

Problem Statement and Goals for SmartLock

4TB6 - Mechatronics Capstone

Team #5, Locked & Loaded

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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
04-04-23	Steffi	Final Updates

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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 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

Table 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:

- Lock Housing - A CAD designed and 3D printed prototype that can house the circuitry and locking mechanism as well as support a chain and connect to the mount
- Locking Mechanism - A solenoid which when placed inside the housing has the ability to engage/disengage which effectively locks/unlocks the bike
- SmartLock Mount - A mount that connects to the bike and the lock so that it can be secured to the bike while riding and locked
- Chain - For external frame locking
- Battery - To power the circuit
- Arduino with Bluetooth capabilities - To connect to the app and control the solenoid

Software:

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

2 Goals

Table 3: Goals

Goals	Measurability
G1: Wireless communication and engagement/disengagement of bike lock	Quality and distance of signal strength
G2: Effective bike lock: The lock can't be forced open by hand or standard tools.	Lock functions, X amount of force before failure
G3: Long lasting battery life	Time - in months
G4: Fits on many different styles of bikes: Children's, Mountain, Road, and City	Can easily be mounted to mountain bikes, city bikes, children's bikes and road bikes
G5: Easily mount on bike frame	Does not require special tools for mount/dismount
G6: 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).