International Journal of Advanced Smart Convergence Vol.5 No3 16-26 (2016)
http://dx.doi.org/10.7236/IJASC.2016.5.3.16

IJASC 16-1-3

Safe Bike : Secure your Bicycle with this smart Arduino based GPS device

Daniel Godfrey[1], Song Mi-Hwa[1], Ph.D.

Division of Information and communication technology, Semyung University, Jecheon City[1]
e-mail: danielgodfrey2@gmail.com, mhsong@semyung.ac.kr

Abstract

This proposed project is about a bicycle anti theft devised system which helps people protect the bicycle from theft and helps to track the stolen bicycle's location using a smart phone. Safety bike uses two main devices to keep the bicycle secured, the vibration sensor and GPS sensor. The purpose of this project is to put all these small devices into one well connected system which will help the bicycle owner have more control over the security of his own bicycle.

The whole system can be divided into two main parts. The first part is about the hardware development whereby all electronics components are connected via the circuit design using wire wrapping technique. This hardware part includes, a vibrations sensor, a GPS receiver, a toggle switch, LED light, Bluetooth and a buzzer. Wireless Bluetooth signals are used as the means of communication between the smartphone and the microcontroller. The second part is the software part which is being to program and control the whole system. The program is written using MikroBasic, a full-featured Basic compiler for microcontroller based systems. In conclusion, this system is designed to enable user to have control in securing his/her bicycle also being able to find and locate it at any time using GPS receiver and mobile android application.

***Keywords**: Arduino, GPS, Android, Bluetooth, Google map*.

1. INTRODUCTION

With life conditions and commodity prices which keep on growing day by day, a good example being gas prices which in a few years ago it was quite a big issue, has led to a large number of people to start driving less and getting into bicycling more and more.

There are lots of reasons why most people are breaking the 4-wheel habit and are starting to prefer riding to driving, the main reason being exercise and saving money [1].

Manuscript Received: July 04, 2016 / Revised: July 15, 2016 / Accepted: July 30, 2016
Corresponding Author: Song Mi-Hwa(mhsong@semyung.ac.kr)
Tel:+82-43-649-1645, Fax: +82-43-649-1747
Semyung University, Korea

So, we saw the need to help bicycle owners to have more control over the security of their bicycles by simply using their smart phones, because it is something we can carry around with us most of the time. This research`s main goal is to develop a device which has a GPS traceable system that can communicate with a mobile phone at any time. The project objectives are:

- Develop a devised system that is small enough to be attached on a bicycle a looks inconspicuous to a thief.
- Develop a system carrying a GPS tracker which can send its location to the owner at any time requested.
- Develop a mobile app with programmed commands to communicate and control the devices activities.

This research focuses on constructing a small device which is capable of being attached on to a bicycle and which comes with a GPS tracker in it. This device helps protect your bicycle using two ways. Firstly, the device has a vibration sensor that can sense any *external impact acting* on the bicycle, which is translated as that someone is trying to move (steal) your bicycle.

But even if a thief was to successfully steal your bicycle you would still be able to track and find your bicycle eventually. In this research the whole system works using the main three ways which includes the concept of GPS navigation system, electronic structure and the mobile application software programming. The device itself works in two main ways. First is the vibration sensor and second is the GPS itself which sends the bicycles location coordinates to the mobile phone using “Bluetooth signals”.

This paper consists of 7 chapters. Chapter 1 explains about the project`s background, the objectives, and the scope of the project.

- Chapter 2: related works.
- Chapter 3: overall system design and configuration.
- Chapter 4: project implementation.
- Chapter 5 : results and discussion.
- Chapter 6: conclusion.
- Chapter 7: references

2. RELATED WORKS

2.1 GPS

Many people tend to confuse the meaning of the term GPS, when people talk of GPS they are actually talking about the GPS receiver since the GPS transmitters are the satellites revolving in the earth`s atmosphere. GPS signal contains 3 types of information[2].

- Pseudo-random code(ID code) which identifies which satellites is transmitting.
- Ephemeris signal is constantly transmitted and contains important information like status of the satellite (health or unhealthy), current date and time.
- Almanac data tells the GPS receiver where each GPS satellite should be at any time throughout the day, these signals are transmitted by each satellite showing the orbital information of that satellite and for every other satellite in the system. For the GPS to be able to determine your position, the GPS receiver compares the time transmitted by a satellite with the time the GPS receiver receives. Using this calculated time difference the GPS receiver can estimate the status of any particular satellite. And by adding the distance measurements from a few more satellites, it becomes possible to triangulate the position of the receiver. This is what a GPS receiver does and by continuously updating your position, a GPS receiver can also accurately provide speed and direction of travel**.**

2.2 BLUETOOTH

Bluetooth wireless technology is a technology that was originally conceived as a low-power short-range radio technology that was designed to easy interconnection between electronic devices without the need of cables. Bluetooth uses the FHSS technique(*Frequency-Hopping Spreading Spectrum*) to communicate, so in order for multiple Bluetooth devices to communicate, they must all synchronize to the same hopping sequence. Bluetooth operates at the same frequency band of 2.402-2.480 GHz where RF protocols like ZigBee and WiFi also exist. Bluetooth basic communication principle is based upon a master/slave operation mode. Any Bluetooth device can be a *master* or *slave* depending on the application scenario[3].

The term "*piconet*" is used to refer to the network formed by one device and all devices found within its range. A *piconet* is formed by a master and up to 7 active slaves(Figure 1). The slaves in a piconet only communicate with the master and up to 10 *piconets* can coexist within a single coverage area.

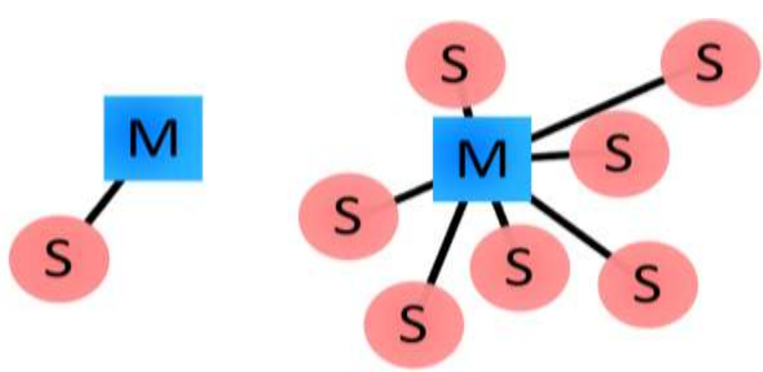

Figure 1. Bluetooth master/slave topologies

These connections are maintained until they are broken, either by deliberately disconnecting the two, or by the link radio becoming so poor that communication cannot be maintained- typically this occurs as the devices go out of range of each other.

Creating a Bluetooth connection between two devices in a complicated multi-step process involving major three progressive states. This steps can further be categorized as follows [4]:

- Passive mode
- Inquiry: Finding access points
- Paging: Synchronizing with access points
- Access point service discovery
- Creating a channel with access point
- Pairing using PIN (security)
- Using the network

When comparing Bluetooth to other wireless protocol, it is not the best choice for every wireless job out there, but it still very useful at short-range cable-replacement-type applications. For example taking in comparison the maximum(outdoor) range between Bluetooth 4.0 low energy (BLE) and WiFi signals, BLE has a maximum(outdoor) range of only 50meters while WiFi signals has a range of 100-250meters even though it still has a great advantage when it comes to it`s relative power consumption..

2.3 ARDUINO(Micro controller)

Arduino is an open source prototyping platform hardware. As inputs, we usually use signals from individual switches or from transducers (temperature, pressure, light etc). This inputs can be digital or analog [5].

- Digital Input / Output Digital input / output works with binary values 0 and 1, in some sources referred to as Low and High value. Logical 0 corresponds to 0 V and logical 1 corresponds to 5 V. Some older versions of Arduino (for instance one of the Pro or Mini Pro versions) have logical 1 corresponding to 3.3 V.

- Analog input Analog input of Arduino has a 10 bit analog - digital converter. This gives us a numerical value range from 0 to 1023 [4]. The value 1023 corresponds to 5 V and a value 0 corresponds to 0 V at the analog input. The difference between two values corresponds to 0.0048 V.

- Analog input Analog input of Arduino has a 10 bit analog - digital converter. This gives us a numerical value range from 0 to 1023 [4]. The value 1023 corresponds to 5 V and a value 0 corresponds to 0 V at the analog input. The difference between two values corresponds to 0.0048 V.

- Analog output Analog output of Arduino has a 10 bit analog - digital converter. This gives us a numerical value range from 0 to 1023 [4]. The value 1023 corresponds to 5 V and a value 0 corresponds to 0 V at the analog input. The difference between two values corresponds to 0.0048 V.

3. SYSTEM DESIGN.

This system`s components can be divided into two parts, the software and hardware. The software part is mostly based on an android mobile application. And as it can be seen from the picture (figure 2) below, the hardware part consists of a microcontroller (Arduino mega 2560), GPS module, Buzzer, LED lights, Toggle switch and Bluetooth device.

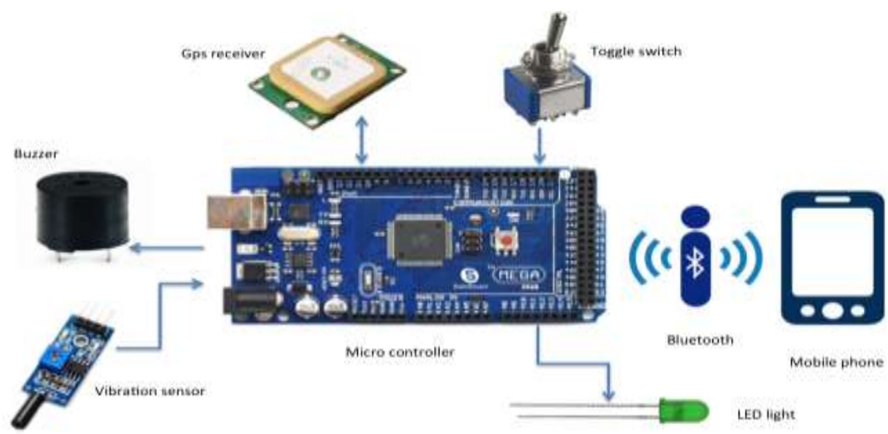

Figure 2. System Configuration of the “Safe Bike” device

As shown from figure 2 above, this device consists of different parts, each explained in summary below; in this project, we use the Arduino mega(ATMEGA 2560) microcontroller as the core component of the project, we use it to send the GPS coordinates to a mobile through Bluetooth signals. The arduino board is an 8 bit system and operates at 16MHz . For experimental reasons, this microcontroller was powered by the laptop battery through a USB port. Figure 3 shows Arduino mega 2560 with some of its important ports [6], buttons and output/input indicators [2] [3].

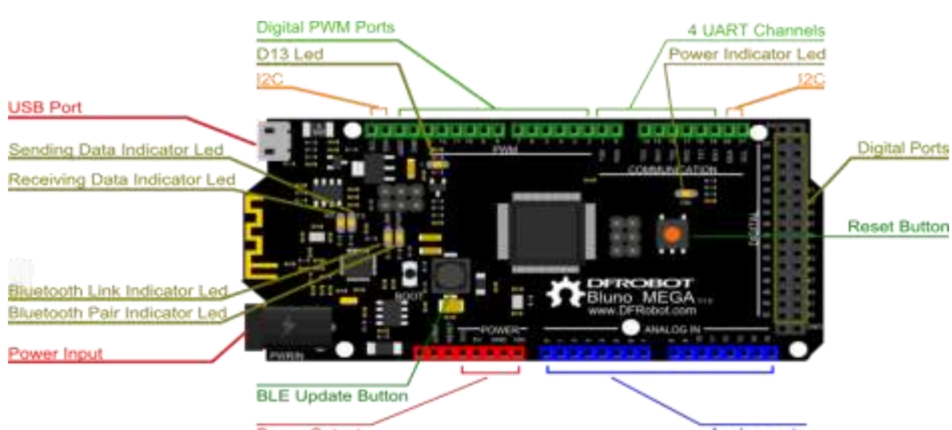

Figure 3. Arduino MEGA 2560.

3.1 GPS module

In this project, we used the LS20031 5Hz (66 Channel) GPS receiver. The GPS receiver is a complete smart antenna receiver, which comes with an embedded antenna and GPS receiver circuit. The receiver is based on proven technology found in LOCOSYS 66 channel GPS SMD type receivers which use MediaTek chip solutions. The GPS smart antenna will track up to 66 satellites at a time while providing fast time-to-first – fix [2], [5]. Some important features of this GPS receiver are;

- MediaTek MT3339 solution
- 5Hz output
- 57600bps TTL serial interface
- 3.3V @ 41mA
- 66 Channel GPS
- Fast TTFF at low signal level
- Up to 10Hz update rates
- Capable of SBAS(WAAS,EGNOS,MSAS)
- Built-in micro battery to preserve system data for rapid satellite acquisition.

When running the command to find the location using this device, the location coordinates are given in terms of latitude and longitude as shown below (figure 4).

Figure 4. GPS receiver location coordinates.

3.2 Bluetooth

We used the Bluetooth serial mode as the means of communication between the micro controller board and a smart phone. This module has 4pins(5V pin, Ground port, RX and TX).[7]

3.3 Vibration sensor and a Buzzer

The vibration sensor's main purpose is to detect any movement or external impacts on the bicycle after it has been set to "safe mode". The external impacts are translated by the sensor as if someone is trying to move your bicycle without your permission. This information is sent to the microcontroller and eventually the command to alert the buzzer is executed. The buzzer alert helps alert people and security nearby.

3.4 LED lights

We use the LED light as an indicator of bicycle status either it is being set on or it is off. If the device is on safe mode, the green light will be on, and otherwise it stays off.

3.5 Toggle switch

We use this to switch the device either on or off. Once the bike owner parks the bike, he switches it on, and when he returns back he has to switch it back off. If the owner does not switch it off, the alarm will go off.

Images of the device from all sides are shown below at figure 4(a) and 4(b).

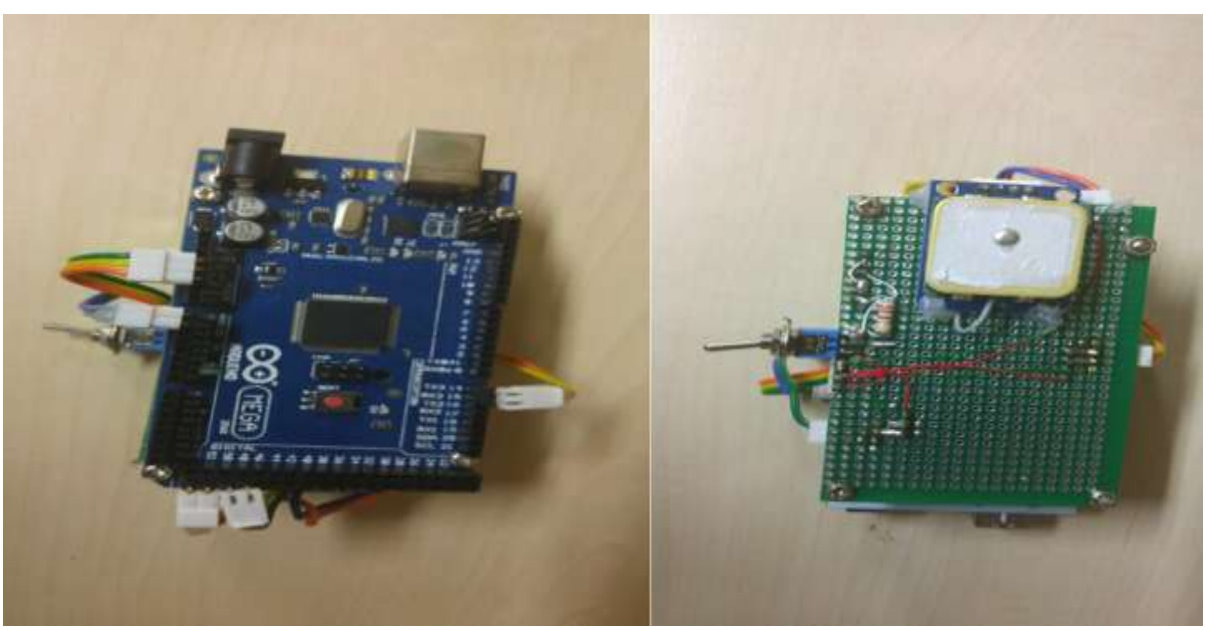

Figure 4(a) Device view from the top and below

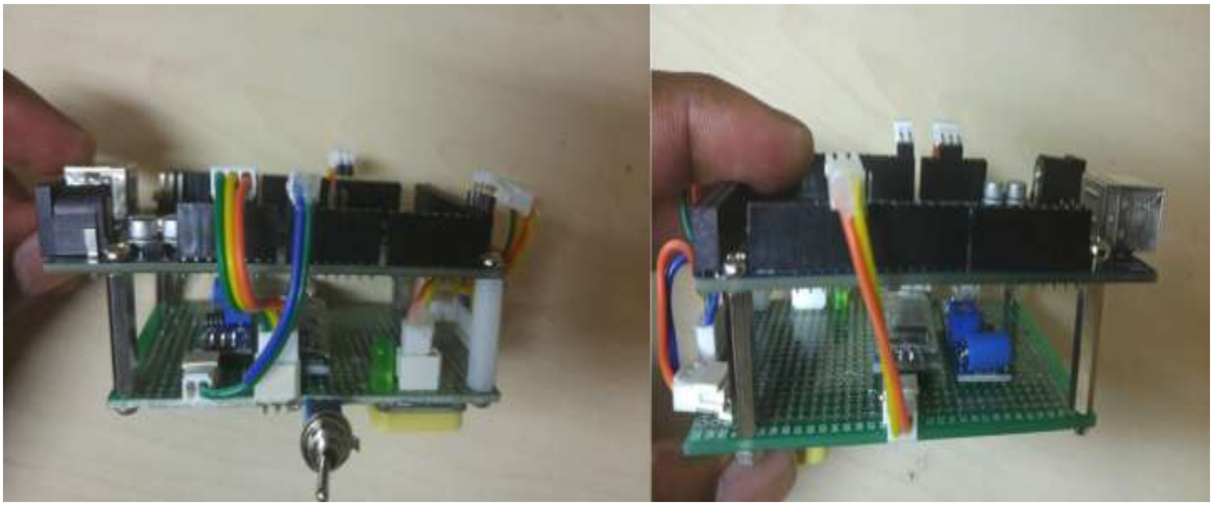

Figure 4(b) Device view from rear sides

4. System Implementation and Result

When the bicycle owner wants to park his bicycle, he switches the device ON, after which the GPS device will mark that location as it`s default location. Following that, the device and the user′s smartphone should get paired through Bluetooth connection. If it happens that either the bicycle location is changed or impacts on the bicycle are detected, then the buzzer alarm will go off and the owner will get notified right away from his phone through pop up notifications. From there he can start by confirming the bicycle location, if it has changed location, then he can continue tracking the bicycle location easily using Google maps from the ″Safe Bike″ application. For this whole process to work, various conditions explained with the flow chart below (figure 5) are to be met first.

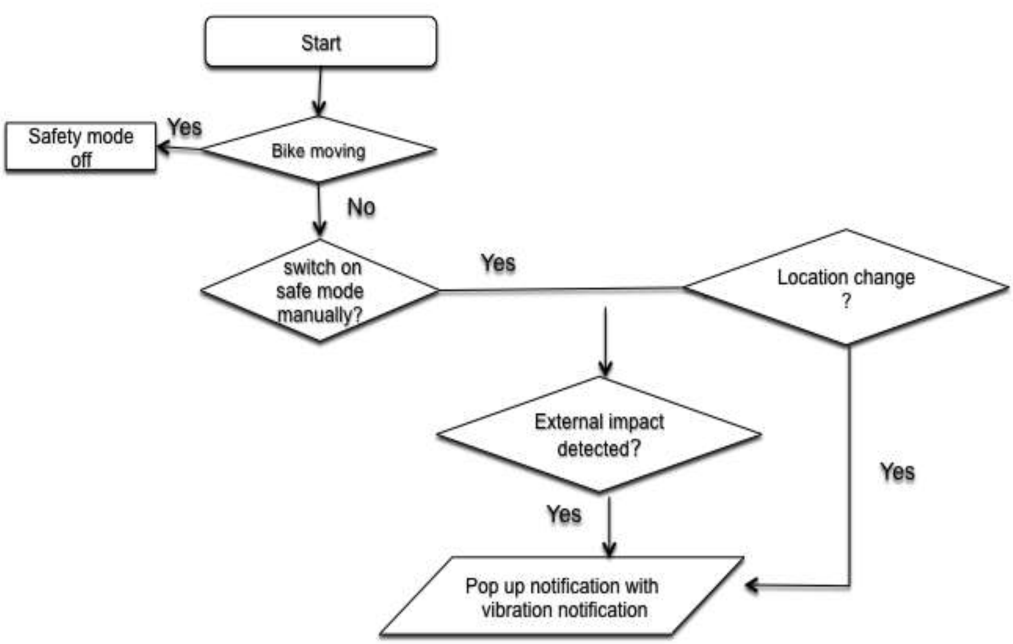

Figure 5. System`s Flow chart

When the bicycle owner is riding the bicycle or when the bicycle is parked at a place where he does not worry about it′s security then the device can just be switched off. So, let us consider the user riding the bicycle to the park. After he reaches the park and after parking the bicycle the first thing he needs to make sure is to switch the device on then pair it with his smartphone through Bluetooth. This Bluetooth connection needs a password, the default being ″1234″. To do this, open an app and click the Bluetooth sign on the map (figure 6). When pairing is successfully done you will be able to see the MAC address of the device`s Bluetooth model (figure 7).

Figure 6

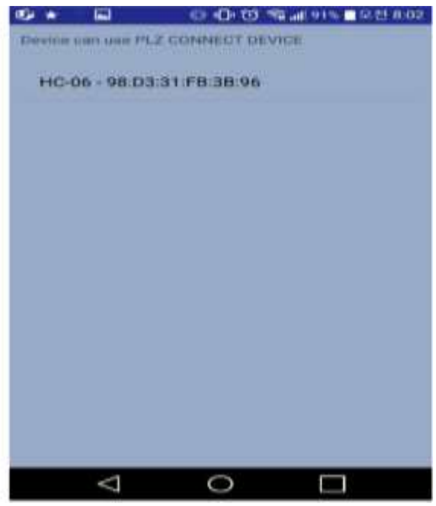

Figure 7

After successfully pairing the device and smartphone, the next thing is to set the device to ″safe mode″. To do this, the user uses the toggle switch on their device. Once the safety is ON, the GPS board will automatically set that location as its default location and you will get notified on your mobile with the message, ″보안모드가 켜져 있습니다″ (figure 8). To check the current location of your bicycle at any time, press the ″자전거 위치로″ button and it will take about 10 seconds to load, after which you will be able to see the location of both yourself and the bicycle (figure 9).

Figure 8

Figure 9

When someone tries to move your bicycle, the vibration sensor will sense the impact and send this information to the microcontroller and the microcontroller will send this to your phone through Bluetooth signals. When this happens you will be notified by the pop up messages on your phone with an alert message "자전거가 위치를 이탈했습니다" (figure 10). From there you can start to track the bicycle location using the application`s Google map (figure 11).

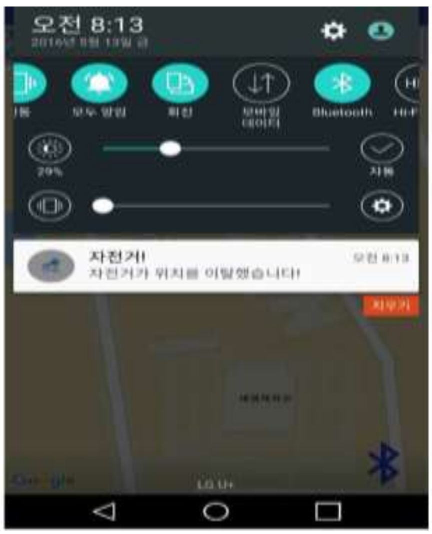

Figure 10

Figure 11

All this can simply be explained using the flow control chart below (Figure 12).

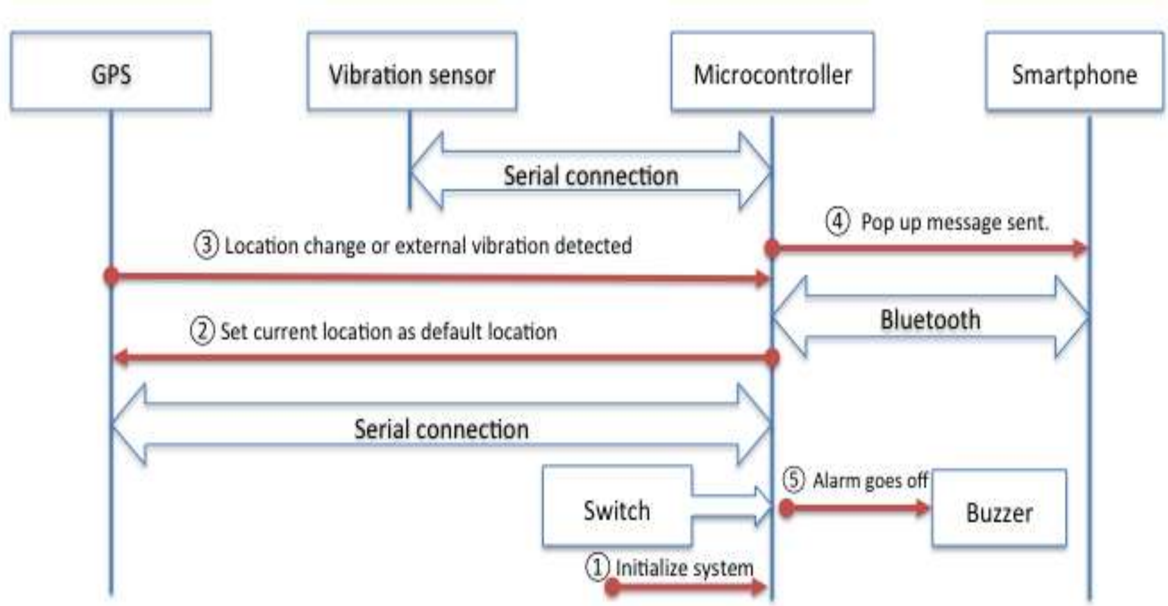

Figure 12. Safe bike system Flow control.

5. DISCUSSION

The Bicycle′s location coordinates received from the GPS are displayed in terms of Latitude and Longitude as seen on figure 4. It is possible to Use these coordinates on Google map or other mapping software to track the exact location of the device. Since we are using Bluetooth signals as a means of communication between the device and smart phone, we find it hard to connect these two when separated at larger distances. That is why we are considering to improve this project in the way that the device and the user′s smart phone would be connected even at large distances

6. CONCLUSION

Living in a place with a high bicycle theft rate, most people find it difficult to keep their bicycle safe. This device could help bicycle users resolve this problem, and might help convince people to use bicycles more. Using the GPS real time tracking feature and vibration sensors on the device, the user would be able to know the location of their bicycle at any time. As soon as someone tries to steal it or even just move it, the user will get notified immediately.

Our project`s future work includes,

- Miniaturization process of this prototype for easy handling.
- Adding an Automation feature which will help to switch the device on without having to do it manually.
- Adding more setting options to the Safe Bike application.
- Adding a location sharing service that can be really helpful especially when parents are trying to monitor their kids location. In addition to this, another function would be making an emergency alarm to notify parents, friends or police when something like a road accident occurs.
- Using a long lasting battery which can be charged by solar energy.

REFERENCES

[1] http://www.mnn.com/green-tech/transportation/stories/12-reasons-to-start-using-a-bicycle-for-transportation

[2] Gregory T.French, “An introduction to Global Positioning System”, First Edition,2009.

[3] UnderstandingBluetooth: http://www.hp.com/rnd/library/pdf/understandingBluetooth.pdf

[4] http://ccm.net/contents/69-bluetooth-how-it-works

[5] El-Medany, W.M.; Alomary, A.; Al-Hakim, R.; Al-Irhayim, S.; Nousif, M., *"Implementation of GPRSBased Positioning System Using PIC Microcontroller*," Computational Intelligence, Communication Systems and Networks (CICSyN), 2010 Second International Conference on , vol., no., pp.365,368, 28-30 July 2010

[6] CORINA DANIELA CUNTAN, IOAN BACIU, CAIUS PANOIU , CEZARA-LILIANA RA.” *The implementation of a set of controls in an Arduino ATMEGA 2560 microcontroller system*”, ISBN: 978-960-474-328-5.

[7] El-Medany,W.;Al-Omary,A.;Al-Hakim,R.;Al-Irhayim,S.;Nusaif,M.,"A Cost Effective Real-Time Tracking System Prototype Using Integrated GPS/GPRS Module," *Wireless and Mobile Communications (ICWMC)*, 2010 6th International Conference on,vol.,no.,pp.521,525,20-25 Sept.2010.