# Modularized Locker

Team 61
Jack Davis
Jake Pu
Josh Nolan

# Package Theft: A Mounting Issue

Package theft is a common problem both in the US and abroad. According to a recent survey, 43% of American consumers claim they have had a package stolen in the past year[1]. As ecommerce becomes more prevalent, porch piracy will only become more prevalent. In 2020, consumers spent $862.12 billion online. This represents a 44% increase from the previous year[2]

Initial Design VS Final Product
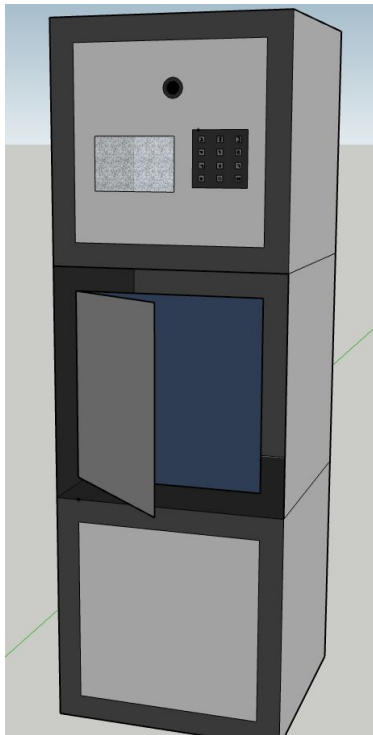
High–Level Overview

- Control Module
  - Real-time connection with cloud server.
  - Keep track of locker status.
  - Control all locker modules.
- Locker Module
  - Control lock.
  - Receive instruction from control module.
- Cloud Module
  - Store security images.
  - Backup all related data.
- GUI
  - Interact with user and delivery services.
  - Help owner setup lockers in first use.
- Website
  - Manage account information.
  - Monitor package status.
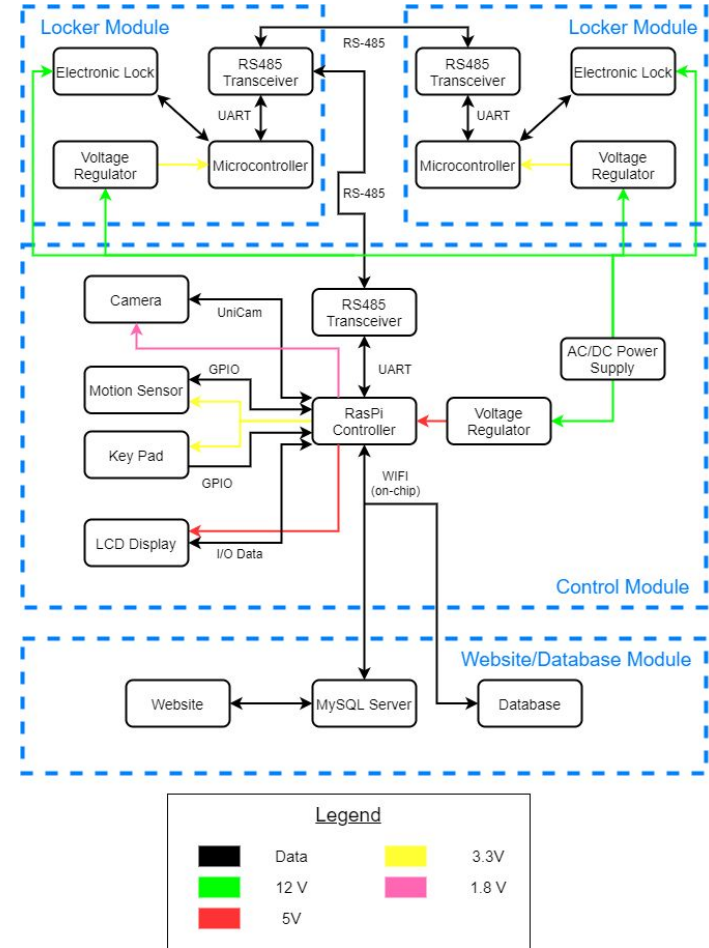
High-Level Requirements

- Connectivity
  - Local locker systems must be able to sync with the cloud server within 5 minutes. Synced data include security footage, pickup / deposit code and local locker information.
- Modularity
  - Locker system must have hardware and software support for multiple locker modules.
- Security
  - Locker system should protect user data, user packages, system information from physical, electrical and digital attacks.

Website Front End

EML

Registration

Your Name [   ] Email [   ] Password [   ] [Register]

Login

[Email...] [Password...] [Login]

Go to Profile

Welcome Josh Nolan!

Current Pickup and Deposit Codes

Pickup Code: 558289
Deposit Code: 682995
[Get new pickup and deposit codes]

Packages Ready for Pickup

You do not have any packages ready for pickup

Admin Information

Current Admin Password: 363987
[Get New Admin Password]

Website Back End

- The back end consists of a server, router with support for protected links, and queries to/from the mysql database
- The back end provides all of the user information necessary to the front end to support its functionality

Locker GUI
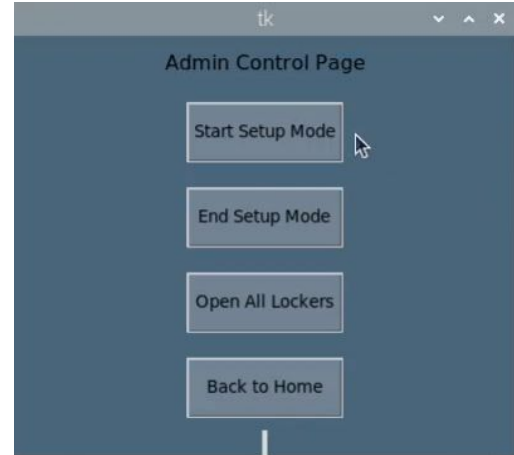
Locker GUI

- GUI provides clear instructions for package pickups and deposits
- Five pages (home, drop off, pickup, admin login, and admin) support all the functionality of the locker
- Only users registered through the website are able to open the lockers once packages have been deposited in them
- The admin page allows users given admin privileges to add new lockers to the system as well as open all lockers in the absence of wifi

Software Overview
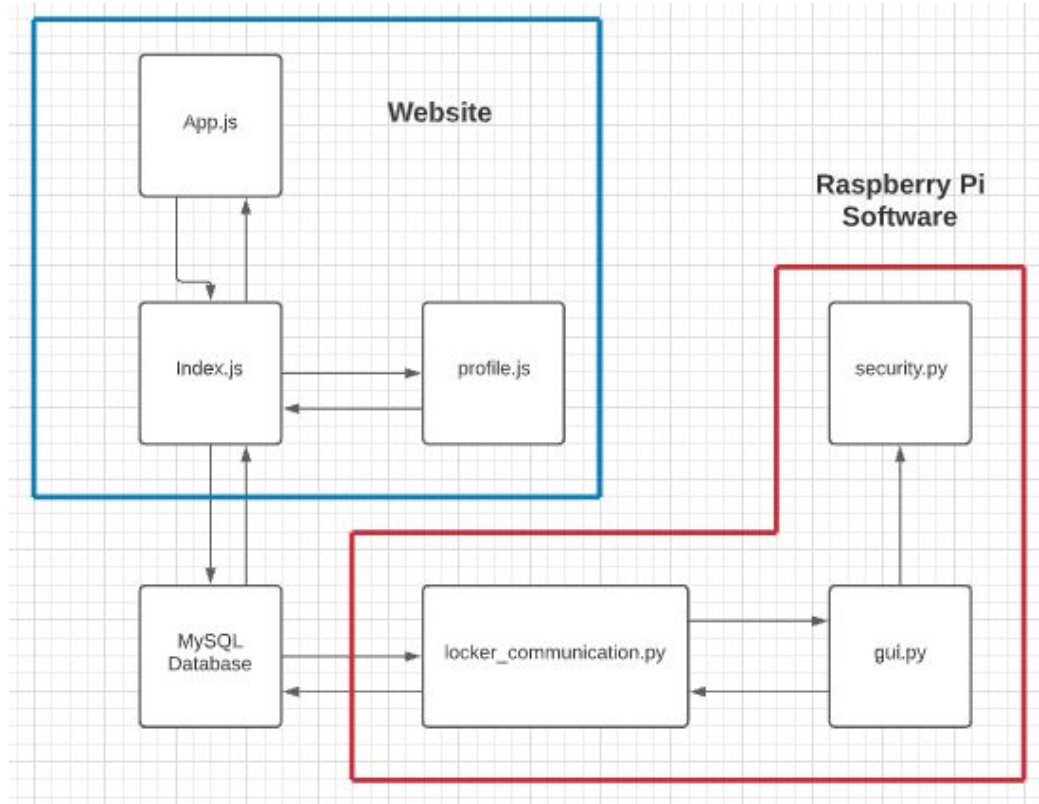
Modularity Using UART on RS 485

- RS485 can support up to 128 devices on the same bus (good for expandability) and transmit up to 4000 feet at 90Kbps without a repeater (good against EMI).
- Since RS485 is half-duplex, collision is avoided by designing proper state machine for all modules.
- Each locker unit can be identified with its MAC address.
- We implemented error detection by using UART parity check and frame check.
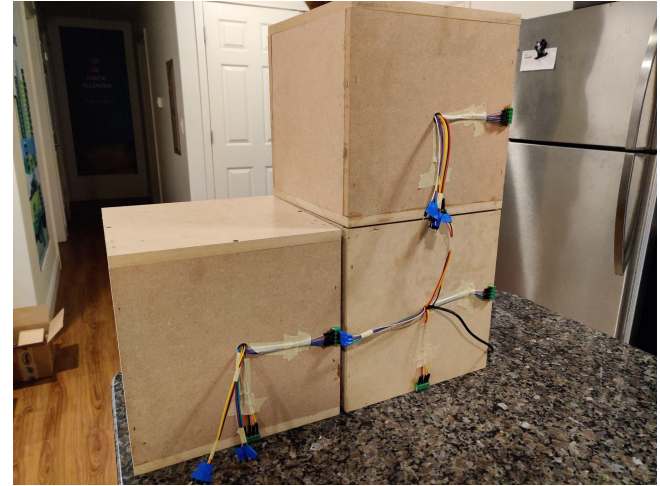
RS 485 Figures 1
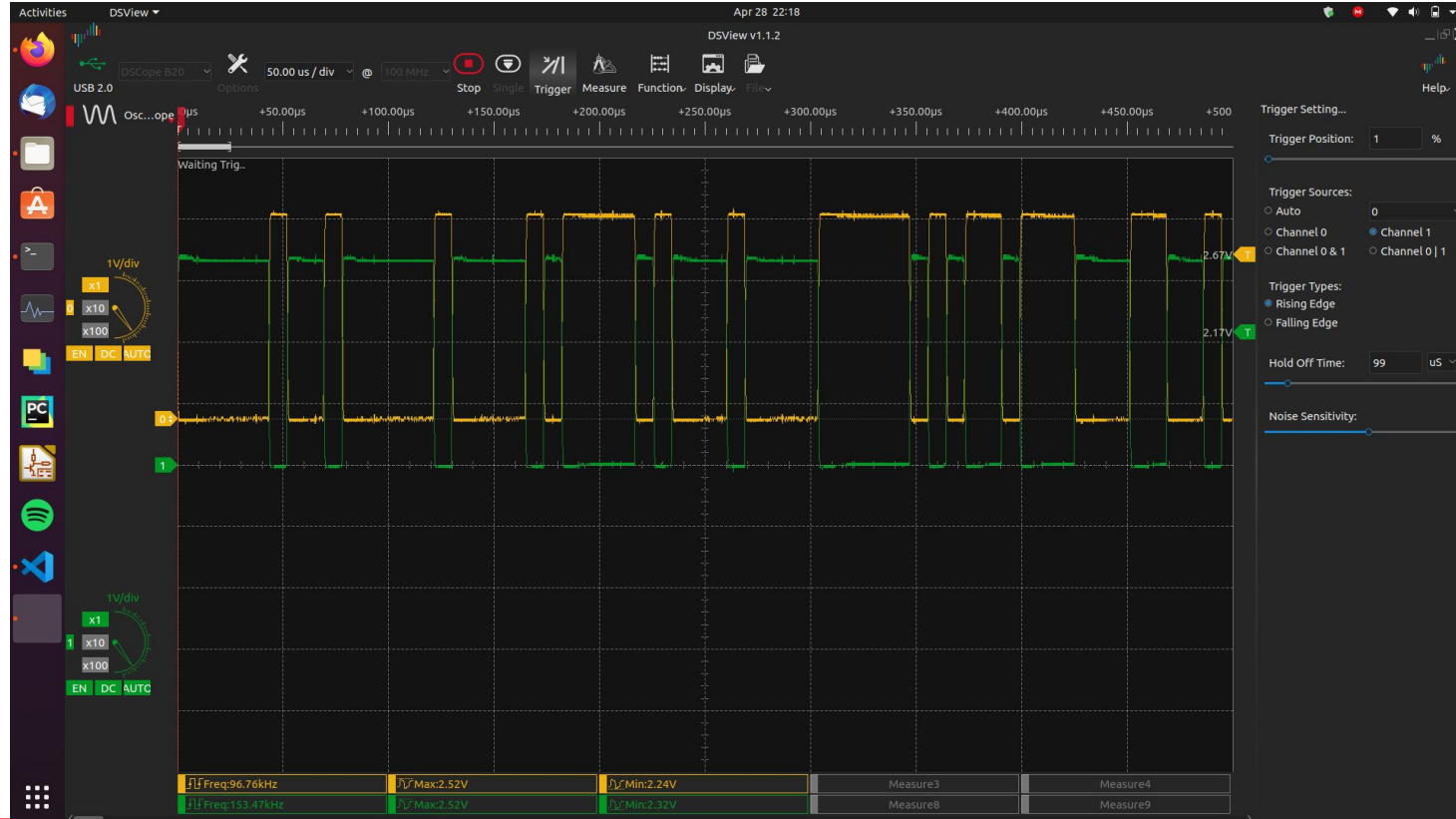
Security Across Design – 1

- Data Security
  - All of the data is stored in cloud and are password protected.
  - All source codes on local machines can be encrypted.
  - Data restoration is automated after a power outage.
- Communication Security
  - WiFi connection are encrypted by WPA2.
  - Locker data bus communication can be encrypted by AES.

Security Across Design - 2

- Electrical Security
  - Unused connectors are disconnected using jumpers.
  - 120V to 12V converter has overvoltage, overcurrent protection.
  - Data bus can withstand ±80V voltage and shorting.
- Package Security
  - Locker system is guarded by motion-triggered camera at all time.
  - Email notifications of package dropoff / pickup.
  - All lockers are locked when powered off.

Goals Accomplished

- User can sign up an account, check password, shuffle password, check package status on the website. All updates are real-time. Supervisor accounts need to be requested.
- Locker System can match deposit / pickup code to specific user, open available / occupied lockers, sync with server in real-time and send email notification to users.
- Security monitoring at all time.
- All data are backed up in the cloud and encrypted.
- Achieved electrical, digital, physical safety.

Things to Improve

1. RPI CPU usage is very high when it is running gui.py. The cpu would overheat and throttle leading to wrong keypad input.
2. Redesign our schematics and PCB to separate transceiver module, power module and MCU into distinct areas and outline them with silkprint for easier soldering.
3. Change UART on RS485 to I2C Differential. I2C is already a very mature protocol that supports multi-master multi-slave mode and handles collision elegantly. In this way, we can easily check the delivery status of the messages on the bus. The I2C addressing is also very helpful so that we do not have to do it ourselves.
4. Improve the reliability of keypad and touchscreen.

References

[1] PracticalEcommerce, 'Porch Piracy Is Growing', 2021. [Online]. Available:
https://www.practicalecommerce.com/porch-piracy-is-growing. [Accessed: 2-18-2021]

[2] Digital Commerce 360, US ecommerce grows 44% in 2020, 2021. [Online]. Available:
https://www.digitalcommerce360.com/article/us-ecommerce-sales/. [Accessed: 2-18-2021]

Further Info on Our Project

- ## GitHub Link
- ## YouTube Demo

Thank you!

The floor is open for questions