kerby — *your curbside parking buddy*

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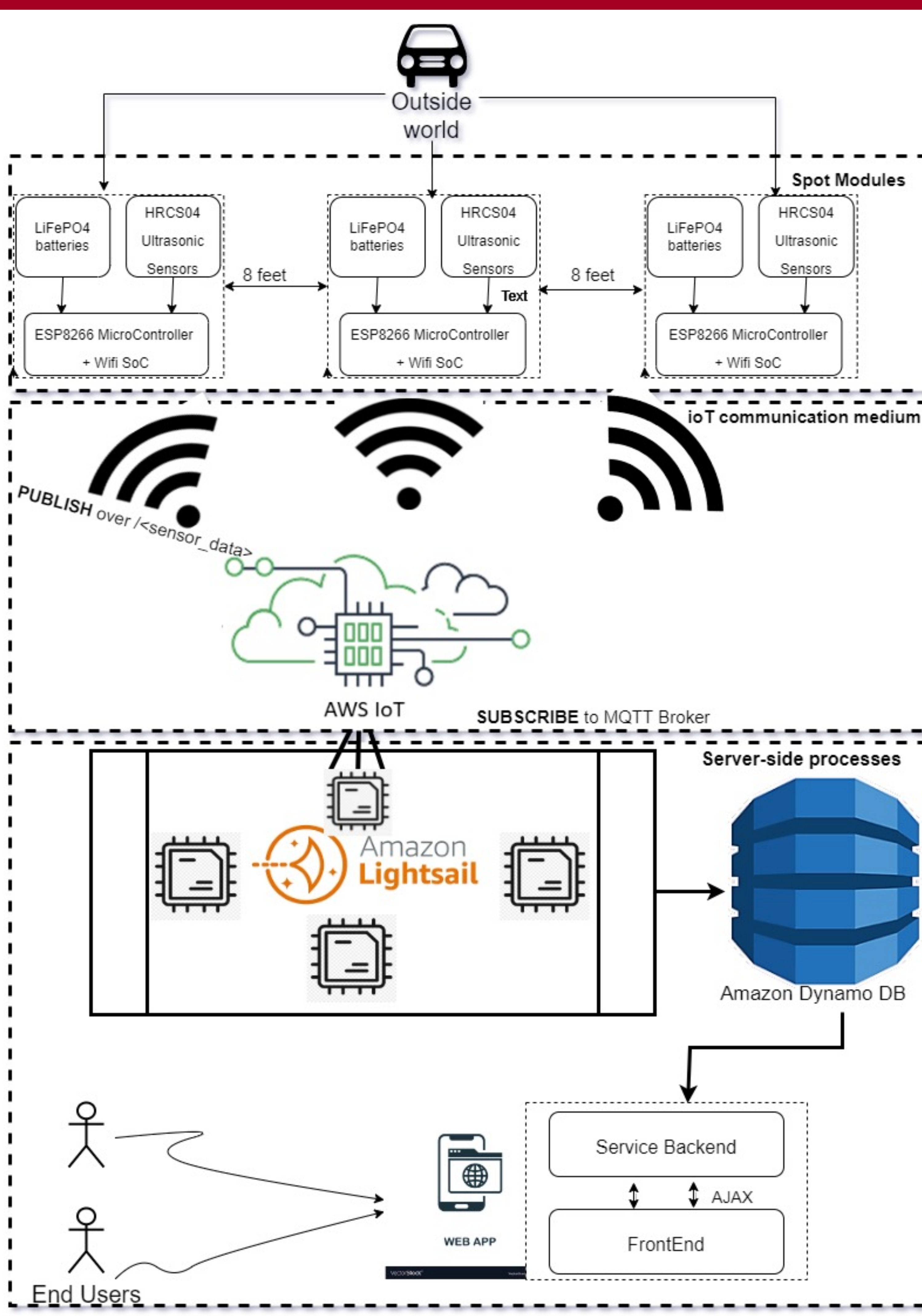
Product Pitch

Kerby is an innovative smart city solution meant to tap into the benefit of parking as it exists in our current civil infrastructure by bringing it online. The network built through Kerby's non-invasive and scalable technology makes an easy-to-install tool available to cities and their residents for modernized parking management.

As *your* curbside parking buddy, Kerby was designed to be useful by most drivers on the road; since the average car measures 14.7 feet long, our final system **points to open spots for vehicles measuring under 16 feet in length**. Similarly, Kerby is usable by anyone as our web application is **accessible on any platform** and has a **user-tested interactive design**. User satisfaction through high location accuracy was met through **use of the reliable Google Maps API**. Burden on current infrastructure was avoided by making modules **not requiring battery changes for six months** as well as keeping a focus on future scalability through modules costing **less than $60 per spot**.

System Architecture



Conclusions & Additional Information

http://course.ece.cmu.edu/~ece500/projects/s22-teamc1/

Kerby, our small-scale proof of concept for the online management of smart city parking systems is very promising threefold:
i) **cost savings** ii) **real-time data sharing** iii) **algorithmic solutions for traffic control.**

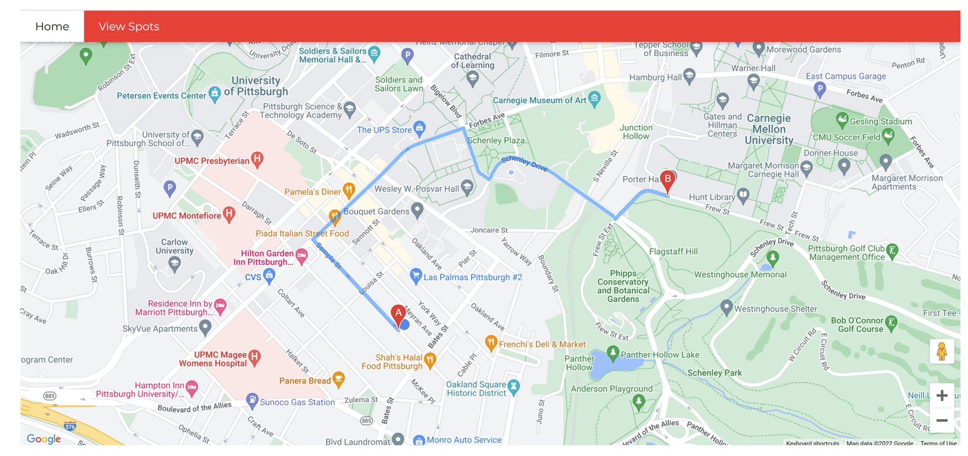
For future efforts, we would like to see our implementation expanded to test more features on a larger scale, including but not limited to:

1. Sensor coverage over a local municipality or state to test network robustness
2. Implementation in rural communities to explore non-WiFi connectivity (e.g LoRAWAN)
3. Exploring other dynamic parking allocation algorithms and their cost analysis

System Description

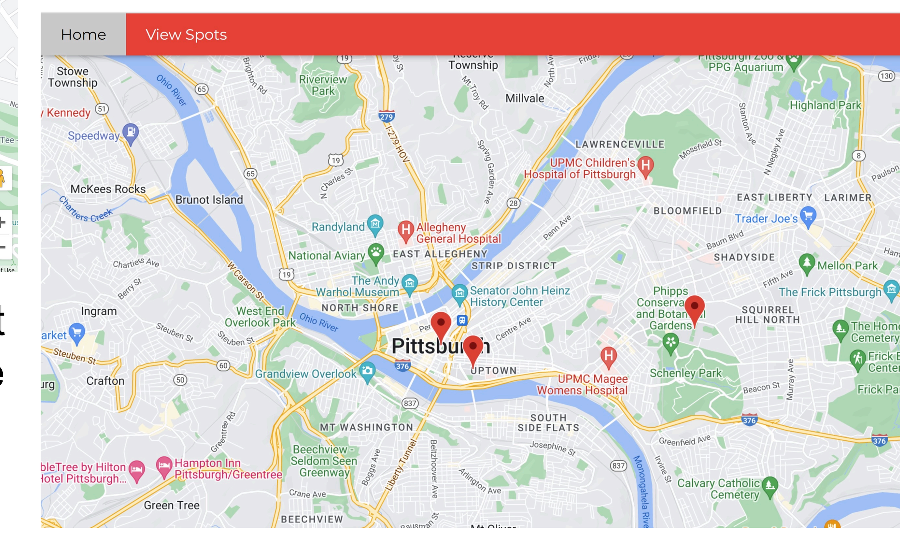
The overall system has three key components: sensing IoT hardware installed on the curbside (called spot modules), an information warehouse stored on the cloud, and the user interface web application.

Kerby has two modes: requesting a spot and viewing all spots.

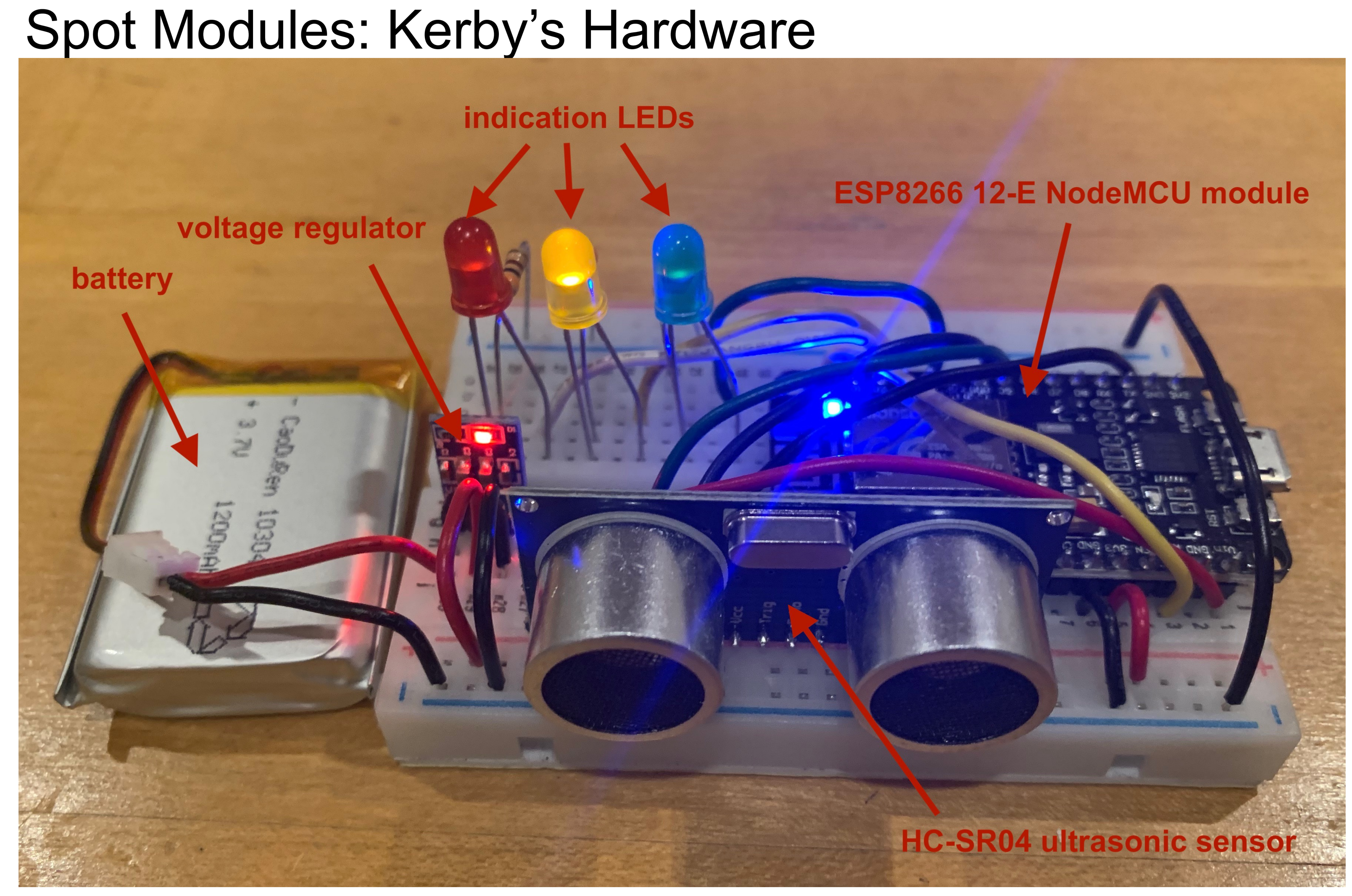


Request: In this mode, the user can request Kerby to give them directions to a curbside parking spot near their destination.

Viewing: In this mode, the user is able to view Kerby's spot modules (locations and availability) on an interactive map.



Spot Modules: Kerby's Hardware



Kerby's spot modules are placed on the curbside, distanced at 8 feet apart. When 3 sensors are detected as free, then an open spot is determined and displayed on the web page.

System Evaluation

Table 1: Testing Results

Requirements	Measurements	Goals	Results
Accurate parking location	Distance between provided location and actual parking spot in real world	< 30ft	✓ < 10ft
Relatively cheap for scalability	Compare to cost of regular parking meters	< $50 per spot module	Per sensor < $20 Per spot module < $60 on average
Easy-to-use web app	Usability Testing	> 3.5/5 stars on average	✓ 4/5 stars on average
Reliable & long-lasting sensor modules	Battery Life *(h)* = Battery Capacity *(Ah)* / Load Current *(A)*	~ approx. 6 months	✓ ** scan QR code for latest results
"Real-Time" Representation	Request E2E Latency	< 5 min	✓ < 2 min

Table 2: Design trade-offs in choice of detection, computing, and transmission devices

Computing Device + Sensing Device	Total Cost
Jetson Nano with Camera	$120 + $26 = $146
Raspberry Pi Zero W Camera Pack	$45
NodeMCU ESP8266 with HC-SR04 Ultrasonic sensor	$6 + $2 = $8

In addition to the design trade-off exploration between computing and sensing devices, building Kerby required discussion of trade-offs between power sources, computing algorithms, and types of sensors. On the testing side, trade-offs between different sleep/wake-up times for the ESP8266 12-E modules were explored. Additionally, the spacing between modules was varied in order to conclude that 8 feet was the best distance for our use-case of vehicles under 16 feet in length while still returning the most accurate number of spots available where our sensors were positioned. Interactive results are available on our website (scan the QR code).

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