



Carrel Corral

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Background

Problem

Finding study space at Hunt Library is a frustrating challenge, especially in the study carrels on the 3rd floor.

Solution

Engineer a low power system that shows live table availability, accessible via a mobile app.





Use Case

- Providing a reliable system to check space availability in Hunt Library, both remotely and in person
- Mapping study spaces to track desk use and assist library staff
 - Aggregating and providing data on traffic and volume
 - Notifying library staff to clear desks with belongings left unattended for long periods of time
- ECE Areas:
 - Mobile App - Software Systems
 - Sensor System - Hardware Systems



Research

- Mapped usage of the library at several different times of day
- Conducted a user study to find students' preferred format of availability mapping

25%

of study carrels were “reserved” by a student’s belongings without the student being present

- Analyzed existing systems - i.e. parking garage sensor systems
- Testing the effectiveness of several sensor combinations



Requirements

Technical

- 90% accuracy of the sensor system
- Max delay of 1 minute for LED indicator to update occupancy change
- Max delay of 5 minutes for app's displayed availability

Visual

- Non-intrusive and visually straightforward mapping
- Seamless integration of physical system in the library and mobile system with Andrew ID authentication



Solution Approach – Overall

- Physical system
 - Array of sensors mounted on the ceiling, above each study carrel
 - Sensors communicate with a low power sensor hub that aggregates and delivers data to the mobile app over WiFi
 - LED indicators: red (occupied) or green (available)
- Software system
 - Mobile app -- most accessible mechanism for students on the go
 - Secured with Andrew ID authentication



Solution Approach – Sensor System

- Combination of thermal and proximity sensors
 - Passive infrared sensor
 - Ultrasonic proximity sensor
 - Capacitive proximity sensor
- Capabilities:
 - Detect the presence of a person in an single carrel
 - Detect the presence of belongings on the desktop without a person present
- Still researching and analyzing the cost effectiveness and accuracy of dozens of sensors



Testing, Verification, and Metrics

Out of 100 tests:

- False positives and negatives should be less than 10
- Average update time is 60 seconds for the LED and 5 minutes for the app map

Based on a user study:

- App's user interface must be intuitive, accurate, and accessible



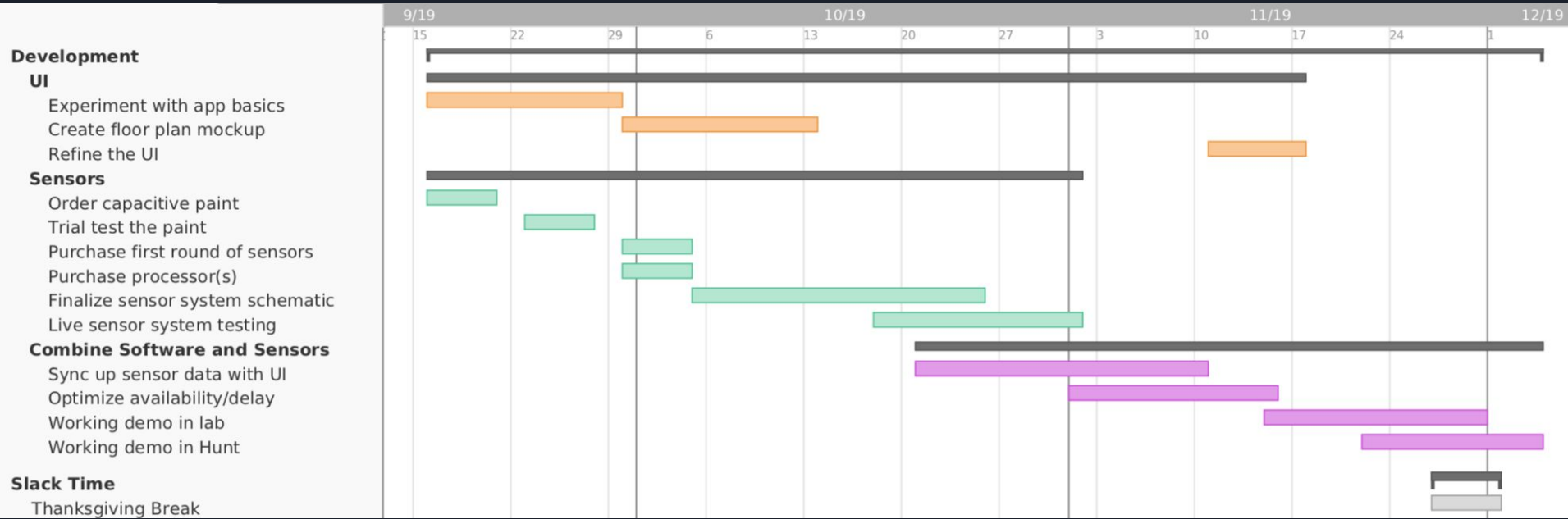
Tasks and Division of Labor

Tasks

- Research sensors and conduct user studies
- Design sensor hub
- Create a budget for equipment
- Design and create the iOS app
- Build and test the hardware
- Integrate the hardware and software portions of project

As a two person team, almost all tasks are equally shared, with Charlotte leading the hardware design and Alisha leading the software design.

Schedule





Challenges

- Designing a user-friendly and reliable mobile app
- Balancing real-time accuracy with maintaining a low power system
- Effectively mapping the space to maximize occupancy accuracy
- Choosing sensor products that make our in-lab MVP scaleable to all of Hunt



Stretch Goal

Install our system in Hunt, even at a small scale

- Test the effectiveness of our design in a live setting
- Understand the viability of our implementation
- Evaluate the cost of installing at scale