WatechPark: SMART Parking Capstone Project

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INTRODUCTION

Proposal:

Many busy parking lots are often plagued with congestion, with drivers competing to find a spot by cruising around and locating the right parking space. This is inefficient, time consuming where productivity is lost for consumers and businesses. The system we will be developing will address payment for parking, capacity management and location finding following an IoT approach using hardware and software. This project is focused on solving these issues by connecting consumers to parking lot owners and providing parking services by using a more convenient, simpler method to retrieve parking lot data seamlessly.

The main objective of this undertaking is to provide a more efficient and reliable platform to aid with parking scenarios. In particular, for the purpose of the consumer demographic who's in the market for an alternative parking lot management system. Our focus was to develop a platform, that would be the gateway to support consumers with finding the best parking space during any time, any place or anywhere in the world.

Idea:

Through the development of this product, we wanted to reach as many demographics and be able to provide an inexpensive and reliable platform where parking lot information can be retrieved at a glance. The idea of this project came up when the group realized that we can develop an easier way to find parking spots, by connecting all the spots to a SMART parking application.

We offer users with the ability to use a SMART parking mobile application to be able to add/manage cars, view parking lot data, make on-the go reservations for parking passes, accessible via an online database to send/receive information in real-time, all built-in with a simple and effective interface.

Background:

In the industry today, there have many occurrences where parking in general has become a hassle for city residents and parking lot owners. Due to this reason, it can lead to congestion in major traffic centric cities, with drivers competing to find a spot. This can be time-consuming, inefficient where productivity is lost for consumers and businesses. This project is focused on helping reduce the impact of this cause, by developing a system that will address payment for parking, capacity management, real-time information gathering to keep consumers up to date with their daily occurrences.

AIM

Bill Of Materials:

Total Project Cost: $261.79

Product Name	Quantity	Unit Cost	Cost
Raspberry Pi 4b (4GB) Kit with power Supply and SD Card	1	$134.99	$134.99
VCNL4010 Proximity Sensor	4	$9.95	$39.80
IR Break Beam Sensor	2	$1.95	$3.90
PCA9685 PWM\Servo Controller	1	$19.84	$19.84
RGB LED (Pack of 10)	1	$5.95	$5.95
Power Adapter for external power	1	$12.98	$12.98
USB Camera	1	$15.00	$15.00
Micro Servo Motors	2	$5.95	$11.90
Jumper Wires	1	$2.59	$2.59
Resistor Kit	1	$14.89	$14.89
Total			$261.79

BOM – Final Project Budget

Required Resources/Tools:

Parts:
- VCNL4010 Proximity Sensor
- IR Break-Beam Sensor
- PCA9685 Servo Controller
- 2 Micro Servo Motors(entry/exit gate control)

Tools/Materials :
- Wire cutters, soldering iron, solder material, helping hand, pin headers

Facilities/People:
The prototype lab in Humber College is the main source of providing the services to etch the PCB board during its final stages of production as well as provide laser-cutting services initially planned. The electronics lab facility also allowed our team to work on the project, for both hardware/software purposes. Adjustments were made to the project through active involvement by our industrial collaborator from ParkingBoxx, Mike Wrona.
Contact: mike@parkingboxx.com

METHOD

Electronics/PCB:

Firmware:

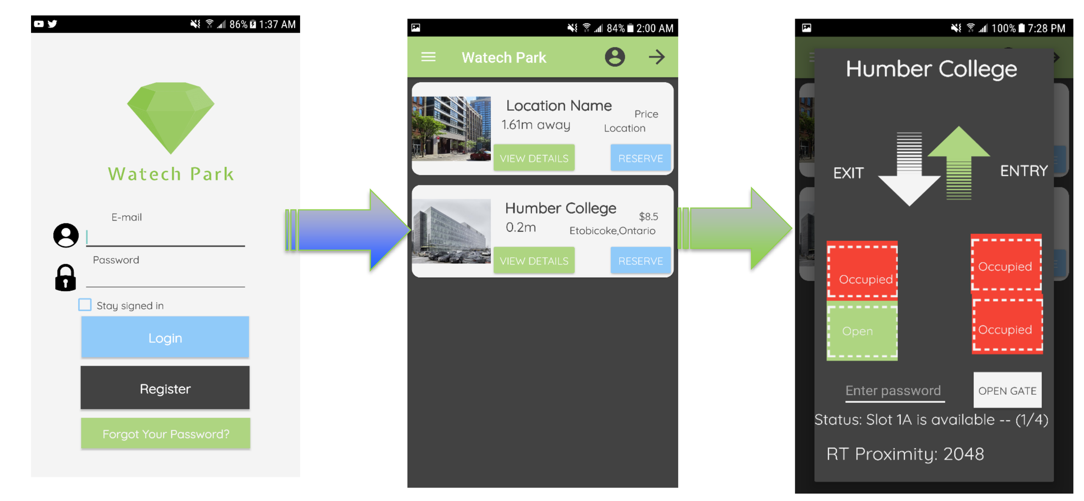
RESULTS

Mobile Application:

Development Environment: Android Studio (JAVA) – API 21 and above

The mobile application works alongside an online database structure through the Firebase database and on-site devices which include the VCNL4010 Proximity sensor, IR Break Beam Sensor, and the 2 servo motors running alongside the PCA9685 servo controller.

The application follows a login and authentication structure and is designed with various screens in mind to support our consumer application. This includes options to add a car, manage added cars, view real-time parking lot data and provide status updates/changes through the supporting sensors/effectors and the data sent and retrieved by the online database. Other features include consumer abilities to reserve a spot in a parking lot, select a parking pass, payment services and ability to view order history/transactions. As well as access settings, customize language preferences and other in-app options.



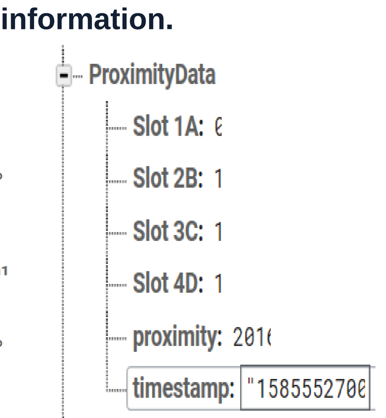
Login Screen *Home Screen* *'View Details' Screen*

Database Configuration:

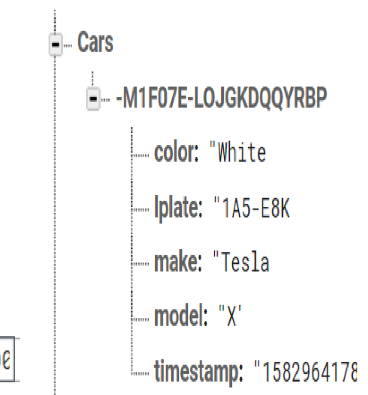
The online database is configured based on essential criteria needed to access the mobile application, hardware and vice-versa. The main source of delegating data is done through the Google Firebase database.
There are five main data structures used in the project, along with four sub-siding tables used for the purpose of the mobile application, and other intended functionality of our parking application. SQL scripts are used with Firebase/Pyrebase , to gain access to the Firebase API using the API key for both the mobile application and parking lot prototype.

The 'TestUsers' data structure stores registration details specific to the user. The UID (user ID) acts as the primary key identifying each existing user and its registered account information.

'TestUsers' Table

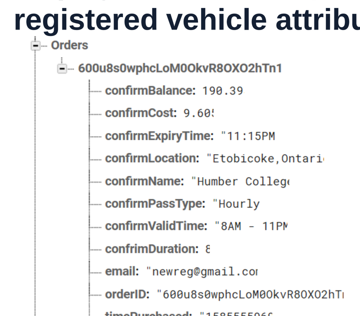


'ProximityData' Table

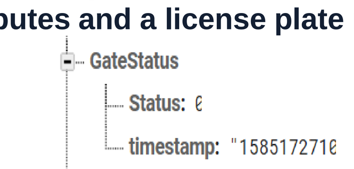


'Cars' Table

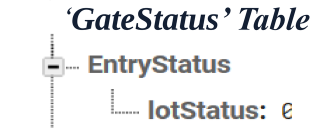
The 'ProximityData' structure stores raw proximity values sent from the VCNL4010 hardware device, and is retrieved by the mobile application to display the real-time proximity levels of the lot. 'Cars' table stores each registered vehicle attributes and a license plate number to identify the user.



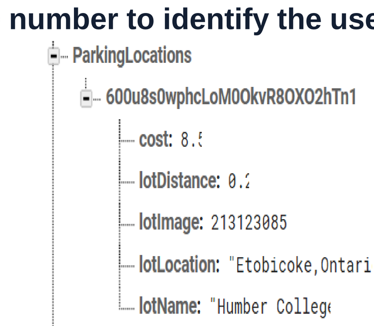
'Orders' Table



'GateStatus' Table



'EntryStatus' Table



'ParkingLocations' Table

'Orders' table stores the payment processing details of the user using a OID(foreign key) to identify the order. The 'GateStatus' table stores IR Break Beam entry/exit status and a timestamp to indicate the exact time an action is performed. The 'EntryStatus' table stores a value of 0 each time the lot is full to track the overall status. The 'ParkingLocations' table stores parking lot details under the specific UID of the current user.

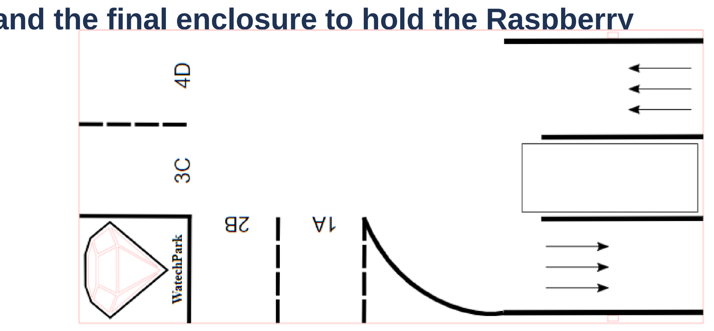
The 'AdminControl' table stores the status of the gate and sends a value of 1 or 0 to indicate an opening or closing of the barrier.

PRINTING

Enclosure/Prototype:

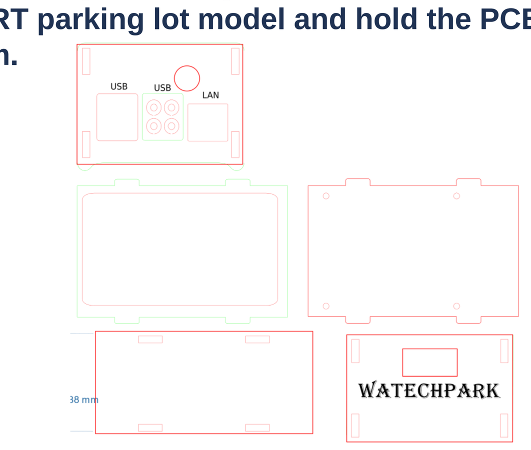
The enclosure would have been set to have a parking lot prototype along with the Raspberry Pi/PCB attached to the center of the entrance and exit. This design would have been used to house the Raspberry Pi platform/PCB components, serving as solid protection from any outside harm and ensuring the safety of the project assembled. The following visuals below, showcase the end design of the SMART parking lot prototype and the final enclosure to hold the Raspberry Pi/PCB unit .

Parking Lot Prototype Design(Inkscape)



As shown above, between the entrance and exit there is available space for the Raspberry Pi and the sensors attached. The sensors/effectors would go through under the parking lot and connect back to the space allotted. The IR Break-Beam sensors are connected to the entry and exit. The VCNL4010 proximity sensor is located at Slot 1A, which would be connected through a wall and attached facing the parking spot to detect the presence of a car approaching the spot. The camera would have been attached to a bar over the entry to scan the license plate on top of the car. The enclosure was designed using the CorelDraw software. The enclosure would clip onto the SMART parking lot model and hold the PCB in place with the Raspberry Pi platform.

Final Enclosure Design(CorelDraw)



CONCLUSIONS: (Next Steps)

The WatechPark IoT capstone project was developed to address the consumer demographic by determining a alternative method in regards to payment for parking, capacity management, and real-time information gathering. During the course of fifteen weeks, we have worked extensively on designing, developing, and integrating hardware/software components in preparation of unit testing, mass production testing phases, and, overall refinement. Therefore, through the combined effort of all team members, we have successfully achieved our proposed objective by creating an alternative parking lot management system, to assist with everyday consumer occurrences and parking situations.

Future steps may include, a more compact PCB design to accompany the use of the two servo motors. Thus, reducing the overall footprint size of the project by a more considerable amount and allowing further room for improvement in terms of hardware use/capabilities. Other possible additions, may include adding support for each available parking spot on our prototype model. This would require the use of a I2C multiplexer to allow individual VCNL4010 proximity sensors to be positioned at each parking space, rather than the current single VCNL4010 device. Additionally, support for the Android mobile application can include future modifications to allow room for a full 'admin' login mode as initially planned, providing the admin user the ability to view advanced metrics/ live data.

ACKNOWLEDGEMENTS

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