

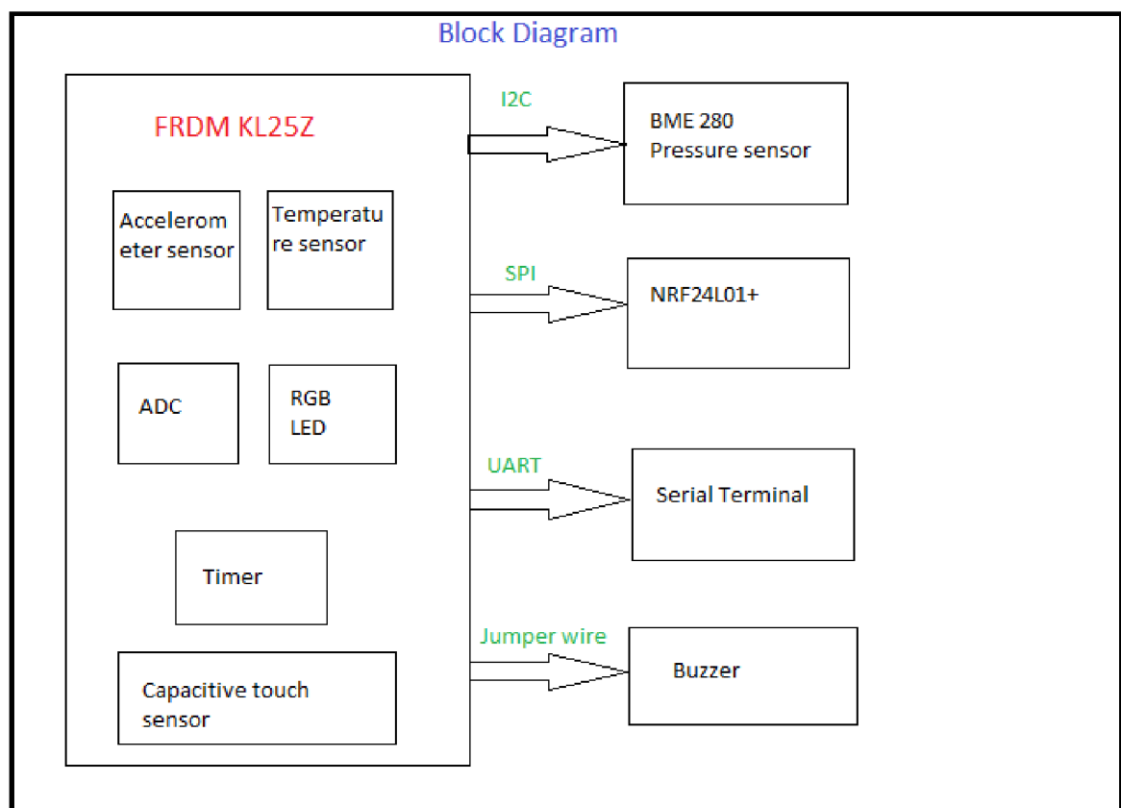
Project Proposal: Bike theft preventive system

Project Overview

Bicycle theft has become a huge issue on college campuses these days and CU Boulder is one among them. There is an estimate that one million dollars' worth bikes were stolen each year in Boulder and this rate is growing alarmingly high. The main attacks on the bike locks are bolt cutter, saw, drill, hammer and blow torch. Our project successfully detects these attacks and alerts user.

Purpose

- On board accelerometer of FRDM KL25Z detects saw, drill and hammer attacks and alarms the buzzer.
- A high pressure or fixed pressure tubes are assumed to be attached to the lock. A pressure sensor detects the change in pressure of tube if it is tried to cut using bolt cutter and the buzzer is alarmed.
- If the lock is attacked with blow-torch, an on-board temperature sensor detects the increase in temperature and alarm the buzzer.
- Capacitive touch sensor is used to activates these sensors which mimics the activation of smart lock.
- On board RGB LED is lit when an attack is detected.
- UART using serial communication take a pin to de-activate these sensors which mimics the



unlocking using a matrix keyboard.

- An alert is sent through NRF24L01P.

Hardware Block Diagram

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Future Goals:

- Transmit the state from FRDM KL25Z to Beagle Bone Black using nrf24 module
- Send an email alert to the user regarding the theft
- Unlocking the bike without a key which is done by connecting the Bluetooth(ATMEL SAMB11) and the mobile device of user.
- We will accomplish these goals after fulfillment of basic project requirements.

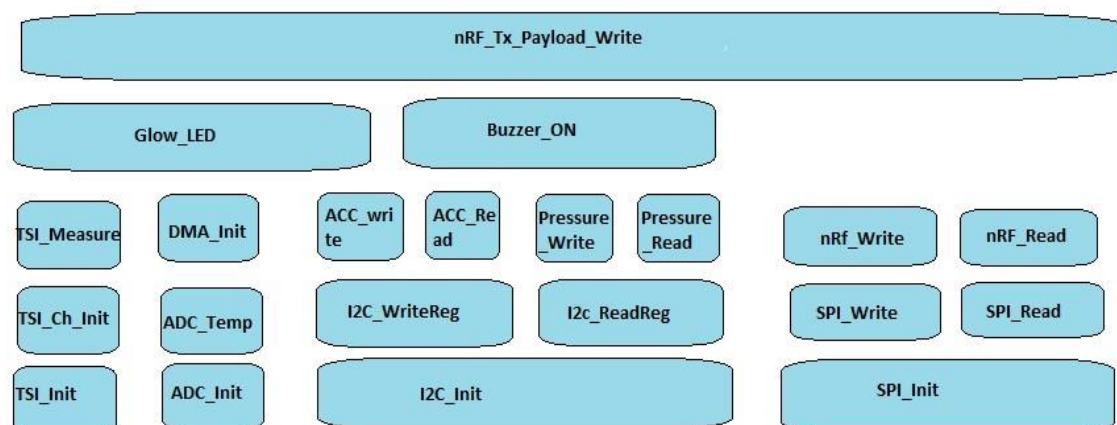
Key components used

- FRDM KL25Z.
- nRF24L01P.
- BME 280 Pressure sensor.
- Serial Terminal.

Responsibilities

	<i>Functionality</i>	<i>Person</i>
1	Temperature Sensor	Raghav
2	Accelerometer Sensor	Mounika
3	Capacitive Touch Sensor	Raghav
4	Pressure Sensor	Mounika
5	Nordic nRF24L01p	Both

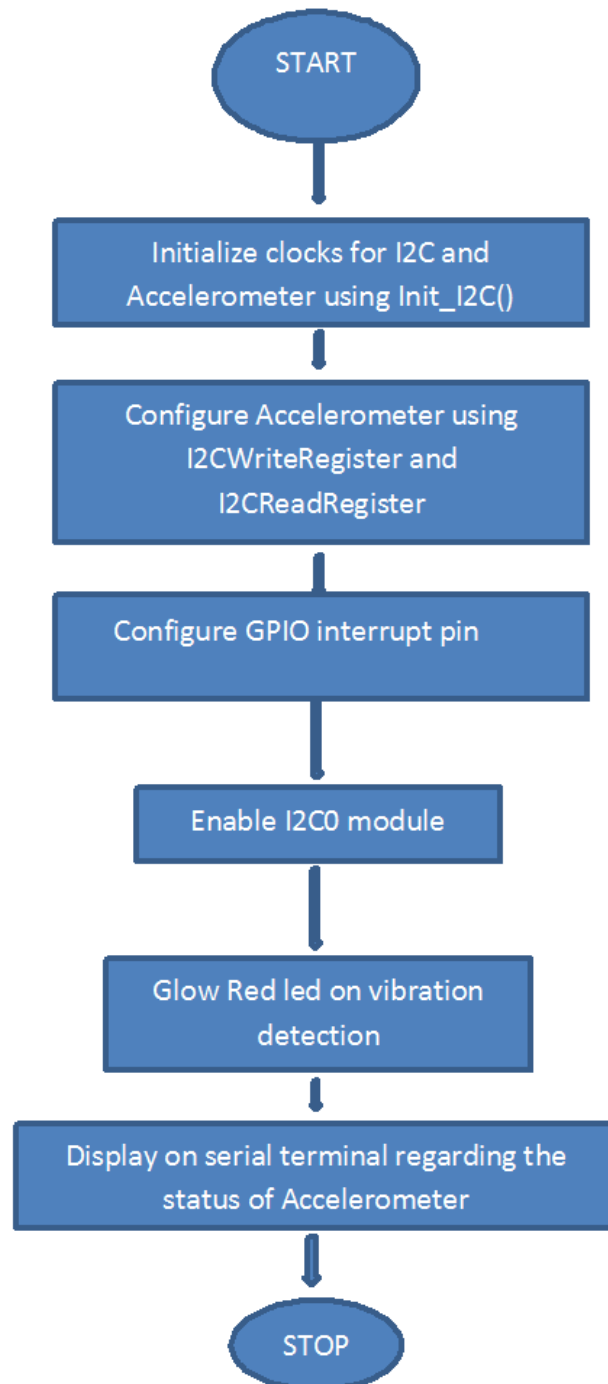
Software Architecture:



Software Architecture

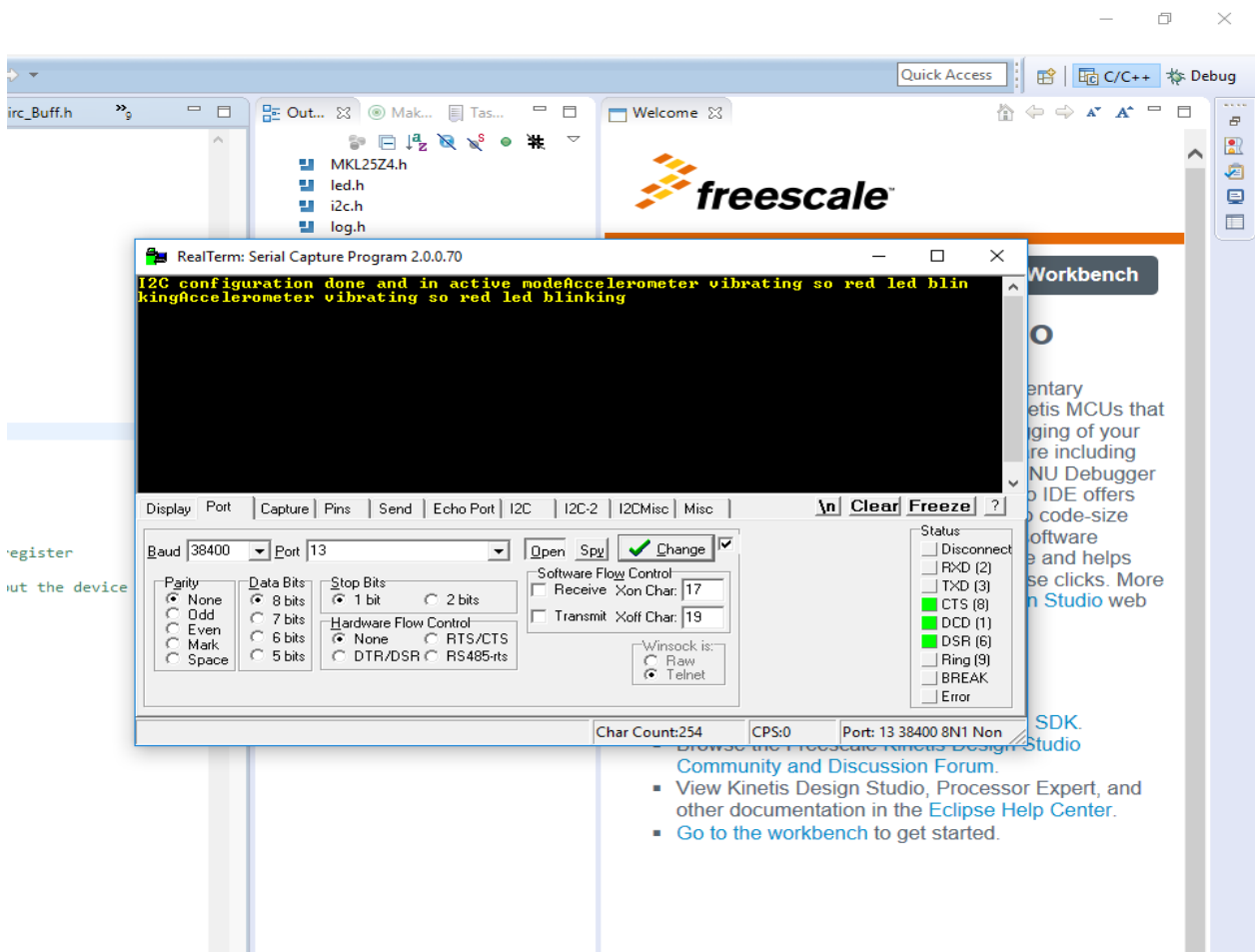
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Flowchart for Accelerometer Sensor Module:



Accelerometer is on board FRDM sensor which is MMAQ8451 which is an I2C based sensor which can be used for motion detection, freefall and transient detection. When someone is trying to steal the bike then they will try to cut the lock using saw or by drilling. So we are using accelerometer for vibration detection/Transient detection. Whenever a vibration is detected a Red Led is glowed and printed on the serial terminal regarding the status of accelerometer.

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Accelerometer status

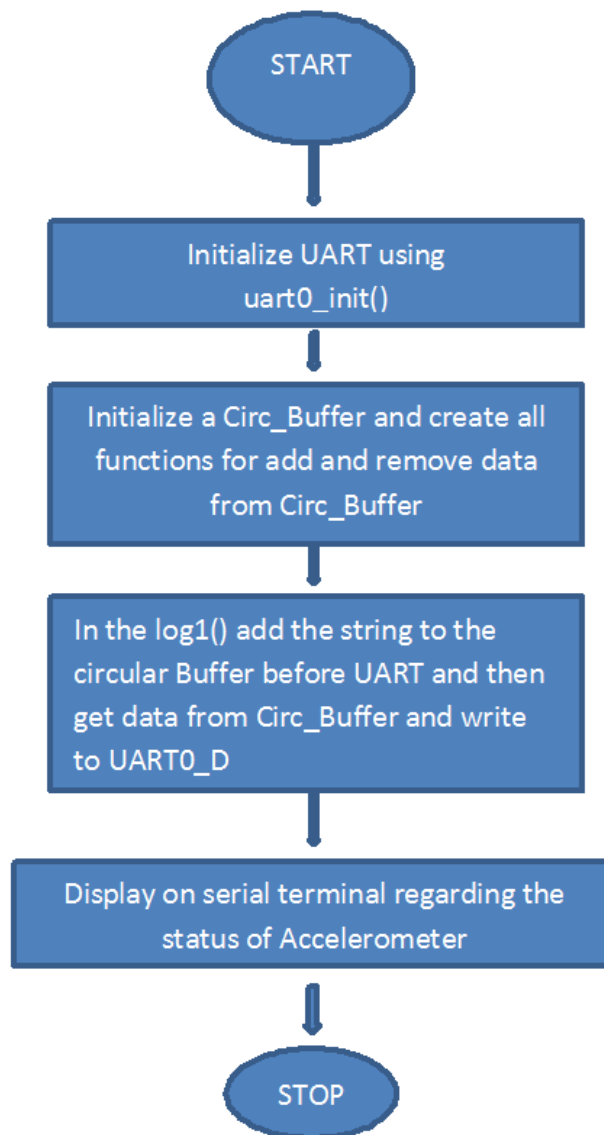
UART as a Logger

UART is a shared resource. It is used throughout the application for logging. If UART is used directly then the logging will be invalid data if an interrupt is generated during UART transmission. So we are using circular buffer to solve this issue if we add the data to be printed to the circular Buffer and then while transmitting send the data to serial terminal by getting the data from circular buffer which will solve this issue as until the data is read from buffer the TAIL pointer will not move forward and data loss issue will be resolved.

Log()->add_data()->get_data()->UART

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Flowchart for Logger Module:

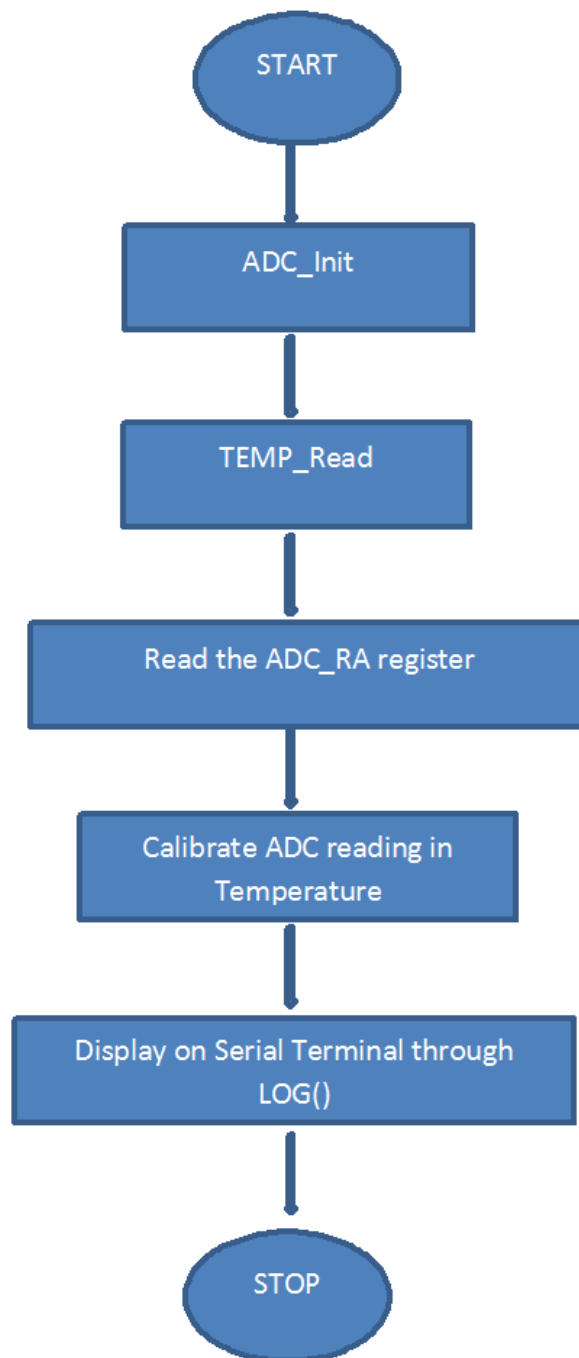


Temperature Sensor:

The other ways of stealing bike is the person can try to break the lock by using Blowtorch or Freeze the lock for it to break. So we need to detect the temperature changes so that we can notify the user regarding the theft. We are using on board temperature sensor which is an analog sensor. So we can use ADC and convert the data to analogous temperature. If the temperature change is greater than threshold then it should the user should be notified regarding theft.

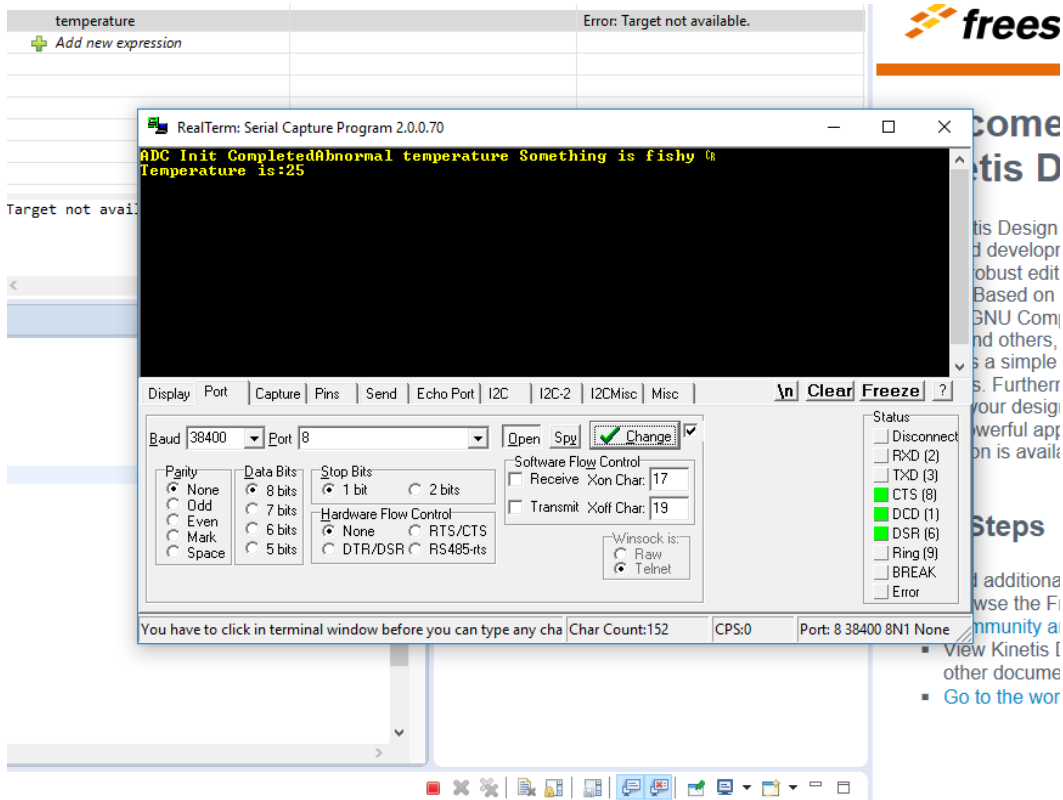
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Flowchart for Temperature Sensor Module:



I simulated the environment of theft by decreasing the threshold to 20 C. Then the user will get notified regarding the theft on the serial terminal.

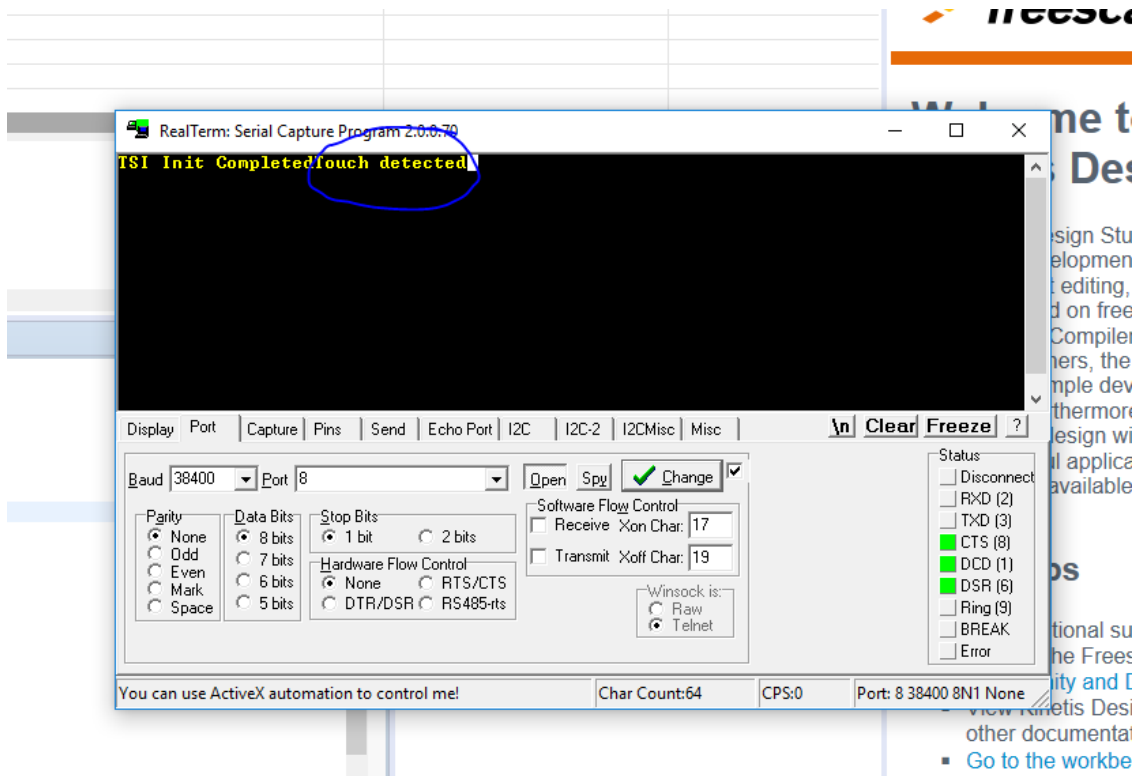
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Temperature sensor status

Capacitive Touch Sensor

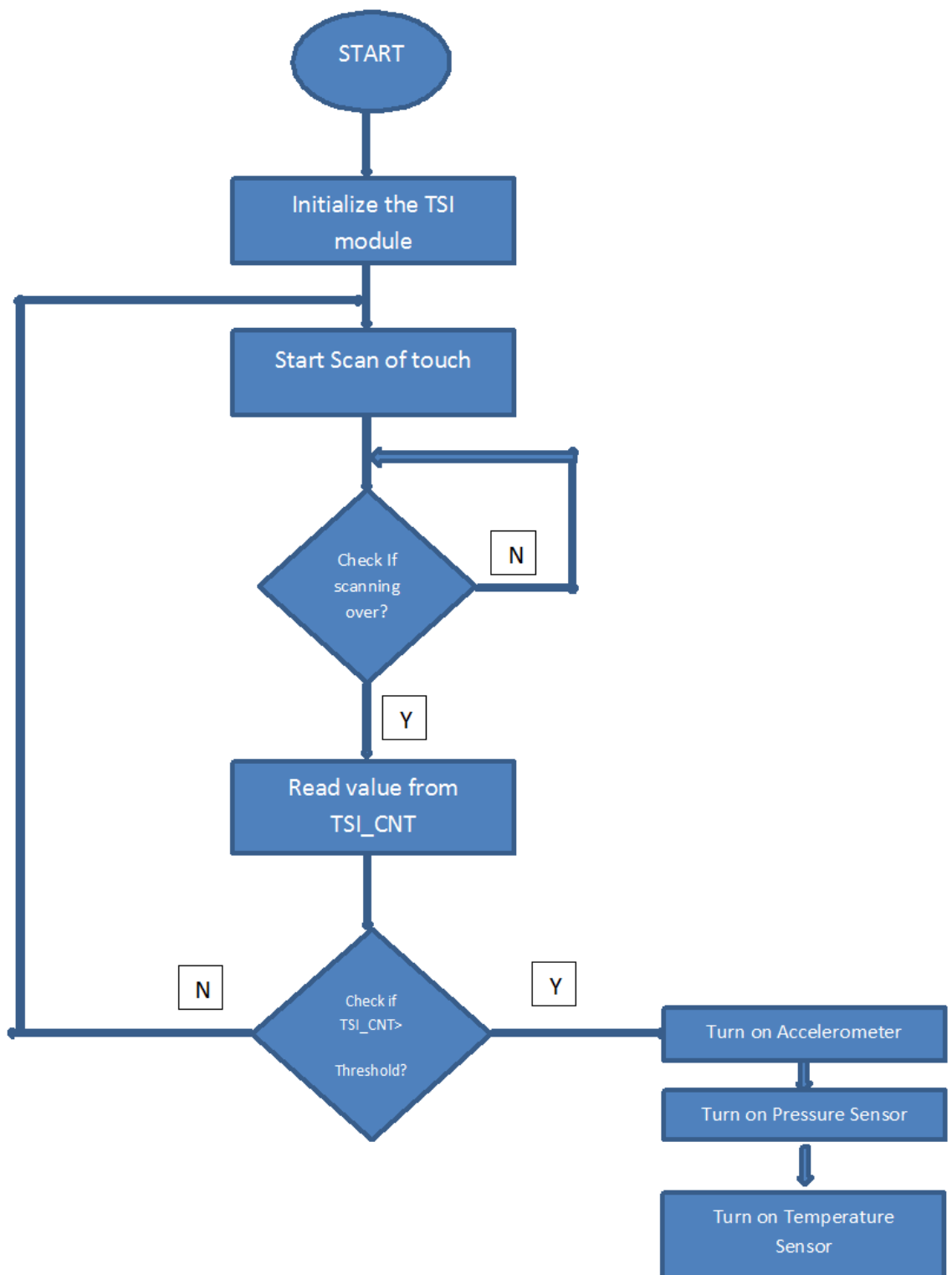
The Capacitive touch is used for making the device turn on and turn off. This gives the user can have the flexibility to switch the bike lock ON and OFF. The user when riding the bike lock is not required. When the user wants to lock to be ON. Then the user can just touch the lock which will make the Smart Bike Lock ON.



Capacitive Touch Sensor Status

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Flowchart for TSI Module:



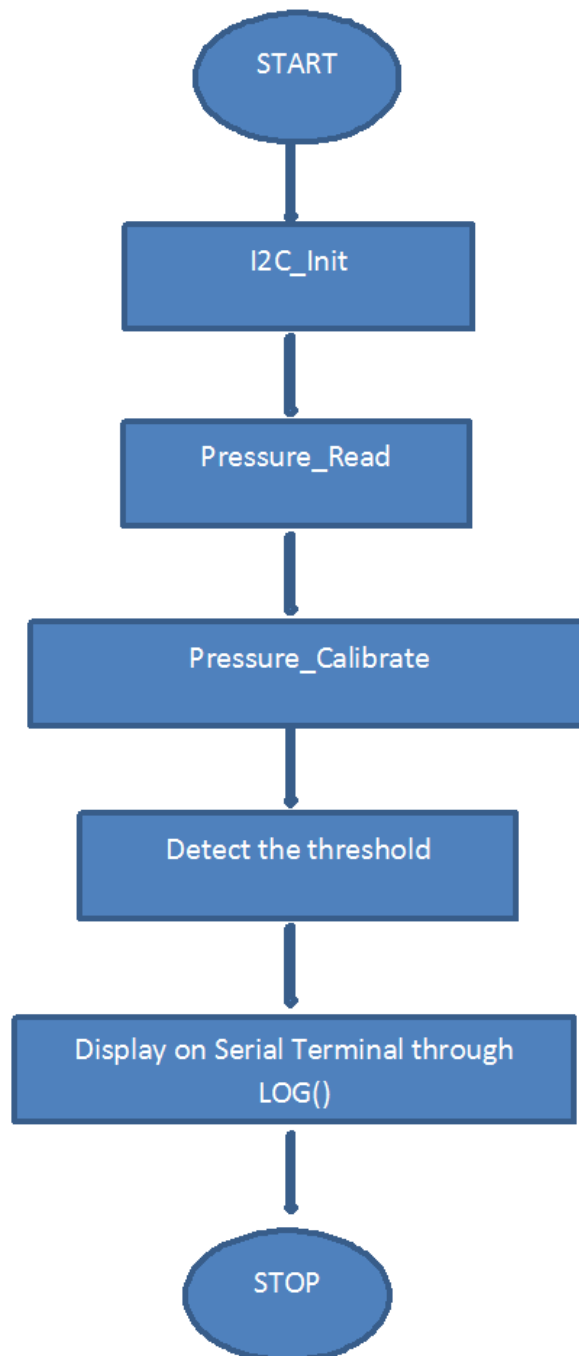
Pressure Sensor:

The bike lock has 2 components a single block and wire which is connected at 2 sides of block. So the theft of the bike can be done by trying to cut the wire. Using a pressure sensor as the pressure inside the wire changes when someone tries to cut the wire. So using pressure sensor we can detect the

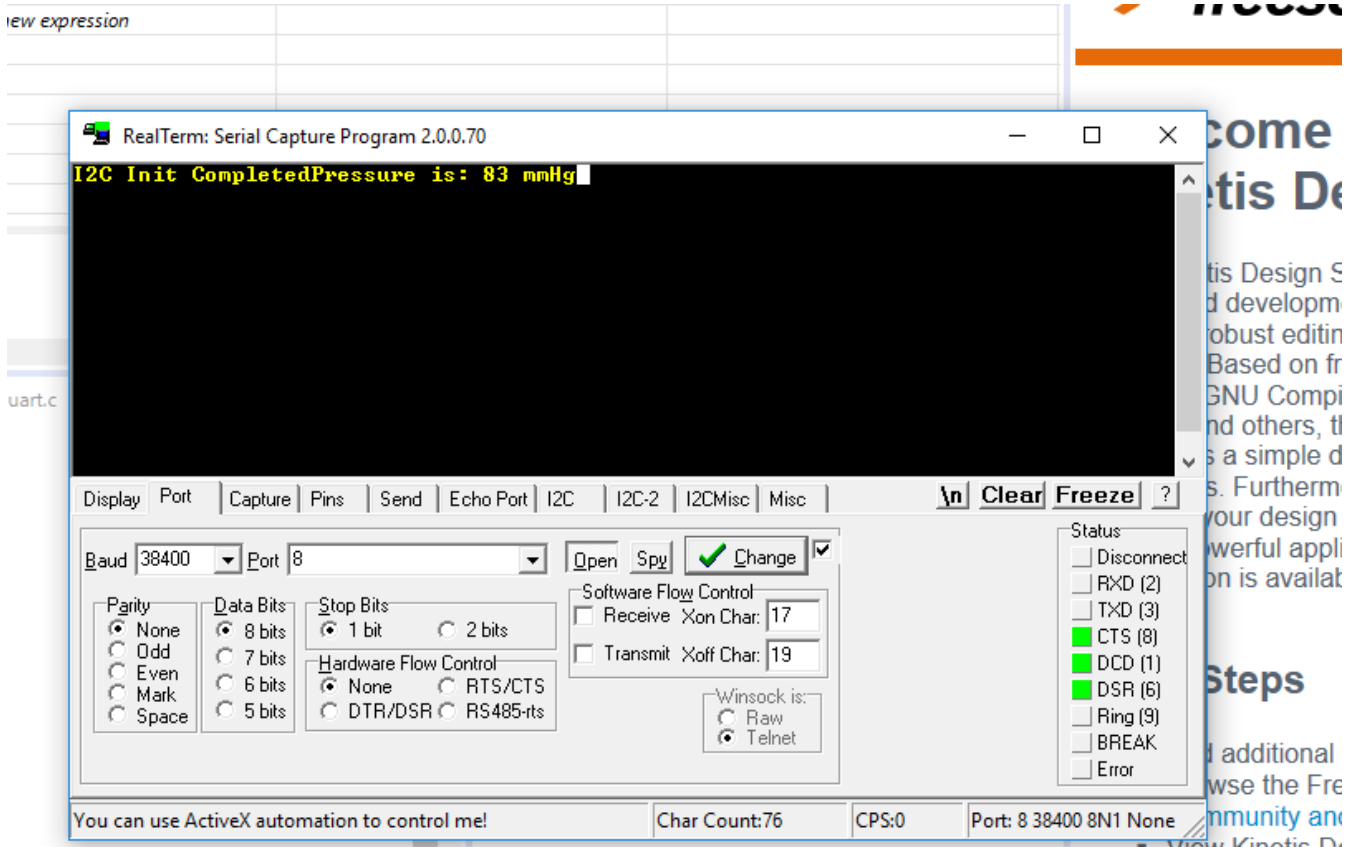
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changes and notify the user regarding the theft. We are using a pressure sensor BME280 which is I2C based sensor. So using I2C1 for this sensor.

Flowchart for Pressure Sensor Module:



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Pressure sensor status

Test Cases:

Function	Feature to be tested	Plan Test	Definition of pass or fail	Pass or Fail
Cap Sensor	Cap sensor turns ON the 3 sensors	Untill the Cap sensor is touched the sensors should be disabled	If cap sensor is not touched then the nothing should be working	Pass
Cap Sensor	Cap sensor when touched	When the Cap sensor is touched then sensors should be activated	If the cap sensor is touched then you will be able to read values from sensors	Pass
UART	Logging	This is for debugging purpose. Check the Serial Terminal for the status of the program	You should be able to see the status at serial terminal	Pass
Temperature		It measures the temperature	Appropriate values of temperature	Pass
Accelerometer		It is used to detect the vibrations	Appropriate values of x,y,z axis	Pass

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Pressure		It measures the pressure	Appropriate values of pressure	Pass
RGB	It should be ON when the vibrations are detected by accelerometer	Vibrate the FRDM	When FRDM vibrated the RED led should be glowing	Pass
Pressure	When the change in pressure reaches the threshold		Pink Led will be used	Pass
Temperature	When the temperature is above the threshold	Use a cold spray or blow torch and simulate the situation of theft	Serial Terminal	Pass
Accelerometer	When the vibrations are detected reaches the threshold	Vibrate the frdm and simulate the situation of theft	Serial Terminal	Pass
SPI	Communication with	Able to write and	See the serial terminal	Pass
	nrf24	read values from registers		Pass
Nrf24 as Tx	Send the data from frdm	Make the buzzer ring	See the serial terminal	Future Goals
Nrf24 as Rx	Receive data from frdm	Make the buzzer ring	Led is glowing on BBB indicating that it received data	Future Goals
Email notification	Send an alert to user through email	Receive data from frdm	Should receive an email indicating theft	Future Goals

Conclusion:

We have successfully implemented Smart Bike Lock which will help in reducing bike thefts. This lock is based on Pressure sensor for wire cutting(Bolt Cutter) , Temperature sensor for Blow Torch/Freezing ,Accelerometer for usage of saw/drill/Angle grinder/Hammer. These are the ways generally used for bike theft. These sensors detects the changes in these values because of someone trying to theft the bike. The status will be notified to the user.

Github: <https://github.com/Mounika1494/Mounika>

Appendix: References

[1] EFM32 Reference manual

[2] <https://www.kickstarter.com/projects/lock8/lock8-the-worlds-first-smart-bike-lock>

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Appendix: Project Team Staffing

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