1 Introduction

1.1 Problem

College students frequently face the issue of bikes being stolen on campus. Even with the strongest of protections, they are not completely capable of deterring thieves who have various equipment. Our own member, Elizabeth, had her bike secured with a substantial solid steel U-lock, but was stolen regardless last fall, when someone apparently sawed through the u-lock at night.

In order to discourage bike theft, it would be useful to have a bike anti-theft device that could enable the user to track the bike's location wirelessly

1.2 Solution Overview

We propose a concealed bike anti-theft device that helps bikers prevent their bike from being stolen by unlocking to a specific RFID key (therefore difficult to mimic), providing GPS tracking so the user has the ability to track down the bike if stolen, and frightening away potential thieves with a loud noise when theft is detected.

The device will receive GPS coordinates and periodically transmit the coordinates over LoRa to be received by the user. To allow the bike system to differentiate between potential thieves and the owner, the owner of the bike will have an RFID tag such that while the user is on the bike, the RFID tag can be detected. If the bicycle is moved when the RFID tag is not nearby, it will trigger a loud and annoying alarm to scare away the potential thief.

The device will be designed in a manner such that it is difficult to find and remove, discouraging potential bike thieves from removing the bike. Additionally, the device will be designed to fit a relatively universal bike structure, which will allow the device to be attached to any bike. A standardized device will be more convenient for users as bikes with integrated tracking systems tend to be very expensive.

Our device will be small, rechargeable, battery-powered, and enclosed in a weatherproof enclosure that can easily be attached to most bikes.

1.3 High-Level Requirements

1. If a user tries to remove the bike from a stationary location without the RFID tag, the alarm will sound.
2. The device receives GPS data *at least* once per minute, and records its own position over time.
3. The device transmits its GPS location data and additional data over LoRa to be received by a base station.

2 Design

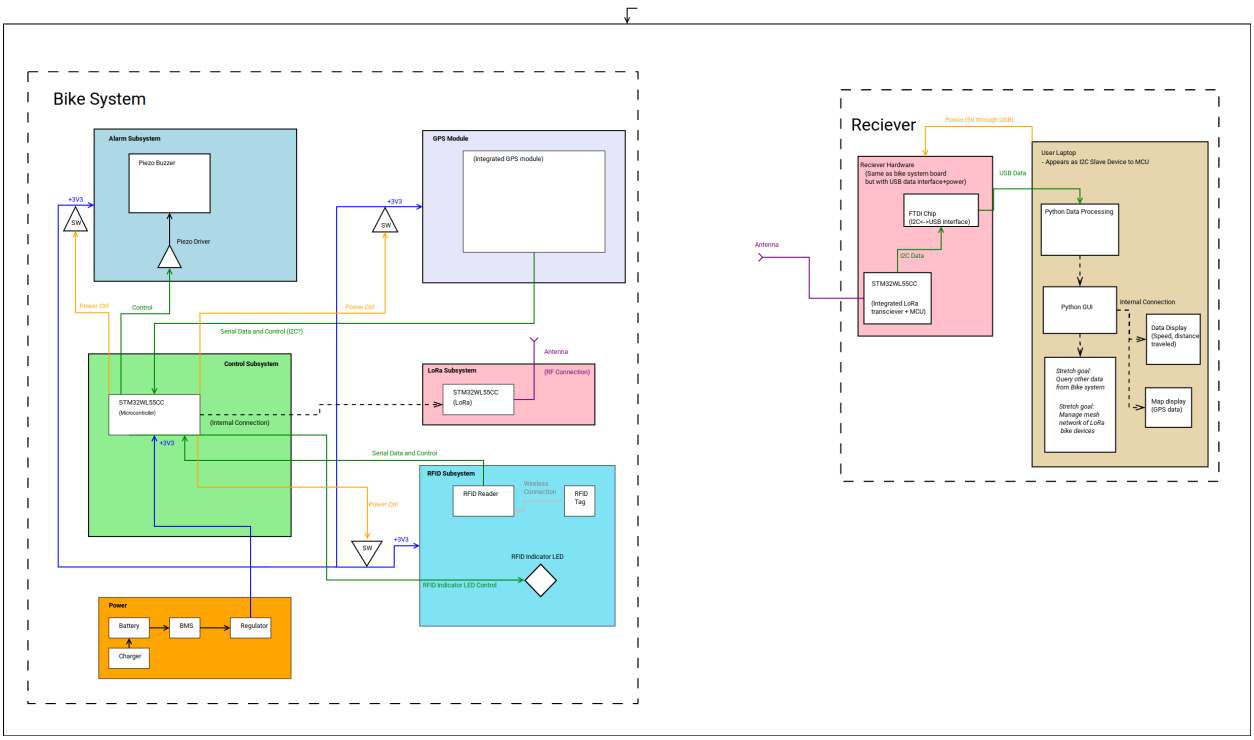

Figure 1: Full Block Diagram

References

[1] IEEE, "IEEE Code of Ethics," *IEEE*, 2022. Available: https://www.ieee.org/about/corporate/governance/p7-8.html. [Accessed: Feb. 10 2022].

[2] LoRa Alliance, "What is LoRaWAN: A Technical Overview of LoRa and LoRaWAN", 2015.

[3] GlobalSat. "GlobalSat GPS Module Hardware Data Sheet." Product No: EM-506. 2013. https://cdn.sparkfun.com/datasheets/GPS/EM506_um.pdf

[4] ID-innovations. "ID-3LA, ID-12LA, ID-20LA Low Voltage Series Reader Modules." 2015. https://cdn.sparkfun.com/assets/c/7/0/e/3/DS-11828-RFID_Reader_ID-20LA__125_kHz_.pdf

[5] Photograph by Julo, public domain, Wikimedia Commons Available: https://upload.wikimedia.org/wikipedia/commons/b/b1/BicycleRetroreflectors.JPG. [Accessed: Feb 10 2022].

[6] STMicroelectronics, "RF matching network design guide for STM32WL Series", AN5457, 2020.

[7] STMicroelectronics, "Multiprotocol LPWAN dual core 32-bit Arm® Cortex®-M4/M0+ LoRa®, (G)FSK, (G)MSK, BPSK, up to 256KB Flash, 64KB SRAM", DS13293, 2021.

[8] Wikipedia, "List of Battery Sizes", 2022. [Online]. Available: https://en.wikipedia.org/wiki/List_of_battery_sizes. [Accessed: 10 Feb 2022].