team members are Wu Liang-Ying, Chou Shih-An, and Liang Kai-Wei. Our advisor is Professor Hsieh Yi-Zeng.

Introduction:

In recent years, campus security incidents have become increasingly common. Although many universities have proposed various solutions, it's still difficult to ensure campus safety 24/7. At night, campuses face several challenges such as poor lighting and a lack of patrol personnel.

To address these issues, our research proposes an Autonomous Patrol System that combines object detection technology with autonomous vehicles. This system aims to provide automated campus patrols, enhance monitoring capabilities, and compensate for the limitations of traditional methods.

Research Methodology:

As shown in the diagram on the right, our system architecture is divided into two parts: the computer side and the autonomous vehicle. The vehicle is equipped with a camera, GPS, and ultrasonic sensors. These signals are processed by a microcontroller, and the Arduino controls the vehicle's movement. Meanwhile, the microcontroller sends data back to the computer via Wi-Fi.

The computer processes this data and uses it as the basis for the real-time monitoring and alert system. With the support of these devices, the autonomous vehicle can follow predefined routes, avoid obstacles automatically, and be remotely controlled by users. This improves the safety, flexibility, and responsiveness of the system.

For object detection, we use YOLOv8. Behaviors are classified into three categories:

- Normal – for example, pedestrians
- Need help – such as someone who has collapsed
- Suspicious – such as people fighting

Progress – Completed Work:

For the autonomous vehicle, we have completed some mechanical design and

testing. These include control of the stepper motor, control of the electric cylinder, and GPS antenna testing. All of these are functioning properly.

In terms of behavior detection, YOLO has shown decent performance. However, there are still cases where detection is inaccurate and needs further tuning.

Progress – Problems and Solutions:

During testing, we encountered some unexpected issues with the Arduino and the vehicle itself. For example, the Arduino may crash during operation, which could be a critical safety issue.

→ To address this, we plan to implement safety features such as an emergency stop button and remote stop functionality to ensure safety comes first.

Another problem is that the Arduino's power output is not enough to drive multiple components at the same time, often causing system crashes due to insufficient current.

→ We temporarily resolved this by using external power banks for additional power supply.

We also found it difficult to install control components onto the vehicle.

→ We're exploring better mounting methods, such as using acrylic boards to secure small components in place.

Additionally, YOLO sometimes misclassifies objects during continuous detection. For example, if frames 1 to 4 correctly detect a person as normal, frame 5 might suddenly label it as suspicious.

→ To fix this, we added post-processing logic that compares previous frames with the current one. This allows us to correct the classification, such as changing a result from normal to suspicious, as shown in the example below.

Timeline:

Here is our Gantt chart. Currently, our overall progress is slightly behind schedule due to some unforeseen challenges. Vehicle control development has not gone as smoothly as expected, but we still believe we can successfully complete the project.

Task Distribution:

Here is our task allocation:

- Wu Liang-Ying is responsible for image recognition, vehicle control design, and driving logic programming.

- Chou Shih-An is responsible for vehicle control design, code integration, and driving logic programming.

- Liang Kai-Wei is responsible for hardware design, code integration, and driving logic programming.

Cost Estimation:

On the right, you can see our cost estimation. Our total cost is estimated to be NT$20,000, including the autonomous vehicle chassis, microcontroller, image recognition module, ultrasonic sensors, GPS, Wi-Fi module, power module, and other electronic components. These are used to implement autonomous patrolling, object detection, and remote communication.

Closing:

That concludes our project presentation.

Thank you, Professor, for your time and attention.
