Automated Parking Assistant

Team 8

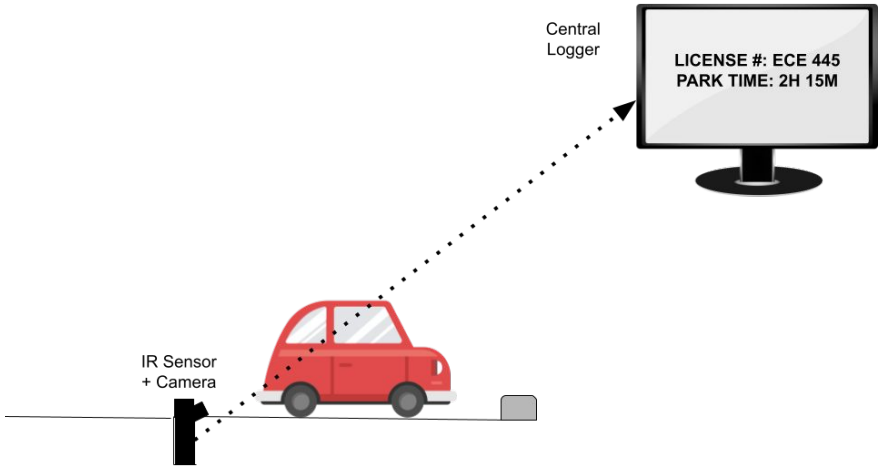
Daniel Ahn
Mehul Dugar
Freddy Zhang

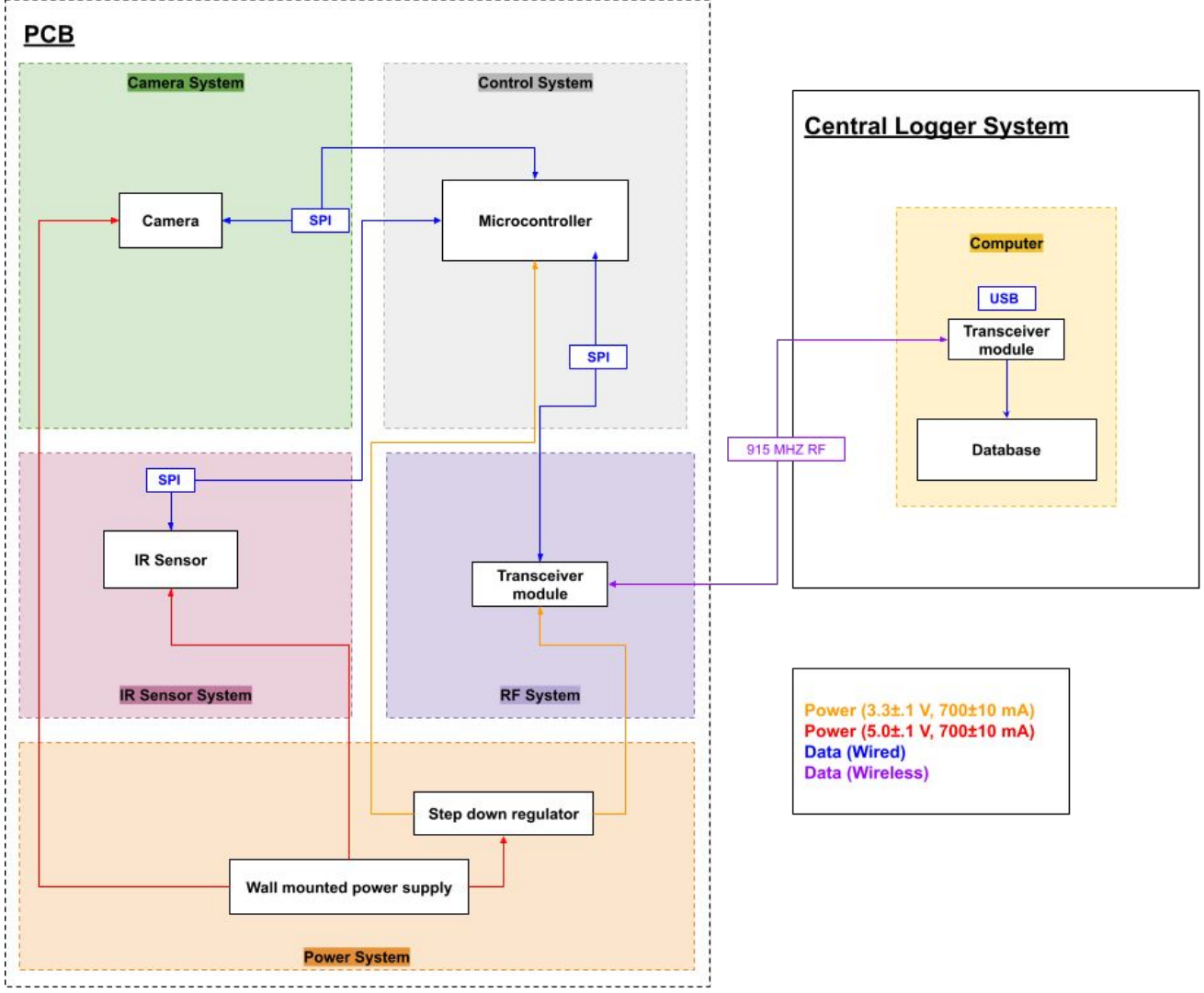
Problem

- Congested parking lot entrance
- Wasted time finding parking
- Sometimes tedious payment methods

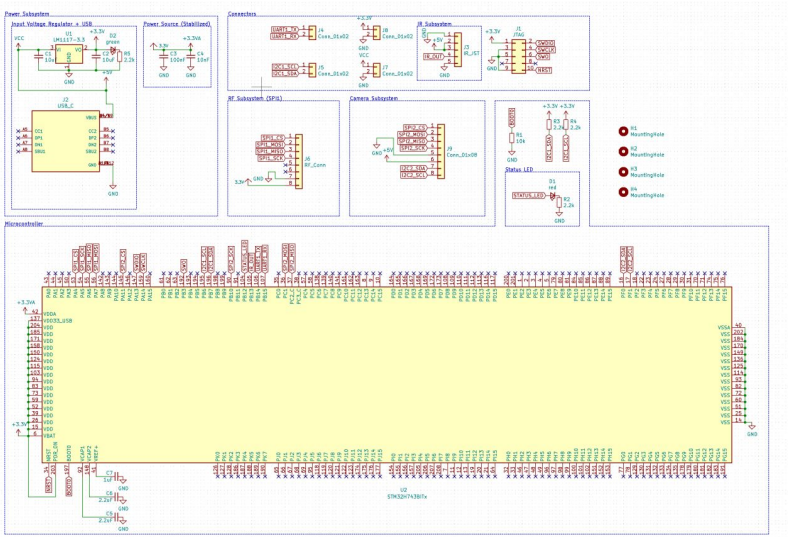
Solution

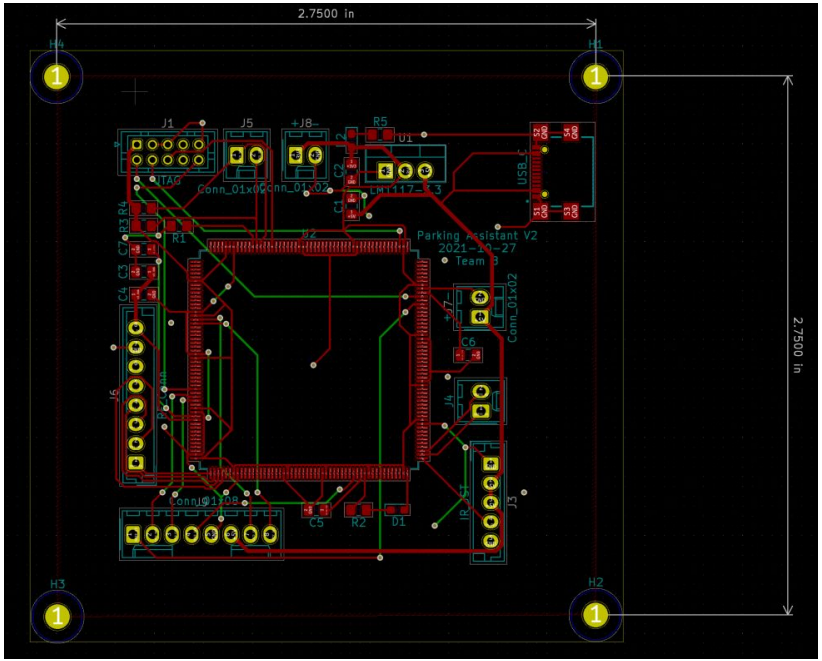
- Embedded license plate reader system
- Remote communication
- Lightweight
- Scalable




PCB
Camera System
Control System
Camera
SPI
Microcontroller
SPI
SPI
IR Sensor
IR Sensor System
Transceiver module
RF System
915 MHZ RF
Step down regulator
Wall mounted power supply
Power System
Central Logger System
Computer
USB
Transceiver module
Database
Power (3.3±.1 V, 700±10 mA)
Power (5.0±.1 V, 700±10 mA)
Data (Wired)
Data (Wireless)

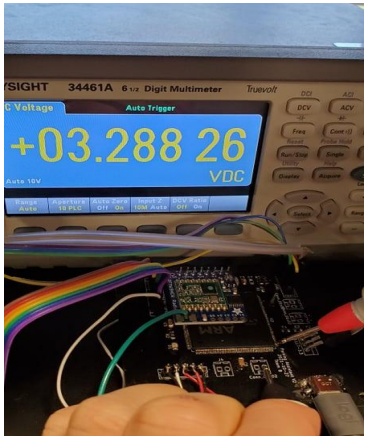
Schematic + PCB





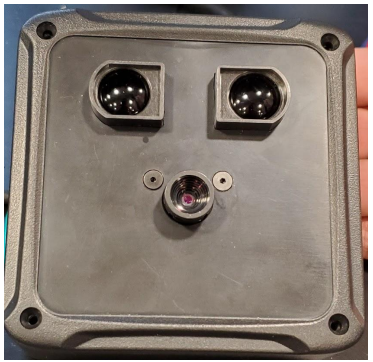
Requirements & Verifications (Power)

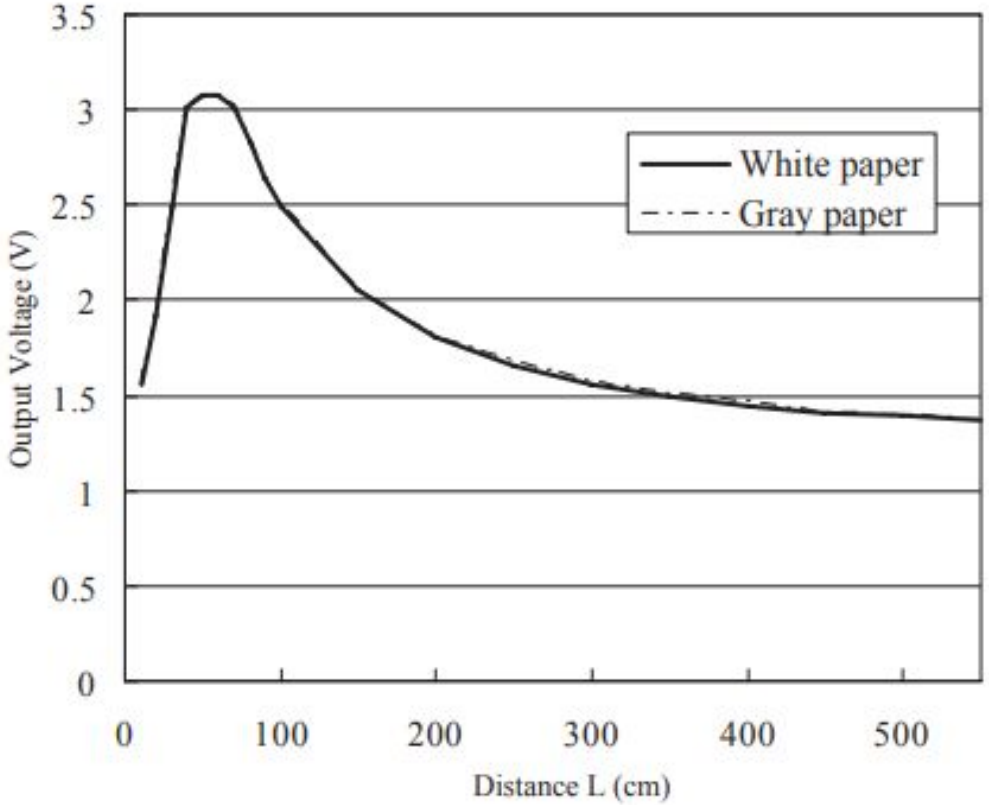
#	Requirements	Verifications	Verified? (refer to images)
1	Accept 120-240VAC as input and output 5±.2 V.	Use a multimeter to check the voltage going to the PCB at the USB-C input.	Yes
2	Outputs 5±.2 V to the camera and the IR sensor.	Use a multimeter to check the voltage going to the camera and IR sensor and see that it is showing 5±.2 V	Yes
3	Outputs 3.3±.2 V to the microcontroller and the transceiver	Use a multimeter to check the voltage going to the microcontroller and transceiver and see that it is showing 3.3±.2 V	Yes



Requirements & Verifications (IR)

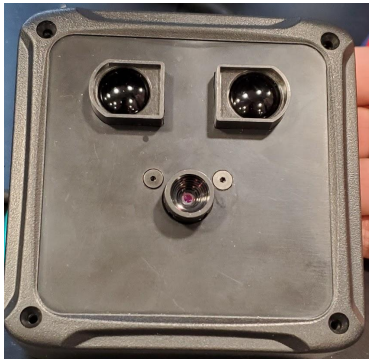
#	Requirements	Verifications	Verified?
1	The sensor must be able to detect the car's distance correctly within 10 cm.	Point the IR sensor at an object at a known distance less than 2 meters away and check the distance measured.	Yes (refer to video in the next slide)
2	The sensor must be able to send a signal to the microcontroller if an object is identified to be within 120 ± 10 cm of the sensor.	Point the IR sensor at an object 120 cm away and check the status LED on the PCB to see that it lights up.	Yes (Live Demo)

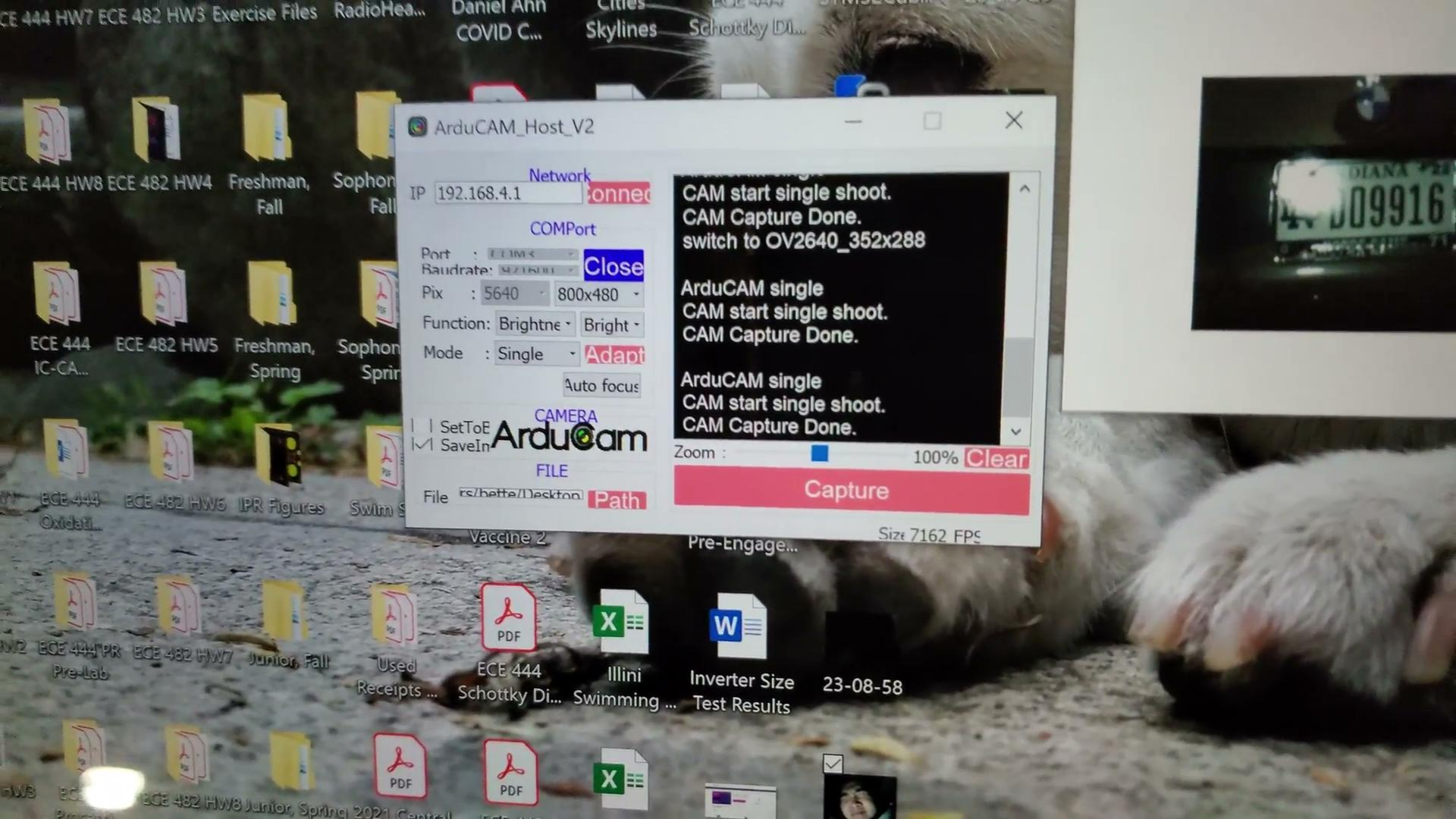



3.5
3
2.5
2
1.5
1
0.5
0
Output Voltage (V)
White paper
Gray paper
0
100
200
300
400
500
Distance L (cm)

Requirements & Verifications (Camera)

#	Requirements	Verifications	Verified?
1	The Camera System must be functional between ambient temperatures of -10° C to 40°C.	-10°C Put the camera module in a freezer for 5 minutes and verify its functionality. 40°C Put the camera module in a warm water bath for 5 minutes and verify its functionality.	Yes
2	The Camera System must be able to receive a signal from the microcontroller that allows it to take a picture and send the picture data out.	Send a signal through the SPI that should take a picture and verify whether or not the output data stream contains the picture that was taken.	Yes (Refer to Video)




ArduCAM_Host_V2
Network
IP 192.168.4.1
COMPort
Port :
Baudrate:
Close
Pix : 5640
800x480
Function: Brightne
Bright
Mode : Single
Adapt
Auto focus
CAMERA
SetToE
SaveIn
ArduCam
FILE
File
Path
CAM start single shoot.
CAM Capture Done.
switch to OV2640_352x288
ArduCAM single
CAM start single shoot.
CAM Capture Done.
ArduCAM single
CAM start single shoot.
CAM Capture Done.
Zoom :
100%
Clear
Capture
Size 7162 FPS
ECE 444 HW7
ECE 482 HW3
Exercise Files
RadioHea...
Daniel Ahn COVID C...
Cities Skylines
Schottky Di...
ECE 444 HW8
ECE 482 HW4
Freshman, Fall
ECE 444 IC-CA...
ECE 482 HW5
Freshman, Spring
ECE 482 HW6
IPR Figures
Vaccine 2
Pre-Engage...
ECE 444 PR Pre-Lab
ECE 482 HW7
Junior, Fall
Used Receipts ...
ECE 444 Schottky Di...
Illini Swimming ...
Inverter Size Test Results
23-08-58
ECE 482 HW8
Junior, Spring 2021 Capitol

Requirements & Verifications (Control)

#	Requirements	Verifications	Verified?
1	MCU is programmable.	Flash a program using *STM32CUBEIDE* and verifying the flash.	Yes (live demo)
2	MCU connects to the IR subsystem	Use the *STATUS_LED* to verify that the object has been detected within a given distance.	Yes (live demo)
3	MCU connects to the RF subsystem	Use the RF receiver connected to the central logger to verify receiving a signal	-
4	MCU connects to the Camera Subsystem	Verify that an image has been successfully captured using the *STM32CUBEIDE*	-
5	MCU connects to the Power Subsystem	Verify that the MCU is successfully powered on.	Yes (LED light shows that the MCU works)

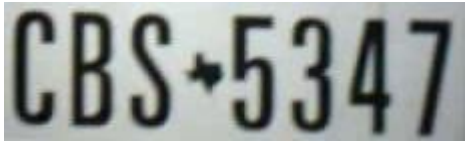
Requirements & Verifications (Image Recognition)

#	Requirements	Verifications	Verified?
1	The OCR program must be able to correctly identify the license plate number from a picture with an accuracy of 85%	The program will read 433 images of license plates in the Kaggle License Plate Dataset, and it must correctly identify at least 368 of the images.	Yes
2	The program must be able to correctly identify the license plate characters from the pictures taken from the Camera System with an accuracy of 80%.	20 pictures of license plates around UIUC campus will be taken using the Camera System, and it must correctly identify 80% of the characters in the license plates.	Yes (Live Demo)

Difficulties with OCR

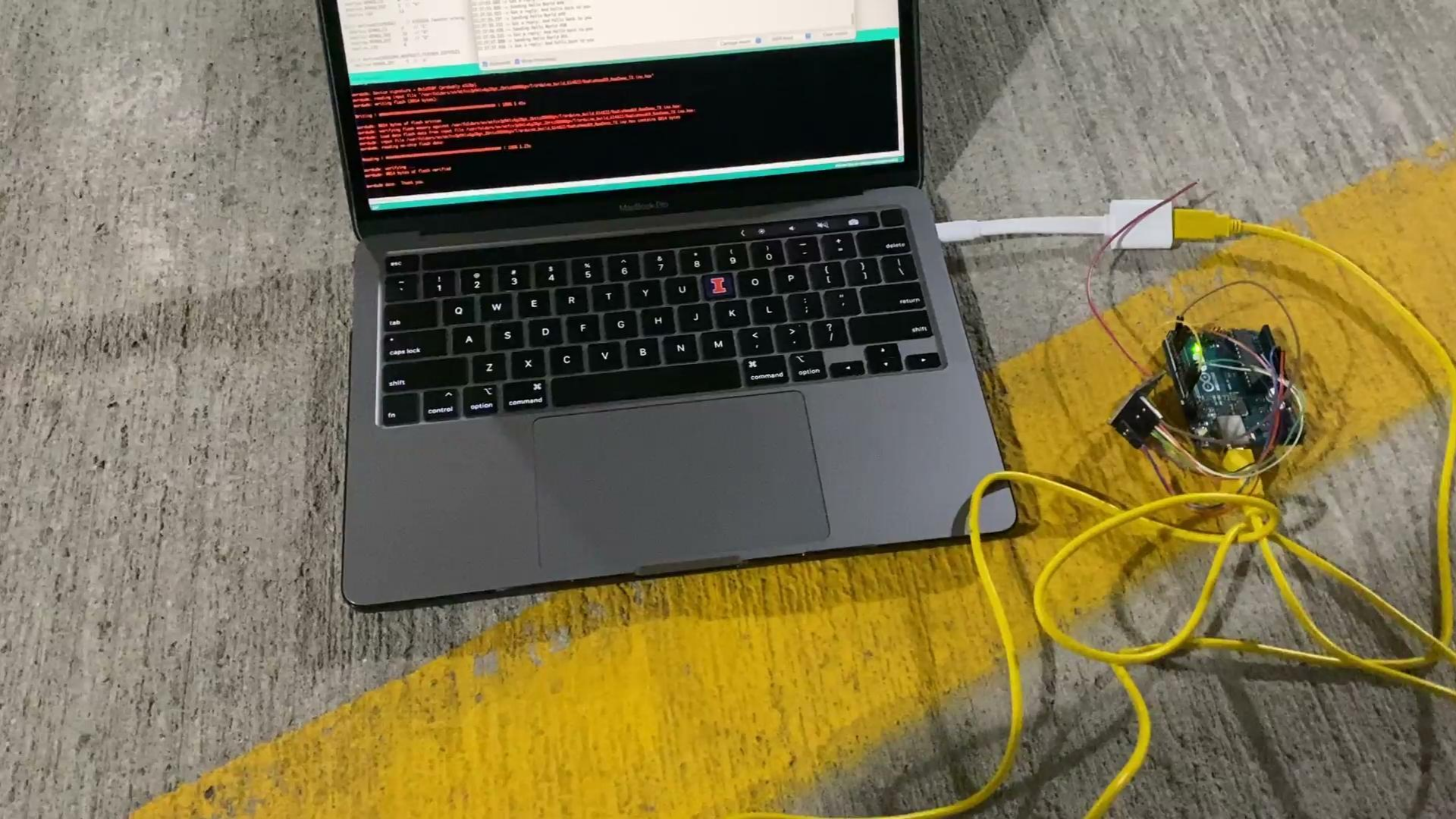
- Unexpected quality drop from camera pictures
- Quality of license plates from online differed
- Inconsistencies in orientation and distances

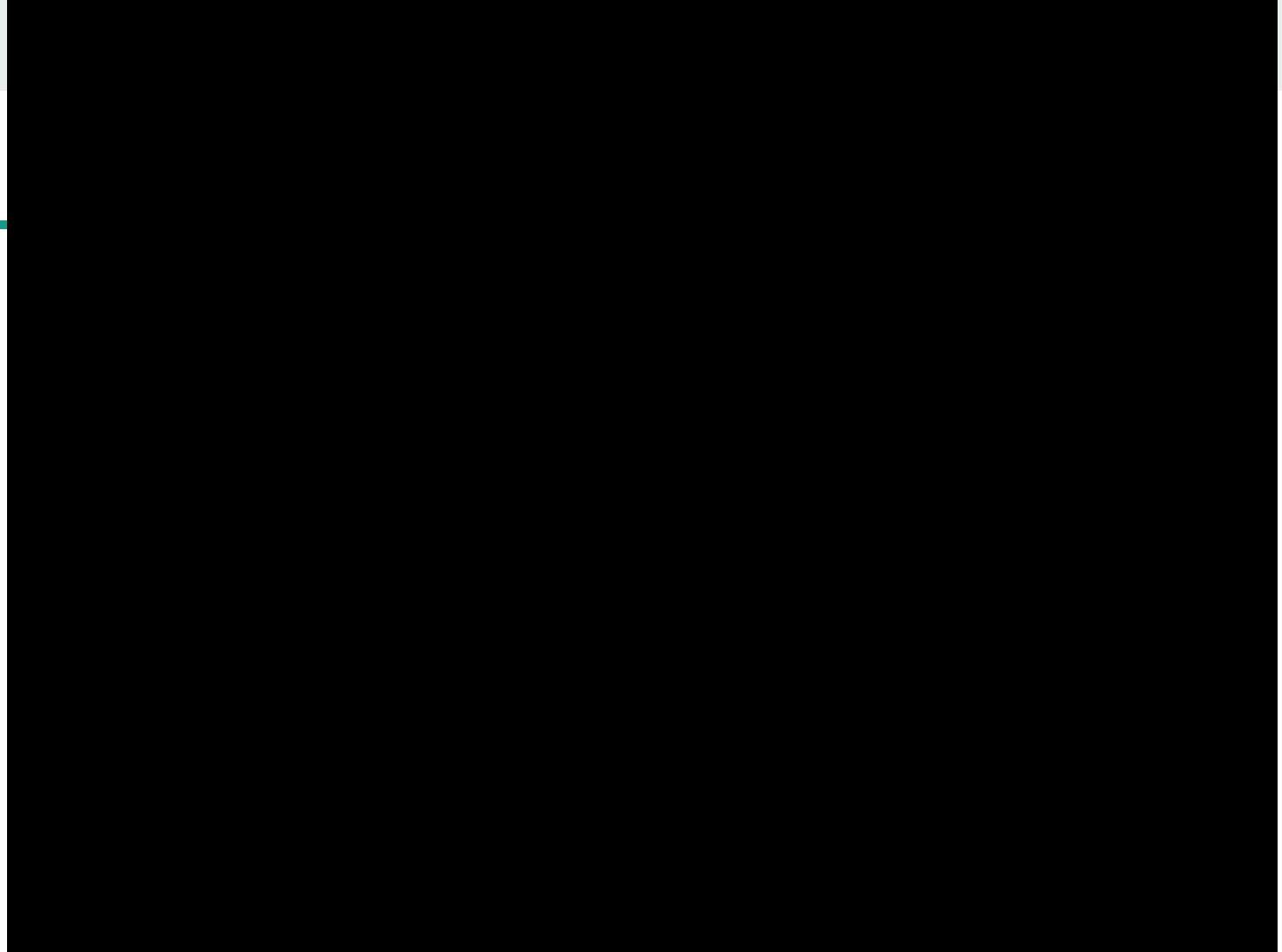
Actual License Plate	Predicted License Plate	Accuracy
2632	2632	100 %
2766655	2766655	100 %
8ROM674	8ROM674	100 %
9179AL1	9179AL1	100 %
ABC92P	ABC92H	83.33%
B933	H933	75.0%
BP76108	HP76108	85.71%
CBS5347	EBS5347	85.71%
CUK6700	CUK5700	85.71%



Requirements & Verification (RF)

#	Requirements	Verifications	Verified?
1	The transceiver must be able to successfully transmit the correct data from a distance of 150 ± 5 ft to ensure a successful communication over a long distance.	Have a LoRa receiver successfully receive a packet from the transceiver that is 150 ± 5 ft away.	Yes (refer to video1)
2	The transceiver must be able to successfully transmit the correct data through concrete structures to maintain a good signal in a car parking lot.	Have a LoRa receiver successfully receive a packet from the transceiver that is behind a concrete structure.	Yes (refer to video2)
3	The transceiver must be able to encrypt and decrypt messages.	Have a pair of LoRa transceivers communicate with each other with a set encryption key and verify the message transmitted is successfully decrypted.	Yes (live demo)





Requirements & Verifications (Central Logger)

#	Requirements	Verifications	Verified?
1	The computer program must be able to read the incoming RF signals from the PCB using the USB transceiver.	Send data packets using 915 MHz and see if the computer receives the packets through the transceiver.	Yes (Live Demo)
2	The computer must have a database of 10 MB to store the parking lot occupancy data.	Check the computer to see how much space it has allocated for the program and the database.	Yes (Live Demo)

Picture of csv file at the Central Logger

	cars
02/12/2021 2:45:27 PM	EROS
02/12/2021 2:46:32 PM	BP76108
02/12/2021 2:47:55 PM	CUK6700
02/12/2021 2:48:03 PM	B933
2/12/2021 2:49:21 PM	8ROM674
2/12/2021 2:50:81 PM	ABC92P

Future Improvement

- Full integration with every component
- Building out the libraries that support the MCU we used
- Improving scalability
- Creating an OAuth Payment system to utilize the logged data

Thanks for listening!

Questions?

Appendix

Mistakes

- Soldering mistakes with chip
- Underestimation of lead times for parts