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Acknowledgement

We thank God Almighty for giving us the strength and persistence to complete this project on time.
We express our sincere gratitude to the HOD of the Department of Electronics and Communication Engineering,Dr.Sameer S.M. and our Project Guide, Mr. Raghu C.V. for being our pillar of support since the beginning of this project. We could not have accomplished this work without his guidance and advice. We also express our heartfelt courtesy to Mr. K.R. Anandan and other lab staff for providing us the lab facility and clarifying our doubts.

Security Tag for Travel Bags

April 9, 2018

Abstract

A lot of theft issues are being reported during travels.It normally happens when the luggage is kept away from the passenger, especially during night travel.This project proposes a security tag, which can be attached to luggages.The basic idea is that when the travel bag is moved from the current position, it communicates with the user‘s smartphone and triggers an alarm in it. User will be able to lock the position of the bag using a mobile app.The tag is designed around a low power microcontroller.The position of the tag is sensed using an accelerometer. The unit will be programmed such that when there is a change in this locked position, the user will be alerted using the mobile alarm.The tag will work from a rechargeable battery setup.

Chapter 1

Introduction

The incidents of theft in trains is a serious issue.A lot of such incidents are being reported and people are loosing ther valuable items through this[1][2]. People who travel alone may have to leave their luggages unattended in situations like moving around to use the lavatory.Even when people travel in groups, the luggages which are kept below the sleeping berths are not safe especially at night.This type of incidents can be avoided by alerting the owner if somebody else tries to grab the luggage from the position where he/she has kept.

This project proposes a rechargeable security tag, which can be attached to travel bags.Whenever the user wants to activate the tag, he can lock its current postion through a mobile app.The tag detects its current position and communicates this information to the smartphone wirelessly.The app will trigger an alarm in the mobile, if the position is different from its locked one.

The tag is implemented using a microcontroller, a low power 3-axis accelerometer and a Bluetooth module.The accelerometer is used to sense the tag‘s position.The smartphone and tag communicates via bluetooth module.The entire operation is controlled through a microcontroller.The tag includes a rechargeable Lithium ion battery along with its charging circuit.

This device wil be useful in other modes of travel also if the luggage is kept away from the owner, but within the range of wireless communication used in the system.

Chapter 2

Design and Implementation

2.1 Hardware

The proposed block diagram of the system is shown in figure 2.1. The design of the tag includes a 3-axis accelerometer(ADXL335) and a bluetooth module (HC05) controlled by a microcontroller(MSP430).All the components are chosen considering their power dissipation.The Bluetooth module uses UART to communicate with the MSP430.The bluetooth reception is based on interrupts i.e, if a bit is sent to the module, the corresponding interrupt is called. The accelerometer‘s movement is fed as analog data to the ADC of the microcontroller.The ADC converts it into digital form and is stored in the device. ADXL335 gives X,Y and Z values to the microcontroller sequentially.It constantly checks for a change in the accelerometer‘s position and triggers an alarm.
The MSP430 microcontroller is programmed using Code Composer Studio(See APPENDIX 1).

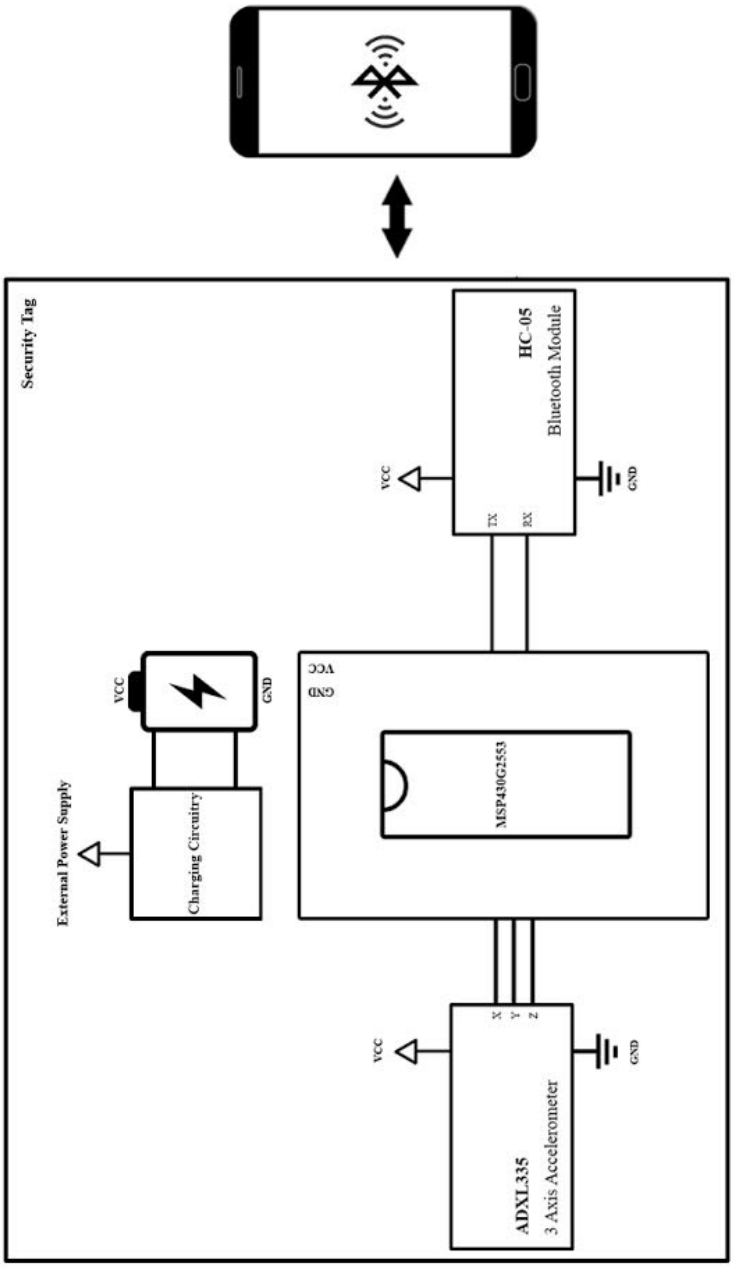


Figure 2.1: Block diagram

2.2 Components

2.2.1 ADXL335:

ADXL335 three-axis analog accelerometer IC[3] is used to detect the position of the tag. The X,Y and Z axis acceleration values are read as analog voltages. The IC can measure acceleration within a range of 3g. The amount of acceleration due to gravity is used as a measure to determine the angle at which the tag is inclined with respect to the Earth. The accelerometer finds out the speed and direction in which the tag is moving, by sensing the amount of dynamic acceleration resulting from motion, shock or vibration. The required bandwidth can be chosen by the user, using the CX, CY and CZ capacitors at the XOUT, YOUT and ZOUT pins.The ADXL335 has extremely low noise and power consumption.
ADXL335 works from 3V to 6V DC Supply Voltage and an onboard LDO Voltage regulator. It can be interfaced with a 3.3V or 5V Microcontroller. It works in ultra low power mode: drawing 40uA in measurement mode and 0.1uA in standby at 2.5V. It has tap/double tap detection and free-fall detection.

Figure 2.2: ADXL335

2.2.2 HC-05:

HC-05 [4] module is a Bluetooth Serial Port Protocol (SPP) module in which information transfers in or out, one bit at a time. HC-05 is designed for transparent wireless serial communication and it can be used in a Master or Slave configuration.The module has CSR Bluecore 04 as an external single chip and utilises CMOS technology. It also has an Adaptive Frequency Hopping Feature(AFHF). The module has a typical 80 dBm sensitivity up to +4dBm RF transmit power. It has a 3.3 to 5 V I/O range and PIO(Programmable Input/Output) control. It also includes a UART interface with programmable baud rate, integrated antenna and edge connector.

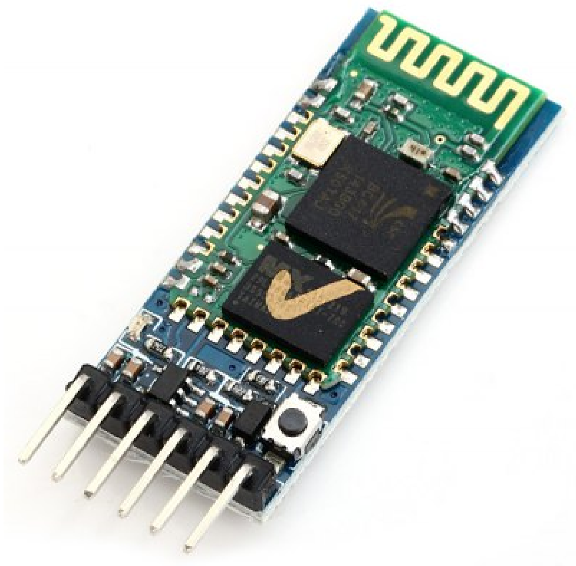


Figure 2.3: HC-05

2.2.3 MSP430:

The MSP430g2553 is a microcontroller from Texas Instruments. It is based on a 16-bit CPU for low power consumption embedded applications. It is an Ultra-Low Power MCU with MIPS of up to 16. It has inbuilt pull-up/ pull-down resistors and low-pin count options. It also includes a Very-Low power Oscillator. The microcontroller further has watchdog timer, brown-out reset, USI module, USCI module, comparator and a temperature sensor. The RAM size of the microcontroller varies from 128B to 4 KB. They are usually user friendly with no write-only registers. An Analog to Digital Converter is also an intrinsic part of the MCU.

Figure 2.4: MSP430

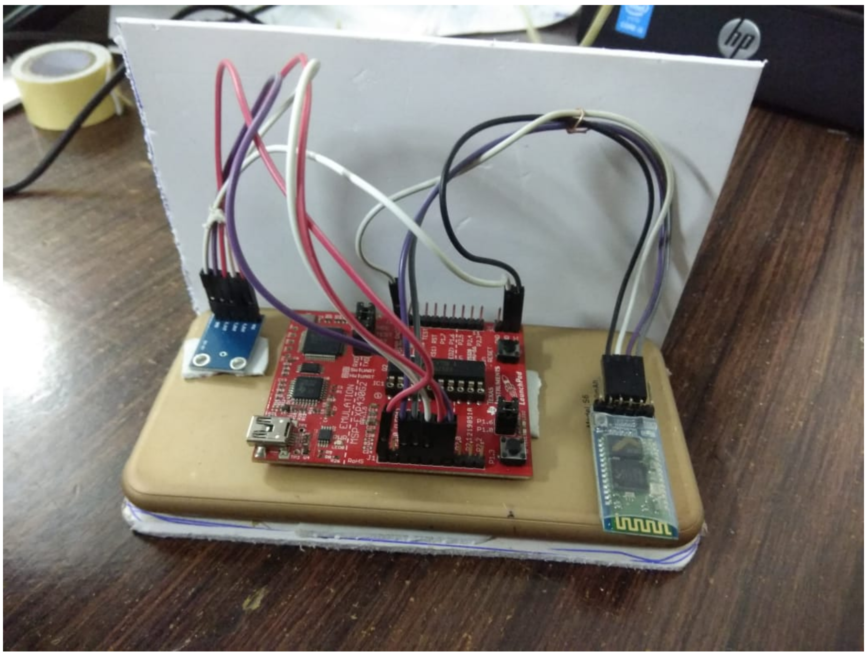


Figure 2.5: Circuit

2.3 Software

2.3.1 App

The app was designed for android devices using Android Studio. It does the following functions:

1 The MAC address of the Bluetooth Module is fixed, so that the app does not connect to other devices.

2 On calling the Main Activity, activities to be done are specified by accessing the global variables.Instructions to enter the Pin, change the current Pin, trigger the phone to ring or vibrate- all of these can be executed using global variables. When the Lock Button is pressed in the app, a bit is transmitted to the Microcontroller. The MCU then sends a 'Locked' message to the app, after storing the current X,Y,Z axis values of the accelerometer. The MCU constantly compares these stored values with the present accelerometer readings. On detecting a change in these values beyond the specified limit, another bit is transmitted to the app, which triggers the alarm to vibrate and/or ring. When the Unlock Button is pressed, a bit to unlock the tag is transmitted to the MCU and the system is unlocked. After unlocking, the MCU stops comparing the stored value with the present value. (See APPENDIX 2)

3 On calling the EnterPin Activity, the passcode can be changed by the user by confirming the current passcode. The changed passcode is saved to the memory for future use.(See APPENDIX 3).

4 On calling the Settings Activity, the entered Pin is compared with the pre-defined Passcode. The system unlocks if the Pin is correct and remains in the locked state if the Pin is wrong. (See APPENDIX 4).

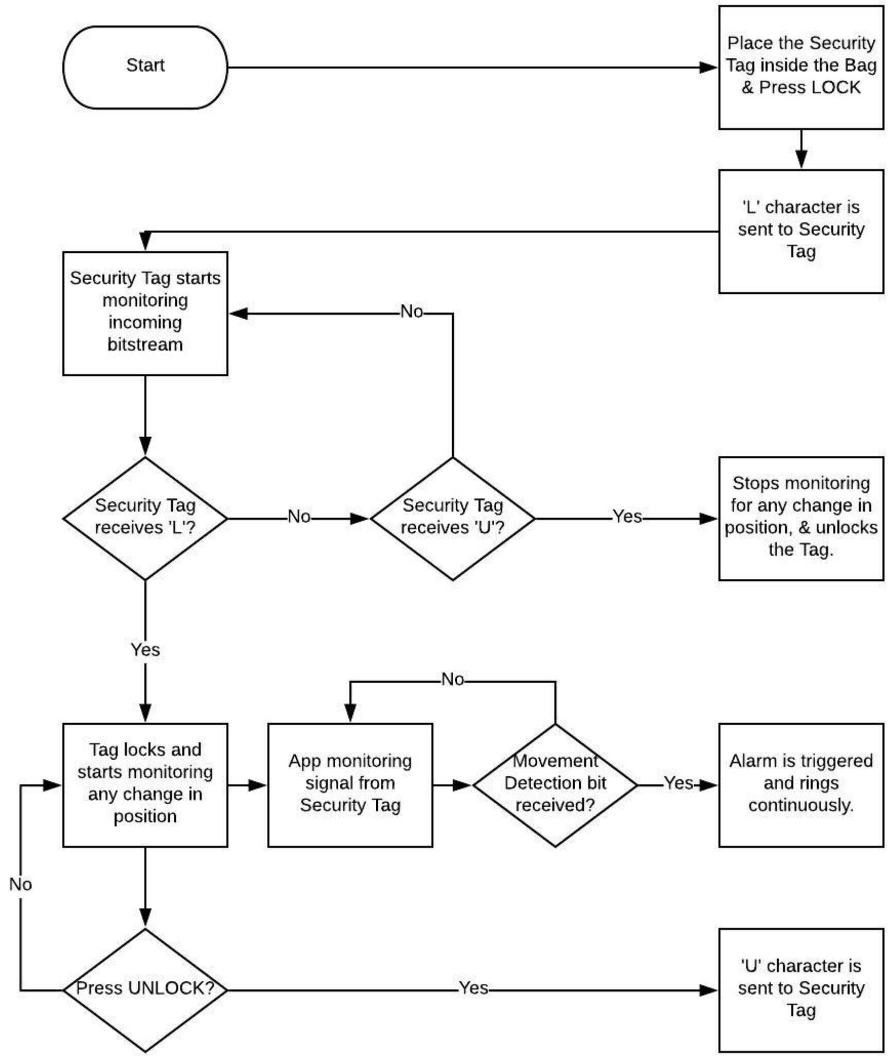
5 Apart from these Activity files, there are XML files which specify the Graphic details in an app.

6 The app fucntioning is not affected by any other apps or calls.

2.3.2 Configuration of MSP430

The procesor frequency is set as 1MHz by loading appropriate values to the Basic Clock System Control Registers. MSP430 has an 8 channel 10 bit ADC.Three of these ADC pins , P1.3 , P1.4 and P1.5 are activated by using ADC control registers.The universal serial communication interface is configured to support UART interface. P1.1 and P1.2 are configured as transmitter and receiver pins respectively.The baud rate of the module is set to a value of 9600.

2.3.3 Flowchart



2.4 Other details

2.4.1 Bluetooth Communication

Bluetooth[5] is a short range wireless communication technology.It is based on IEEE 802.15.1 Network Standard. The latest "Bluetooth 5" has a range of approximately 400 metres and upto 1000 metres outdoor. Bluetooth range typically depends on factors like output power of the transmitter, sensitivity of the receiver,physical obstacles in the transmission path and antennas.
Bluetooth operates at frequencies between 2402 and 2480 MHz. This is in the globally unlicensed industrial, scientific and medical (ISM) 2.4 GHz short-range radio frequency band.Bluetooth gives us uninterrupted band of frequency in which user can work . Bluetooth divides transmitted data into packets, and transmits each packet on one of 79 designated Bluetooth channels, each having bandwidth of 1 MHz.Bluetooth Low Energy uses 2 MHz spacing, and can accommodate 40 channels.
Bluetooth is a commonly used feature present in PCs and phones to transfer media and documents between devices. The general uses of Bluetooth includes wireless connectivity between devices,wireless multiplayer gaming, wireless peripheral accessing like printers and Bluetooth is now widely used inside vehicles for wireless connectivity between vehicle and devices.

2.4.2 App Development

App development[6] deals with creating user friendly applications which will benifit a large group of users by reducing the work load of the specific job to be done.App development is done using Android IDEs (integrated development environment) which is a software application that provides facilities to computer programmers for software development. An IDE normally consists of a source code editor, build automation tools, and a debugger.Most modern IDEs have intelligent code completion.Integrated development environments are designed to maximize programmer productivity by providing tight-knit components with similar user interfaces. IDEs present a single program in which all development is done. This program typically provides many features for authoring, modifying, compiling, deploying and debugging software.

Android Studio

Android Studio[7] is basically the android software development environment in which softwares are developed to run various applications in an android operating systems. Apps can be written using java,c++ or kotlin using the android studio.The basic goal of google when this platform was launched was to make user able to create applications according to their need and which will inturn reduce the work load of the user.This platform

is an example of an Android IDE.
Basic feature of the studio includes instant run which enables us to type in codes and the resources will changes to a usefull app.Each project is done using different modules like android app module,library module and Google App Engine modules.We can customize the view of the project files and make changes to specific aspects of the app.Android studio includes powerfull code editor which has more advanced editing capabilities when compared to other IDEs.

2.4.3 Code Composer Studio

CCS[8] provides an IDE to incorporate the software tools. CCS includes tools for code generation, such as a C compiler, an assembler, and a linker. It has graphical capabilities and supports real-time debugging. It provides an easy-to-use software tool to build and debug programs. The C compiler compiles a C source program with extension .c to produce an assembly source file with extension.asm.The assembler assembles an.asm source file to produce a machine language object file with extension.obj.The linker combines object files and object libraries as input to produce an executable file with extension .out.

Chapter 3

Results and Discussion

The app opens with a dialog box to enable the Bluetooth of the device. The connect button pairs the device with the microcontroller. Once the devices are paired, the accelerometer is locked by pressing the respective button. The change in the accelerometer's position triggers an alarm on the phone. The Stop Siren button stops the alarm. The user can unlock the tag by entering the password when it is no longer required. The alarm can be customized to just vibrate or to activate sound or both, as per the user's wish. The password is set to 1234 by default. The user can change the password from settings.

The maximum horizontal range tested was found to be 65 metre without obstacle and 50 metre with an obstacle in between. The maximum vertical range tested was found to be 50 metre, between two floors.

The developed setup is just a prototype and should be further modified, made compact and durable so as to fit travel needs.

Figure 3.1: Tag Prototype

3.1 App Screenshots

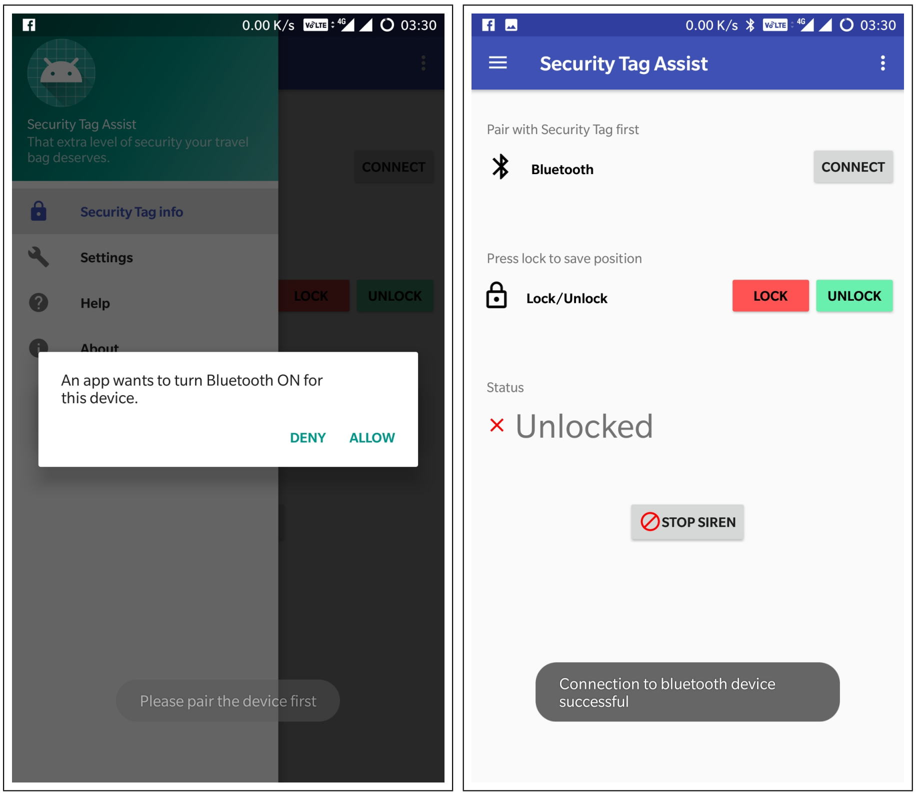


Figure 3.2: App connects to bluetooth

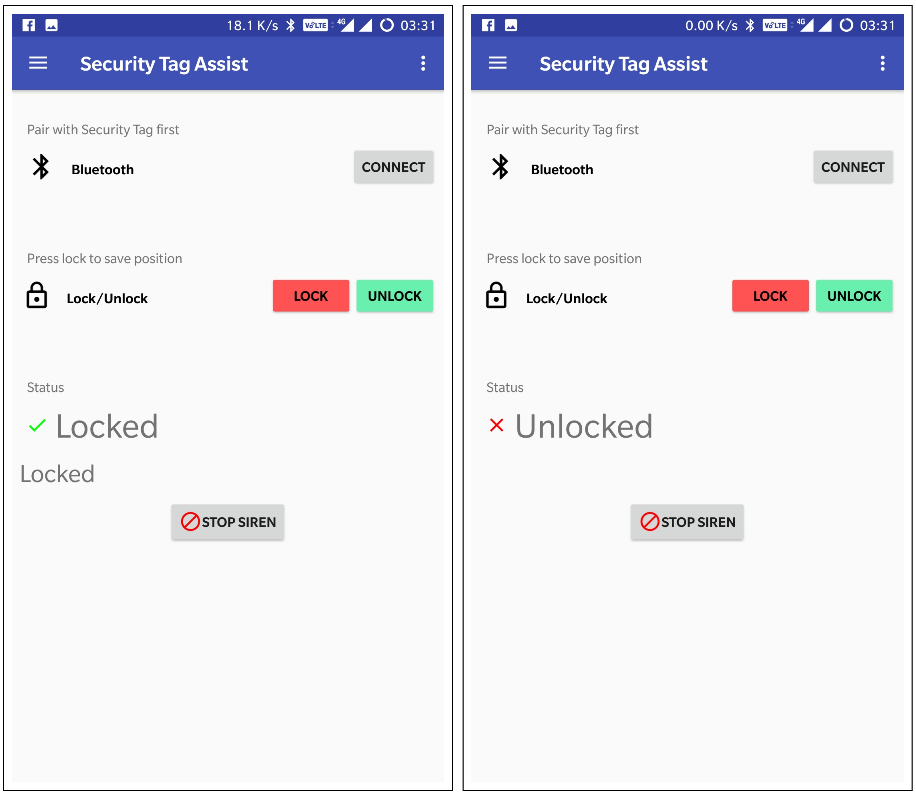


Figure 3.3: Locked or unlocked state

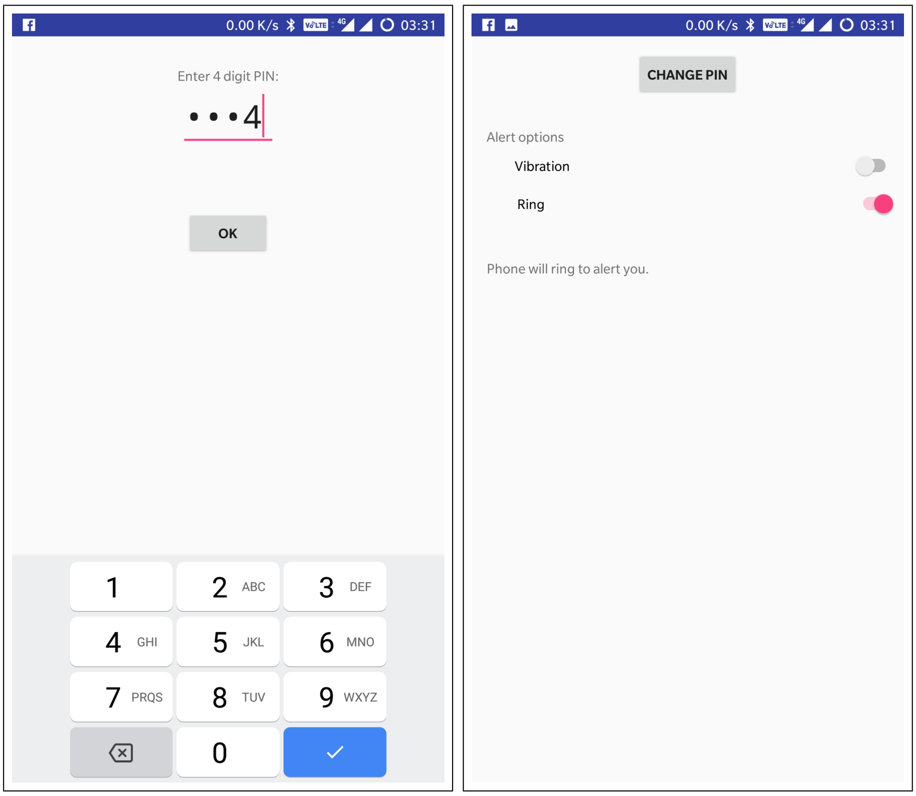


Figure 3.4: Unlock PIN and Settings

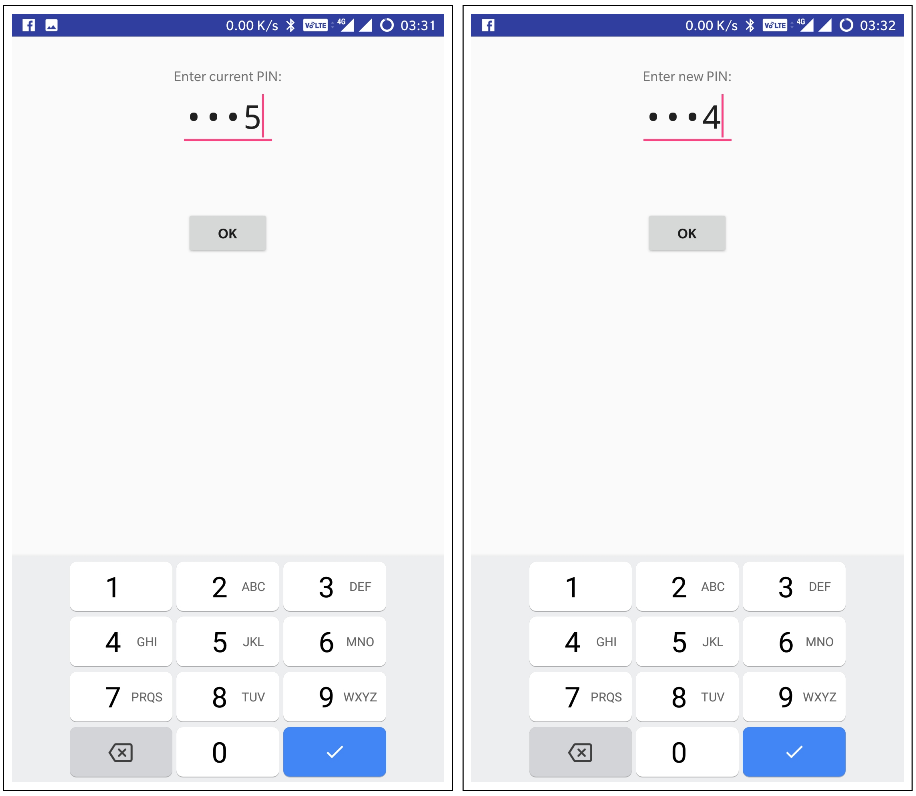


Figure 3.5: Change PIN

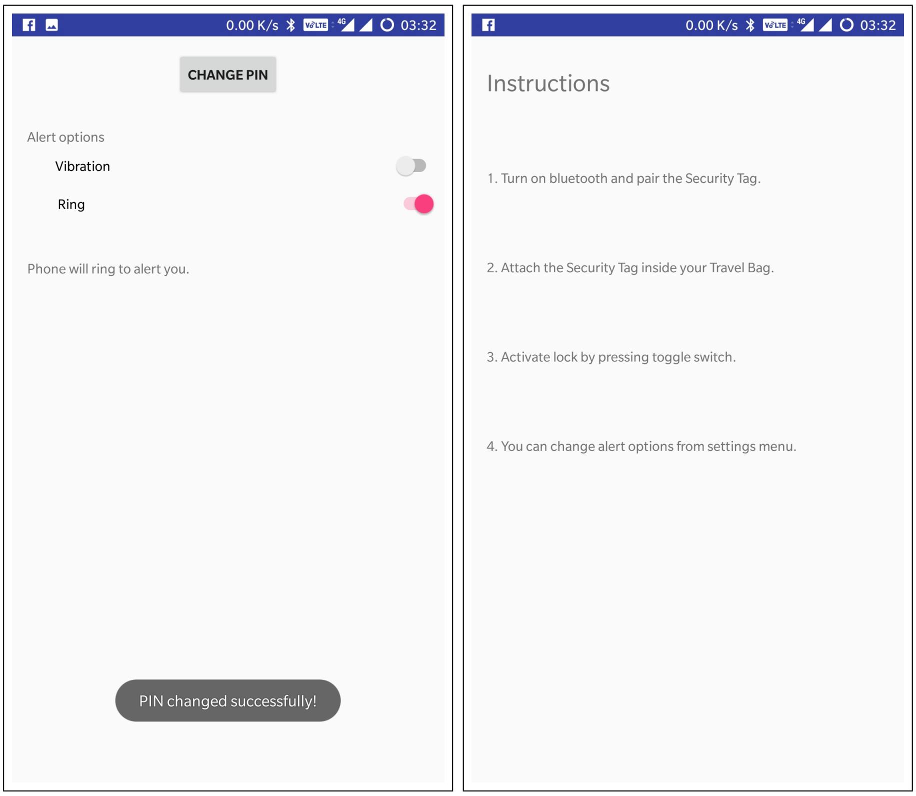


Figure 3.6: User instructions

Figure 3.7: About app

Chapter 4

Challenges and Further Improvements

The major concerns in the design are:

1 The physical size of the tag.The device has to be as small and handy as possible.The user should be able to attach it the tag to conventional briefcases and bags using a clip on its back.

2 The Bluetooth connectivity between the smartphone and the tag might be lost if the user is in a crowded area, or at a distance farther than the normal range. Unlike Bluetooth, other connectivity techniques will not operate in low power.Hence, the range issue can be solved only to an extent.

3 The tag is supposed to be heavy duty as it is used for travel purposes. Hence the covering material has to be strong enough and light weight at the same time.

4 The app has to wait indefinitely for the message sent from the micro-controller at the event of a theft. This waiting process caused the app to freeze. To fix this issue, Multithreading in java had to be used.

5 The tag can also be manufactured along with a pairing module using better wireless communication alternatives than bluetooth

Chapter 5

Conclusion

The project aims to solve a very common issue experienced by travelers in general.The tag proposed here uses simple principles and devices for implementation.Eventhough the prototype designed was bigger in size, using latest technologies and by large scale production,the tags can be made smaller and cheaper.

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