Problem Statement and Goals for SmartLock
4TB6 - Mechatronics Capstone

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Table 1: Revision History

Date	**Developer(s)**	**Change**
25-09-22	Steffi	Completed
19-11-22	Steffi	Updates for grammar, formatting and terminology
23-11-22	Steffi	Updates for consistency across documentation

Contents

1 Problem Statement

1.1 Problem

There are many problems associated with bike locks today. People often forget or lose their keys, lock or combination. Additionally, current locking systems are often not comprehensive – they may not lock all parts of the bike that can be stolen (the seat, front and back wheels and frame).

Furthermore, the problem stretches beyond the locking mechanisms; bike locks can be bulky, heavy and dangerous to carry around. The combination of these issues can lead to individuals leaving their bikes without properly locking them. The city of Toronto reports an average of 3625 stolen bikes annually, and the Canadian Cycling Magazine estimates that only 15-20% of stolen bikes are reported, indicating a rather expansive problem that needs to be solved [1, 2].

Our team presents the SmartLock, which is a bike lock that is locked/unlocked through a smartphone application. Users can secure their bikes automatically, eliminating the need for manual locking through keys or a combination. The application includes a geotagging component to locate the bike in case the user forgets where they locked (parked) it. Additionally, the SmartLock is intended to be mounted permanently on a bike frame, eliminating the need to carry a lock altogether. The sleek design will ensure that the lock is unobtrusive while riding.

1.2 Inputs and Outputs

Inputs	**Outputs**
SignalLock (to lock latch)	LatchLocked
SignalUnlock (to unlock)	LatchUnlocked
SignalOpened	LockOpened
SignalClosed	LockClosed
BatteryPower	BatteryPercentStatus
GeotaggedLocation	BikePosition

1.3 Stakeholders

Cyclists or aspiring cyclists who are interested in improving the efficiency, usability and security of locking/finding their bike(s).

1.4 Environment

Below is a list of the hardware and software needed to implement the solution to the problem.
Hardware:

- Physical Lock
- Lock Housing/Mount
- Chain (for external frame locking)
- Power Source
- Electromagnet
- Arduino with Bluetooth capabilities
- Positioning Sensors

Software:

- Smartphone App
  - Flutter App UI code
  - Integrated C code to communicate with the Arduino via Bluetooth

2 Goals

Goals	**Measurability**
Wireless communication and engagement/disengagement of bike lock	Quality and distance of signal strength
Effective bike lock	Lock functions, X amount of force before failure
Long lasting battery life	Time - in months
Fits on many different styles of bikes	Can easily be mounted to mountain bikes, city bikes, children's bikes and road bikes
Easily mount on bike frame	Does not require special tools for mount/dismount
Cross-platform implementation	Can be used on both an iPhone and an Android smartphone

3 Stretch Goals

- Integrating with fitness apps (ie. Strava) for increased capabilities
- Integrating the battery with a solar panel for self-charging to reduce user interaction with the lock further
- GPS location services to track the bike if it stolen
- The locking mechanism shall be able to disengage manually (e.g., with a key/fob), in addition to remotely

4 References

[1]"bicycle-thefts," data.torontopolice.on.ca. https://data.torontopolice.on.ca/pages/bicycle-thefts (accessed Sep. 25, 2022).
[2]L. Hansen-Gillis, "Bike thefts are increasing in Canada: Here's what you can do to protect your bike," Canadian Cycling Magazine, Nov. 04, 2020. https://cyclingmagazine.ca/sections/news/bike-theft-canada/ (accessed Sep. 25, 2022).