SPL

Smart Parking Lot

andrewhlu.com/spl

Problem

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Drivers spend too much time in parking lots trying to find an open space. Many parking lots only have per-floor capacity indicators, and existing solutions are prohibitively expensive.

What if we could utilize low-cost sensors and a companion application to navigate drivers to empty parking spots faster, at a low cost to facility owners?

Solution

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Our aim is to create a **small, inexpensive wireless device** that will be placed on each parking spot, capable of lasting **five years on a single charge**. Each device contains a **vehicle-detecting sensor** that can detect whether a car is parked in that particular spot. The devices are all connected using a **low-power communication protocol** to a central gateway device. This gateway device propagates sensor data to the Internet, which allows users to view parking spot availability through a **mobile application or website**.

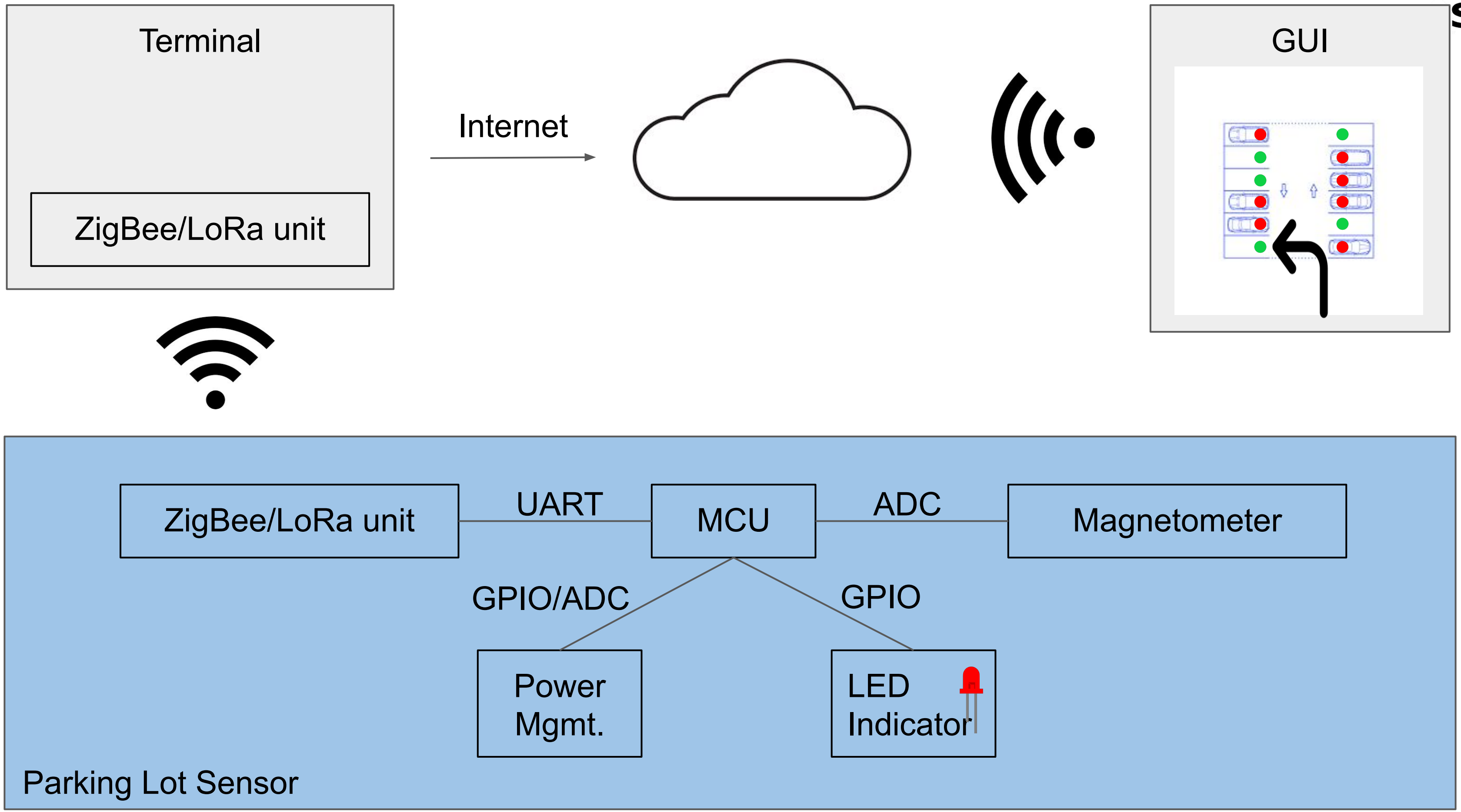
Roles

Short-term Responsibilities:

- Finn L. and Luyao H. - Vehicle detection sensor research
- Andrew L. and Jun C. - Communication module research

Long-term Responsibilities:

- Andrew L. - Parking Lot Terminal / Gateway
- Finn L. - Wireless Communication Firmware
- Luyao H. - Sensor Firmware / PCB Design / Power Management
- Jun C. - GUI / Path Finding Algorithm


Terminal
ZigBee/LoRa unit
Internet
GUI
ZigBee/LoRa unit
UART
MCU
ADC
Magnetometer
GPIO/ADC
GPIO
Power Mgmt.
LED Indicator
Parking Lot Sensor

Vehicle Detection Methods

- Sensing Technologies
  - Magnetometer
  - Ultrasonic
  - Infrared
  - Light Grid
- Magnetometer
  - Magnetoresistive (inductive)
  - Hall Effect
  - Differential Hall Effect
- Sensor Attachment
  - Power Consumption
  - Maintenance

Vehicle Detection Methods

	Max Sensing Range	Size of Target	Mounting	Power Consumption	Environment Noise
Wireless Magnetometer	Depends on the size of target	All sizes	Can be installed above or below grade	comparatively low	Relatively stable
Wireless Ultrasonic Sensor	4 meters	All sizes	Must be mounted overhead	Comparatively high	Relatively stable
Radar Sensor	<50 meters	Large, predictable targets (e.g. trains)	Minimum of 6 feet from target	Need power outlet	Relatively stable
Optical Sensor (Infrared)	<100 meters	5 millimeters or greater	Requires mounting for both emitter and receiver	Comparatively low	Sensitive to ambient light, sunlight
Measuring Light Grid	<2 meters	All sizes	Requires mounting for both emitter and receiver	Need power outlet	Sensitive to ambient light, sunlight

Communication Protocols / Modules

	Max Transmitting Range	Frequency (Potential Interference)	Data Transmission Rate	Power Consumption	Part(s) Used for Testing
Zigbee	10-100 meters	2.4 GHz	250kbps	2.96 J	STM32WB55 Nucleo Pack
LoRaWAN	2-15 kilometers	433 MHz, 868 MHz, 915 MHz	0.3-50 kbps	3.50 J	ESP32 LoRa 32 (V2) Development Board STM32L053R8 Development Board NUCLEO-LRWAN1 Expansion Board
WiFi	50 meters	2.4 GHz, 5 GHz	150-200 Mbps	5.00 J	N/A
Bluetooth Low Energy (BLE)	50-150 meters	2.4 GHz	1 Mbps	4.5 J	N/A

Due to concurrent device limitations, power consumption concerns, and transmission range, we are starting with the Zigbee and LoRaWAN communication standards.

Power Management IC (PMIC)

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LP3905

- -.2V to 6V range
- 0 to 600 mA range
- Used typically for low power handheld devices
- 2 Buck Regulator (DC2DC step down voltage/Step up current)
- 2 LDO (Low Dropout Regulator)
- No Recharge

Schedule

Fall Quarter, Week 8	**Finalize Initial Parts List**
Fall Quarter, Week 10	**Initial Circuit Design**
Winter Quarter, Beginning	**Initial Prototype**