## **Purdue ECE Senior Design Semester Report**

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| **Course Number and Title** | ECE 477 *Digital Systems Senior Design Project* |
| **Semester / Year** | Fall 2016 |
| **Advisors** | Prof. Thottethodi, George Hadley |
| **Team Number** | 7 |
| **Project Title** | Automated Number Plate Recognition (ANPR) parking system |

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| Senior Design Students – Team Composition | | | |
| **Name** | **Major** | **Area(s) of Expertise Utilized in Project** | **Expected Graduation Date** |
| Zhihao Liu | Comp E | Software | Fall 2016 |
| Kaiwen Yu | Comp E | PCB Layout, Soldering | May 2017 |
| Zhuofan Li | Comp E | Packaging | May 2017 |
| Tian Qiu | Comp E | Software | May 2017 |

**Project Description:** Provide a brief (2-3 page) technical description of the design project, as outlined below:

1. Summary of the project, including customer, purpose, specifications, and a summary of the approach.

The Automated Number Plate Recognition (ANPR) parking system is a technological upgrade to our tried-and-true system of parking which does away with the use of tickets, and instead automatically tracks vehicles via their license plates through the use of cameras. Our target customer will be parking garage management company. Parking spot LED indicator modules are included in individual parking spots, providing information about parking place vacancy, further improving the parking garage management process. The main system will be located at entrance and exit where entrance and exit are closed to each other. There are two cameras taking pictures of license plates from the back of the cars at the entrance and the exit. Then a Raspberry Pi will process the images of license plates and records the vehicle information into system. After the Raspberry Pi has done its job, the corresponding gate barrier will be raised by the motor module, allowing the vehicle to enter or exit the parking garage. Each parking spot will have an LED indicator showing if the parking spot is empty. The LED indicator consists of an infrared sensor and an LED. Once a car parks on a spot, the LED indicator will turn red. LED will be green when a parking spot is empty.

1. Description of how the project built upon the knowledge and skills acquired in earlier ECE coursework.

The project uses skills from previous microprocessor class, Python scripting language from ECE36400 Software Engineer Tools Lab class and hardware experiment technics from ECE20700 and ECE20800 class. The microcontroller is used to implement different modules that we learned from microprocessor class and able to implement desired signals such as SPI module and PWM module. The Raspberry Pi uses Python as its main programing language, which we have learned from ECE 36400 Software Engineer Tools Lab, a scripting language class. When we are designing PCB and testing the PCB, we have many experiences from ECE20700 and ECE20800 lab class and able to design and test the PCB.

1. Description of what new technical knowledge and skills, if any, were acquired in doing the project.

Several new skills and knowledge is required for this project. First of all, none of the team members had ever dealt with custom layout of Printed Circuit Boards. Kaiwen learnt it and designed the whole PCB layout for our project. Secondly, before the project, we were not quite sure how to solder the micro controller chip onto the PCB. We learned from demo in a lecture and Joe also taught us the way to do that. Moreover, for the software part, at the beginning of the project, none of us was familiar with software development using Raspberry Pi. Also, none of us knew which open source plate recognition algorithm is the best choice for our project and how to actually implement it. Those aforementioned things are the new technical knowledge and skills for us.

1. Description of how the engineering design process was incorporated into the project. Reference must be made to the following fundamental steps of the design process: establishment of objectives and criteria, analysis, synthesis, construction, testing, and evaluation.

In the beginning of the project, establishment of the objectives and criteria was the main problem. After we met with course instructor team, the objectives and criteria for this project finally got settled. In the analysis and synthesis stages, the architecture of the system became the key point for the whole design. We made a lot of graphs to describe the functionality in details based on the devices that have been chosen. In the synthesis and construction stage, after the code was finished, the modules were constructed together. Then the main task is to test all the functionalities. After making sure all the parts ran as expected, we were ready for evaluating the whole system.

1. Summary of how realistic design constraints were incorporated into the project (consideration of most of the following is required: economic, environmental, ethical, health & safety, social, political, sustainability, and manufacturability constraints).

## **Economic:** The design process took into consideration a lower cost microcontroller to ensure affordability among small parking lots of the target market. The economic aspect was done by selecting cheaper modules to be incorporated in the device. Our design will lower the budget since our project does not have parking ticket payment machines, which are not a small cost of a system.

## **Environmental:** The whole system is going to have low environment impact with no paper ticket used in parking garage design, and using environmentally improved method making PCB.

## **Ethical:** Since the device has a data storing capability, it can be used by parking lot owners to monitor the license plate of vehicle coming to the parking lot. Unfortunately, we haven’t design an encryption for the data communication, which will be developed in the future.

## **Health & Safety:** The device should have no impact with health by using environmental friendly materials and the only safety consideration is about the lifting bar, which may drop off accidently. And we design to use lighter material building the bar to lower the risk of damage.

## **Social:** The ANPR system is social friendly. The system acts like regular parking garage without paper tickets. People using our system should have no concern about payment process and missing tickets.

## **Political:** There is no explicit political consideration about this device.

## **Sustainability:** The device is designed to make use of no batteries in actual design, therefore, the sustainability is good with constantly power supply. The data is stored in a drive. The system could recover all the information after a power shortage happens.

## **Manufacturability:** Assuming that all chips and passive components can be soldered onto the PCB via an automatic process, the manufacturability of the device is quite simple. And it is not hard to deal with assembling the whole system and easy to install.

1. Description of the multidisciplinary nature of the project.

## This project required computer engineering knowledge and skills. To achieve communication between microprocessor and Raspberry PI, the programmer needs to understand and utilize SPI interface protocol. For receiving and processing infrared sensor signal, electrical engineering knowledge is needed to design the corresponding circuit. For gate barrier design, mechanical engineering is also required to meet the torque criteria. The camera module utilized by Raspberry PI requires a full software setup and related software development skills. Then, the project packaging design uses CAD and Sketchup to build product illustrations and blueprints. Finally, PCB layout knowledge has been used for creating the custom PCB, and soldering knowledge to solder components of various electrical packaging to the PCB.

1. Description of project deliverables and their final status.

The desired functions were delivered by the final prototype. Our system was able to raise and lower gate barriers programmatically via microcontroller PWM module. This function is one of our PSSCs. Our system was able to receive and process infrared signals correctly and use that information to control cameras. This meet our PSSC #2 and PSSC #4 to detect a vehicle and capture image of plate using camera. Our system is able to recognize the license plate number and the plated number information can be recognized and transmitted to the microprocessor. Our system was able to track individual parking time by saving plate number information to a file which is the ability of PSSC #5. The segments display show clear and intended information, which meet our PSSC #3. Finally, the spot circuit can show the occupancy by lighting red or green LEDs.