Smartwatch Using EduArm Kit

Project Report

Submitted in partial fulfillment of the requirements
For the degree of

Bachelor of Engineering (Computer Engineering)

By: -

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University of Mumbai
2018-2019

Internal Approval Sheet

TERNA ENGINEERING COLLEGE, NERUL Department of Computer Engineering Academic Year 2018-19

CERTIFICATE

This is to certify that the project entitled "**Smartwatch Using EduArm Kit**" is a bonafide work of

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Submitted to the University of Mumbai in partial fulfillment of the requirement for the award of the Bachelor of Engineering (Computer Engineering).

PROJECT GUIDE	**PROJECT CONVEYOR**	**HEAD OF DEPARTMENT**	**PRINCIPAL**

Approval Sheet

Project Report Approval

This Project Report – An entitled “**Smartwatch Using EduArm Kit**” by following students is approved for the degree of B.E. in "Computer Engineering".

Submitted by:

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Examiners Name & Signature:

1. ---

2. ---

Date:

Place:

Declaration

We declare that this written submission represents our ideas in our own words and where others' ideas or words have been included, we have adequately cited and referenced the original sources. We also declare that we have adhered to all principles of academic honesty and integrity and have not misrepresented or fabricated or falsified any idea/data/fact/source in our submission. We understand that any violation of the above will be cause for disciplinary action by the Institute and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been taken when needed.

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ABSTRACT

Smartwatch is a digital watch that provides many other features besides time keeping. We will develop Smartwatch with the help of EduArm kit. EduArm is an ARM cortex-M3 core LPC1768 educational development board.

EduArm has an extensive set of peripherals that allows users to build and design various applications. Smartwatch developed on EduArm board will have functionalities such as it will display time, measure steps of the user. The time will be displayed in both analog and digital form. The most exciting feature of the EduArm kit is the 2.8" inch TFT touch screen display screen. The on-board low power audio codec with line in and line out, interfaced with I2S bus, and provides a complete audio solution for portable device application development.

EDUARM KIT that is proposed here aims at developing embedded systems applications. The EduArm kit also reduces the problem of interfacing various sensors as EduArm has some inbuilt sensors such as low power 3-axis accelerometer. Along with these onboard peripherals EduArm has 2 auxiliary ports which has variety of peripherals like GPIO, PWM, ADC, UART, I2C and external interrupt which allows user to extend its functionality .

EDUARM kit also has on-chip CAN controller which in combination with on-board CAN transceiver makes it suitable for CAN network. EDUARM kit also has a USB connector for both powering and programming purpose. The board has a FTDI chip for USB to serial conversion. Along with the rich set of on-board peripherals eduarm has a reset switch and following indicator led's such as PROG LED, POWER LED, USB LED. Thus the overall proposed system developed by using Eduarm kit is been given name as Smartwatch Using Eduarm kit.

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CHAPTER 1

INTRODUCTION

1.1. Aim:

To develop a smartwatch using EduArm development board that can show time to the user, set alarm for the user and measure the steps walked by the user. The time will be displayed to the user in both analog and digital form.

1.2. Objective:

The Smartwatch using EduArm kit project is proposed as an alternative to the existing microcontrollers such as Arduino , Spark core. As various microcontrollers such as Arduino, Spark core requires interfacing of hardware stuff externally, EduArm development board has interfacing of some hardware components internally.

EduArm is aimed at reducing the issue of interfacing various hardware components such as display screen, sensors with the microcontroller. Besides gaming and software application which can be implemented on EduArm kit, we decided to develop embedded systems project like smartwatch to extend and test its functionality.

1.3. Project Motivation:

EduArm kit specifications are as follows:

- LPC1768 CORTEX-ARM M3 microcontroller.
- Inbuilt 3-axis accelerometer.
- TFT touch Screen display screen, SD card for data storage.

This gave us the main idea behind this project that was to develop a smartwatch that would show time to the user. Also, we intend to add functionalities such as set alarm and accelerometer. Due to the touch screen display screen, games and software applications such as paint can be easily implemented but using the microcontroller and sensors internally embedded into it we decided to develop a smartwatch which will have the functionalities same as that of normal smartwatch.

1.4. Organization of Report

Chapter 2 contains Literature Survey. In this chapter, we have studied and reviewed the previous work done on the topics related to our project. We did a detailed study on five such papers published in international journals including our own publication. We also studied on the limitations of those systems.

Chapter 3 is Analysis of our system. Analysis is done on the basis of its feasibility, that is, practicality of the system and risk analysis, which consists of things that would affect the system from operating as per original idea.

Chapter 4 Methodology includes the problem statement, scope of project, project development plan, project design.

Chapter 5 consists of UML diagrams such as state diagrams, sequence diagram and also flowchart.

Chapter 6 contains results and analysis. In this chapter, we provide our findings and compare those with the existing system to finding the percentile increase in performance.

Chapter 7 concludes our project research and further upgrades that can be implemented to refine the system.

Chapter 8 lists out all the references and sources that helped us during our research phase including research and contribution papers.

Chapter 9 lists our research publication in the International Research Journal of Engineering and Technology (IRJET).

CHAPTER 2

LITERATURE SURVEY

2.1. Study of existing research

Authors	Paper Title	Brief	Drawback
A M Ch Jyothi, N Santoshi	Graphical Scientific Calculator Using EduArm Kit [1]	Basically tells us how to burn files from flash magic software to EduArm controller.	No proper explanation given on how to burn our own hex files and also syntax to code on flash magic software is also not mentioned.
HAO QIU , XIANPING WANG , FEI XIE	Calculate Steps Using 3-axis accelerometer[2]	It proposes a method to calculate number of steps of the user using 3-axis accelerometer.	Multiple factors need to be considered while calculating number of steps walked by the user.
Garry M. weiss, Jessica L. Timko , Catherine M. Gallagher	Smartwatch based Activity Recognition[3]	This research paper examines the activity of smartphones and smartwatches for activity recognition.	Accuracy for recognition of activity is not highly accurate enough.

Table 1: References cited

2.2. Drawbacks of Existing System

As Eduarm kit consists of LPC1768 microcontroller, TFT display screen and inbuilt 3-axis accelerometer, the problem of interfacing hardware components is reduced. In the existing Arduino and spark core microcontrollers, we had to interface various sensors.

In arduino and spark core the problem of data storage also rises as there is no facility to store the data . Eduarm kit provides a 2 GB memory card slot for the data storage. Eduarm kit also has a inbuilt interfaced touch screen TFT touch display screen. The existing systems like arduino and sparkcore microcontrollers does not have audio codec which is used for alarm purpose.

Also, the proposed system includes a audio codec which is used for buzzer to enable as when alarm happens. Thus Eduarm kit is highly efficient in terms of interfacing and functionality features as compared to arduino and spark-core micro controllers. Eduarm kit has onboard 320x240 ,262K colors touch screen display. Here TFT display is interfaced with 8 bit parallel bus while touch screen is interfaced with SPI bus. Thus in arduino we have to interface the touch screen externally.

CHAPTER 3

ANALYSIS

3.1. Feasibility Analysis

Comparing the proposed system with the existing ones allowed us to analyze the feasibility of our system. The main aspects considered during the feasibility study are:

3.1.1. Economic Feasibility

The proposed system is entirely hardware based. The EduArm kit has LPC1768 microcontroller which has RTC, Accelerometer and touch screen display embedded in it. This reduces the cost of buying sensors and touch screen display screen to interface it with microcontroller externally.

3.1.2. Technical Feasibility

Smartwatch developed using EduArm kit will require the usage of battery or watch cell to continuously increment time with the help of RTC. Also installation of Flash Magic software is essential to burn the required HEX files on the EduArm development board.

3.1.3. Operational Feasibility

The Smartwatch will also have a GUI which will help the user to choose his functionalities. The GUI developed can be accessed with the help of keypad buttons and touch screen.

3.1.4. Environmental Feasibility

Flash Magic software has libraries developed which are based on concepts of C programming. This makes one easier to code as all the functions and structures syntaxes are similar to that of normal C compiler. This creates a sense of familiarity amongst the users.

3.2. Risk Analysis

Being hardware and software based embedded application there are various risks involved in it.

3.2.1. Inadequate power supply

Smartwatch will have the functionality of time. To increment the value of time on the kit it is necessary that the EduArm board is connected to a battery so that it is continuously power on. The battery voltage supported by the EduArm kit can be maximum up to 5V.

3.2.2. Improper installation of Flash Magic software

For burning the hex files on Eduarm, it is essential that all the libraries of flash magic software are installed properly. Also it is essential that proper system path of make file is given as the code written will be executed by the make file..

3.3. Hardware and Software Requirements

3.3.1. Hardware Requirements

- EduArm Development Board
- Battery of 5V

3.3.2. Software Requirements

- Flash Magic software

3.4. Functional and Non-Functional Requirements

3.4.1. Functional Requirements

Functional requirements are the functions or features that must be included in the system to satisfy the business needs and be acceptable to the users. Based on this the functional requirements of the system are as follows.

- **Pre-start checks:**
  By executing the make command, the flash magic software checks for errors in the code. After the execution of make command the user should click the start button to build the hex file and the desired functionality output will be displayed on eduarm TFT display screen.

- **Runtime permissions:**
  The user must explicitly grant access to the path of the folder where the executing code files are stored in. This will help in the working of flash magic software tool efficiently.

3.4.2. Non-Functional Requirements

- **Robustness:** While burning the hex file on Eduarm the user must see that whether the make command is executing or not. The file is successfully burned if and only if make command is executable and when the make command executes, the user must see that there are no errors..
- **Efficiency:** As Eduarm uses less sensors to be interfaced due to availability of inbuilt sensors which are interfaced with LPC1768 microcontroller internally, the eduarm board is highly efficient as it uses less amount of resources..
- **Data retention & integrity:** It is made sure that the predefined library files of flash magic are not changed as functions used while coding are defined in library files and some changes done by the user will affect the whole working of flash magic software.

Integrability: Flash Magic is the most efficient toll for integrating hardware and software. This software tool is specially used for developing embedded applications in which the coding is based on microcontroller pin configuration.

- **Supportability**: Smartwatch will be supportable to the user provided Eduarm kit has adequate power supply, USB connection with eduarm and desktop computer or laptop so that after burning all the hex files the user will be able to use the functionality of smartwatch.

CHAPTER 4

METHODOLOGY

4.1. Problem Statement

Eduarm is a development board on which various hardware and software applications can be implemented. Since Eduarm has a latest cortex arm M3 based LPC1768 microcontroller which is capable for developing embedded applications, our main aim was to develop a smart watch that can show time to the user in both forms such as analog and digital. Also the user shall be able to set an alarm for the required time which he wants to set. The user should also be able to calculate number of steps walked by him with the help of 3-axis accelerometer.

4.2. Scope of Project

Eduarm can be extensively used in both embedded and software applications. We developed a smart watch that shows time to the user in both analog and digital form. User will also be able to set an alarm at given time. User will also count number of steps walked by him with the help of 3-axis accelerometer.

4.3. Software Development Paradigm

We used the Waterfall model while developing the smart watch application. The typical steps involved in the development process were:

- Planning
  - Deciding the methods, platform, and basis of the project.
  - Planning and deciding the UI for the smart watch.
  - Research paper planning.
- Construction
  - Constructing the decided UI.
  - Backend coding for showing time, alarm clock.
  - Coding for accelerometer.
  - Integrating all the codes with the UI and associating it with Eduarm keypad.

- Testing
  - The constructed smart watch was tested with various models of Eduarm kit to test whether all the desired functionalities are working according to users requirements.
- Communication
  - The tested product was delivered to our guide and modifications suggested were implemented in the system
  -

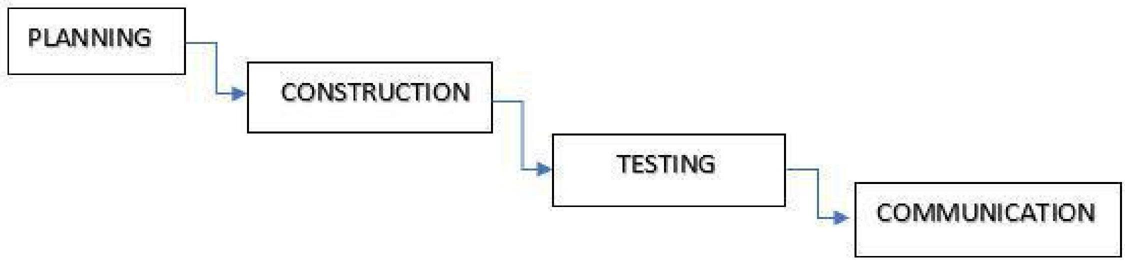


Fig.4.1 Waterfall Model

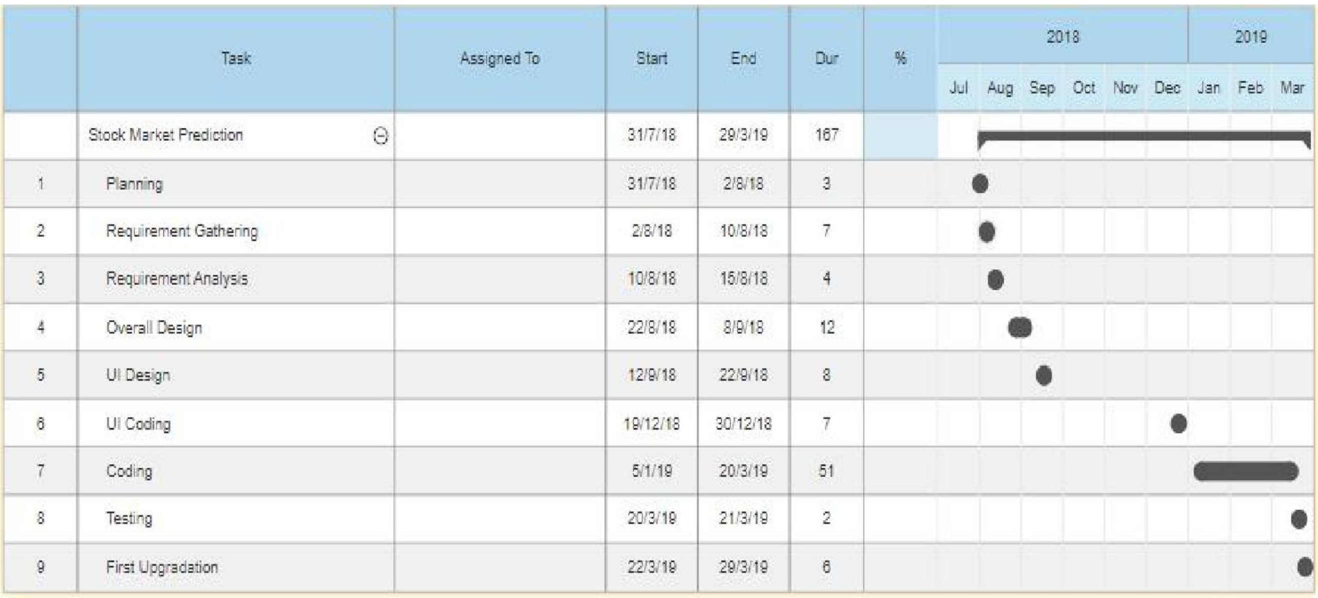
4.4. Project Development Plan

The project development plan below shows all the dates and all the relevant information. The core idea was implemented and tested properly. Additional coding (1^{st} update) was completed within the predefined deadlines.

Phase	Duration (Days)	Start	End
Planning	3	31/7/18	2/8/18
Requirement Gathering	7	2/8/18	10/8/18
Requirement Analysis	7	10/8/18	18/8/18
Overall Design	14	22/8/18	8/9/18
UI Design	9	12/9/18	22/9/18
UI Coding	11	19/12/18	30/12/18
Coding	73	2/1/19	15/3/19
Testing	1	16/3/19	16/3/19
Additional coding(1st update)	4	25/3/19	29/3/19

Table 4.1: Project development plan

The entire flow of the system development can be visualized in the Gantt chart below:



	Task	Assigned To	Start	End	Dur	%
	Stock Market Prediction		31/7/18	29/3/19	167	
1	Planning		31/7/18	2/8/18	3	
2	Requirement Gathering		2/8/18	10/8/18	7	
3	Requirement Analysis		10/8/18	15/8/18	4	
4	Overall Design		22/8/18	8/9/18	12	
5	UI Design		12/9/18	22/9/18	8	
6	UI Coding		19/12/18	30/12/18	7	
7	Coding		5/1/19	20/3/19	51	
8	Testing		20/3/19	21/3/19	2	
9	First Upgradation		22/3/19	29/3/19	6	

FIG.4.2 Gantt Chart

CHAPTER 5

DESIGN AND IMPLEMENTATION

5.1. Design

5.1.1. UML DIAGRAMS

5.1.1.1.Activity diagram: This State Diagram describes the different states that the objects of our application will be in and the external or internal events that control these states. Based upon mode selected, we will have two different state diagrams as:

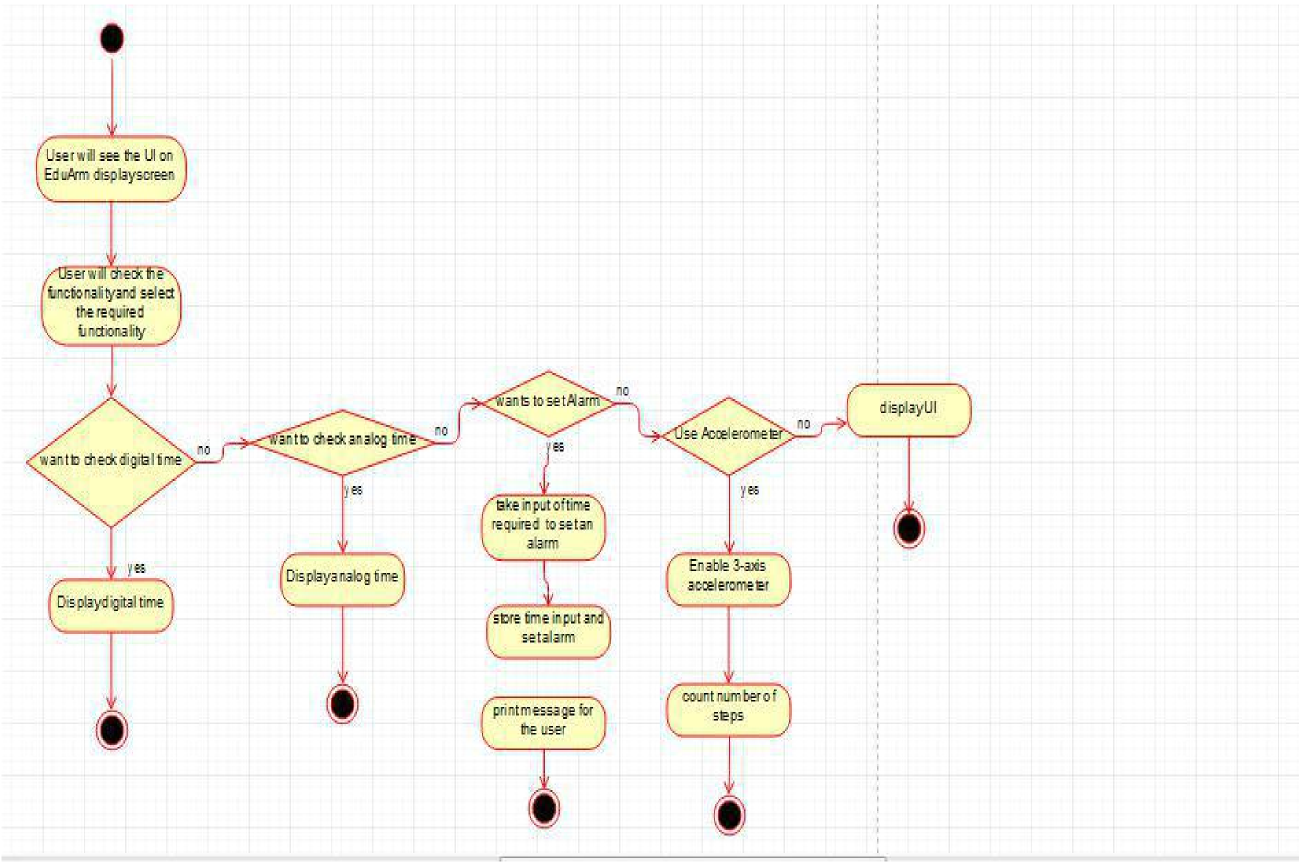


Fig.5.1 Activity diagram for Smartwatch

5.1.1.2.Sequence Diagram: The sequence diagram shows the sequence in which eachtransaction occurs.

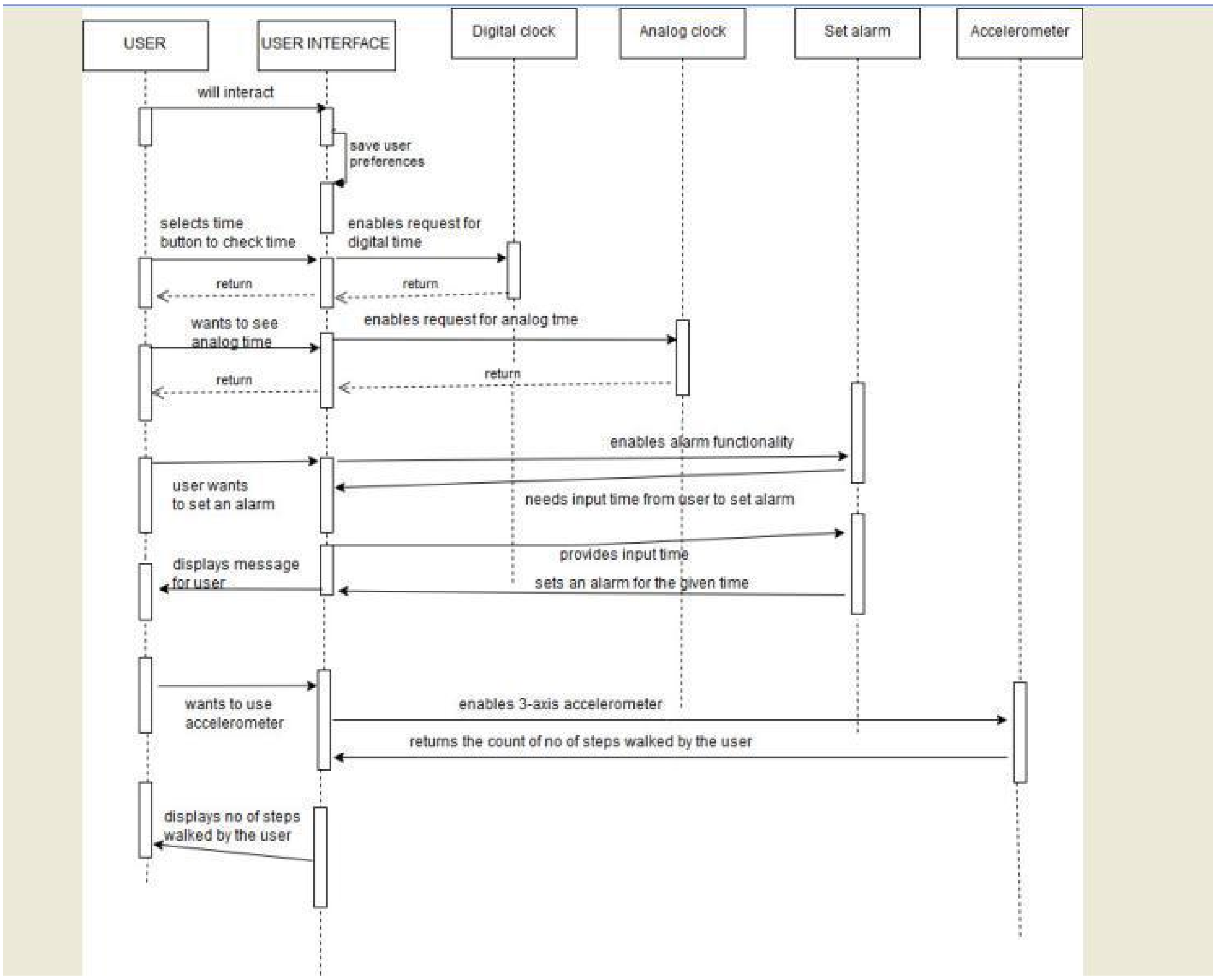


Fig.5.2 Sequence diagram

5.1.2. Flowchart

The flowchart here shows the entire system workflow of the FAST application.
The working of Sender and receiver is shown in the collective flowchart below.

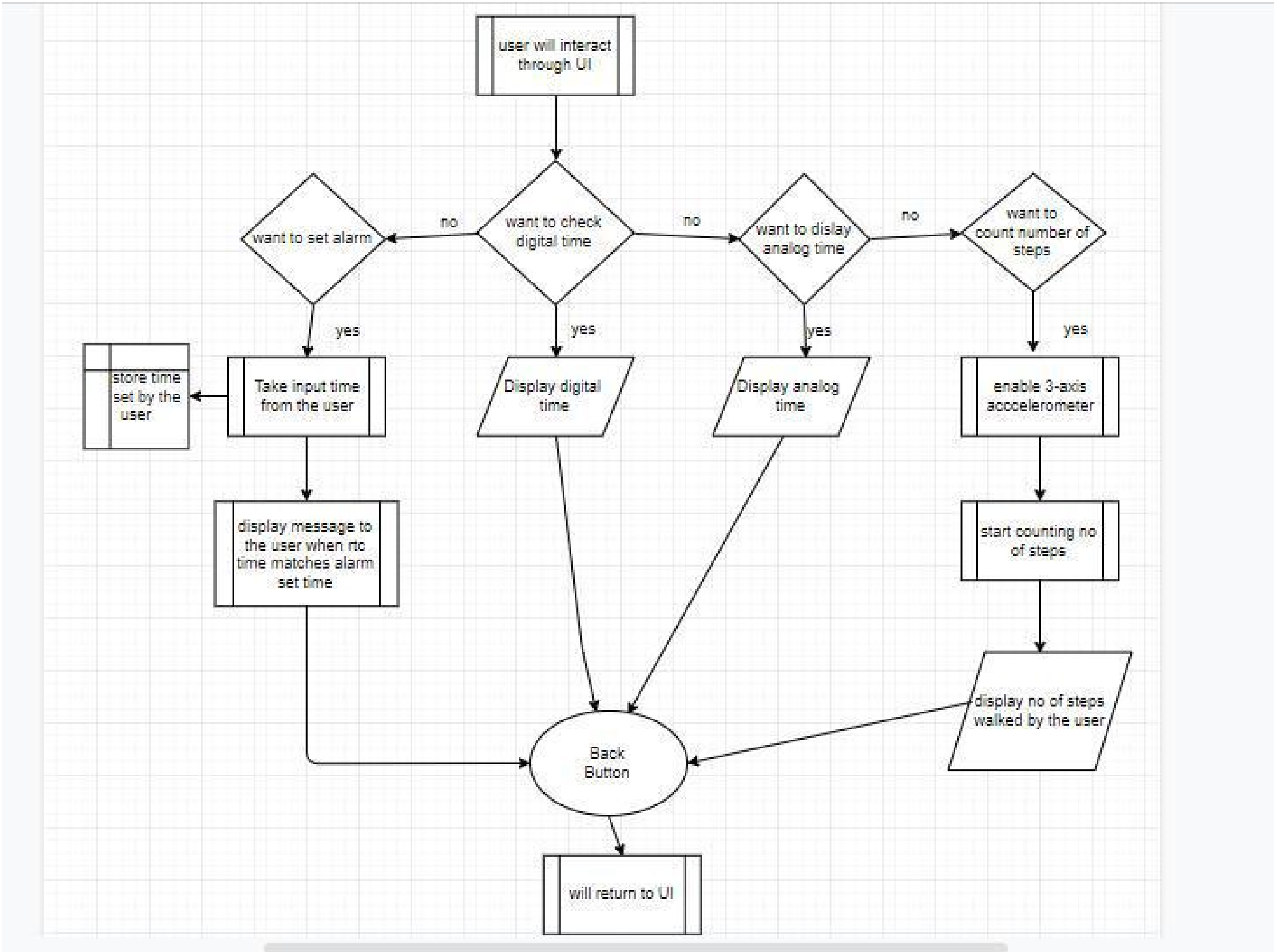


Fig.5.3 Flowchart for the Smartwatch process

5.2. Implementation

5.2.1.

The application's code is written in flash magic software with the help of following libraries :

1. **Prime_RTC**:

    This library is used to implement time and alarm function. This library has structures and methods predefined. The structure defined for time consists of members like hours, minutes, seconds, date, day of month, year. This library also has predefined methods to get time and set time. The pointer variable used to access the members of the structure is also defined in this library.

2. **Prime_RTC_Core**:

    This library has all the various libraries defined in it. In order to use Prime_RTC library we first have to include this library. If this library is not included in the time and alarm code then the flash magic compiler will show error.

3. **Graphics:**

    Graphics library is used to display text, draw various geometric shapes and also to create buttons. This library has various methods defined for various geometric shapes. In this library there is also a special syntax for a text to be displayed. Some of the methods used in our project are gfxdrawstring(), gfxdrawcircle().

4. **Tmath:**

    Tmath library consists of trigonometric functions such as sin,cos, tan. This library is used for the implementation of digital clock. This library is useful to take measurement of angle and rotation of clock hand.

CHAPTER 6

Results and Discussions

1. UI display.

When user powers on the Eduarm kit, he is greeted with the following user interface. The user will have 4 options to choose on the user interface. The 4 options will be to display digital time, to display analog time, to set alarm, Accelerometer.

Fig.6.1 Home screen

2. Display Digital Time:

When user clicks on ‘Display Digital Time’ button, the user will get to know the digital time. The time is incremented to the user with the help of RTC. The time is displayed in the form of conventional clock form. To continuously increment time with the help of RTC, the RTC must be connected to a battery of maximum 5V. The user can also access this feature with the help of keypad buttons. The keypad button assigned to use this functionality is”2”. The user will also be provided with the back button to return to the home UI.

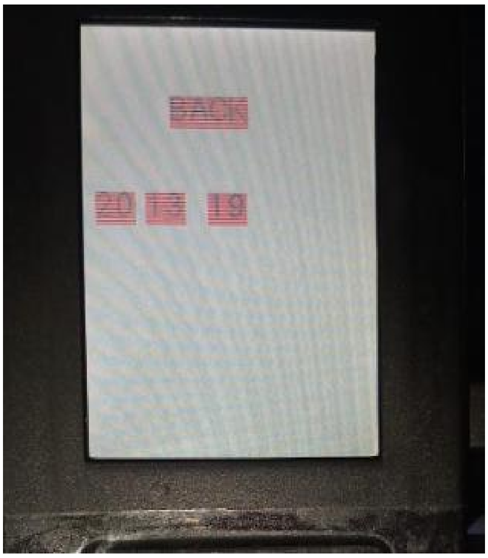


Fig.6.2 Display Digital Time.

3. <u>Display analog time</u>:

When user clicks display analog time button, the user will be able to see analog time. The time will be displayed to the user in the form of hours, minutes and seconds. This feature is implemented only when RTC is enabled and RTC is provided with adequate power supply or connected to battery. Also the user can access this functionality with the help of keypad buttons. The keypad buttons assigned to use this feature is”1”. The user will also be provided with the back button to return to the home UI.

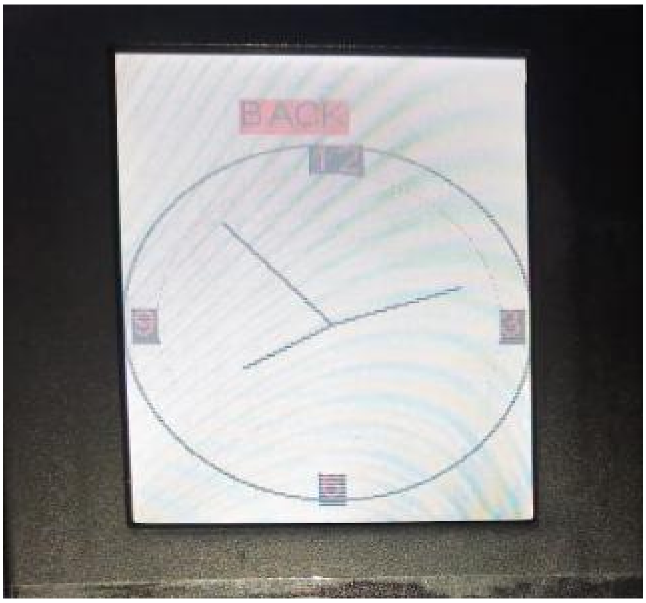


Fig.6.3. Display Analog Time.

4. Set Alarm:

When user selects set alarm feature he will be directed to give input time which he wants to set as alarm. The time provided by the user will be stored in internal storage of Eduarm kit. When the alarm time matches with the RTC time the user gets a message on the TFT display screen of the eduarm kit. The message text displayed to the user will be "ALARM".

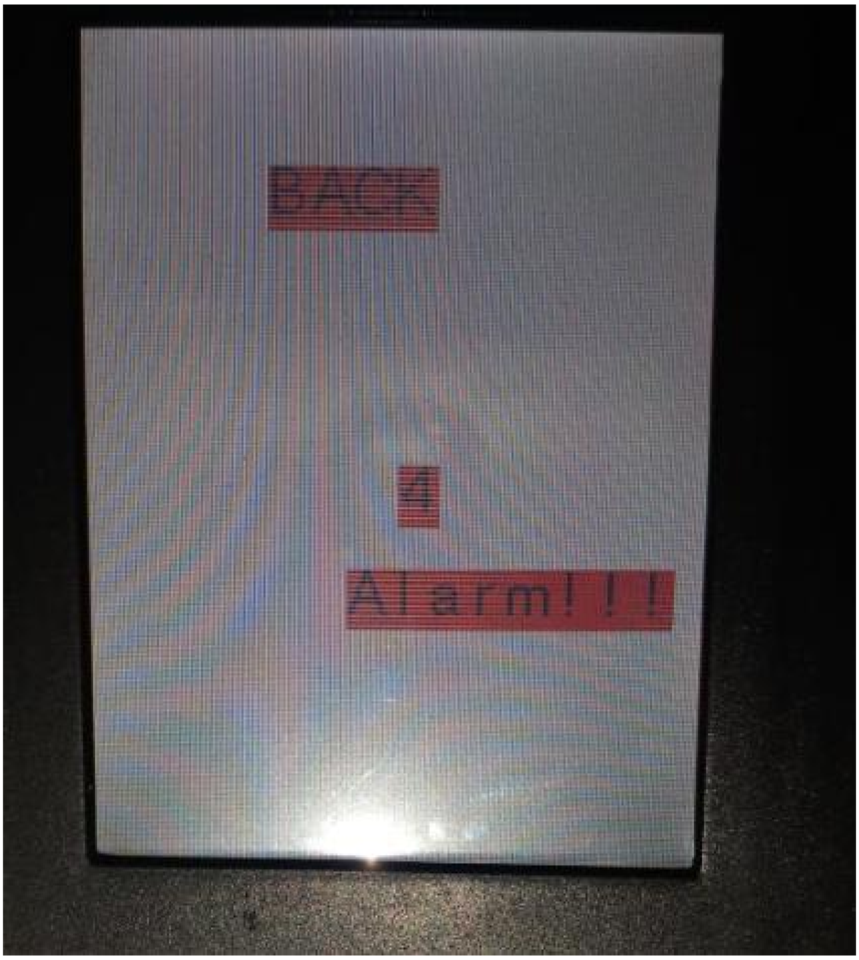


Fig 6.4. Alarm clock

CHAPTER 7

CONCLUSION AND FUTURE SCOPE

SMARTWATCH application developed here, is a considerable improvement over traditional methods like smartwatch developed using arduino. Also, we managed to overcome the drawbacks of existing systems like arduino, spark core. The drawbacks of the existing system were overcome by using this development approach. The typical problems which were overcome in our development approach was that less amount of interfacing is done among sensors externally as some sensors are interfaced and integrated internally.

Here, we attempted to make a smartwatch that shows time to the user in both the forms that is analog and digital. The user is also able to use alarm clock feature which takes input from the user. The digital and analog functionality is being implemented with the help of prime rtc and prime core libraries defined in flash magic. For touch screen display we used a predefined touch screen libraries in flash magic so that user can experience touch screen functionality. We have used concept of interrupts to implement the functionality of Alarm in our smartwatch.

As Eduarm kit is being developed recently and its application was much restricted for gaming purpose only, we tried to enhance its application usage by implementing smartwatch on it. By interfacing heart rate sensor with the auxiliary port one can measure his heart rate on eduarm kit. Thus Eduarm kit can be used in implementing wide range of applications that is from software to embedded systems.

Chapter 8

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Chapter 9

PUBLICATION

Ojas Indulkar, Mitesh Gohil, Shweta Shilamkar, Nidhi Shetty – “Smartwatch using EduArm Kit”, International Research Journal of Engineering and Technology (IRJET), Volume: 06 Issue: 03 | March-2019, e-ISSN: 2395-0056.

SMARTWATCH USING EDUARM KIT

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Abstract - EduArm is a ARM cortex-M3 core LPC1768 educational development board . *EduArm has an extensive set of peripherals that allows users to design and build various applications .Smart watch is a device which gives user many more functionalities besides time keeping . In this paper we present the various functionalities which can be added into the smartwatch using EduArm kit . EduArm board is suitable for beginner , intermediate and advanced embedded developers . The smartwatch developed will support various functions similar to that of the ideal or basic smartwatch .*

Key Words: LPC1768, SPI, TFT display, prime framework , Cortex-M3.

1.INTRODUCTION.

EduArm is a ARM cortex-M3 core LPC1768 educational development board . *EduArm has an extensive set of peripherals that allows users to design and build various applications. The most exciting feature of this board is the 2.8" touch screen TFT display screen. The onboard low power audio codec with line in and line out , interfaced with I2S bus provides a complete audio solution for portable device application development. The board also features a low power 3-axis accelerometer with digital output for gaming and other applications. Along with these onboard peripherals EduArm has 2 auxiliary ports which has variety of peripherals like PWM , GPIO , ADC , UART , I2C And external interrupt which allows user to extend it's functionality. We will develop functionalities such as to display time to the user , set an alarm for the user , count number of steps walked by the user .*

2. FEATURES OF THE EDUARM DEVELOPMENT BOARD.

- EduArm has 2.8" inch 262k color TFT display with 8 bit parallel interface.
- It has onboard touch screen controller using SPI interface .
- SD card connector for data transfer and storage using SPI interface.
- Onboard buzzer for warning and feedback.
- 3-axis accelerometer interfaced using I2C .
- 3.5 mm stereo jack for mic and headphone.
- USB power and programming.
- 5 keypads with 3 user led and power led.
- CAN interface on RJ11 connector.
- Low power audio codec with inbuilt headphone amplifier using I2S interface.
- Reset switch and power button.
- JTAG header for debugging and programming.

3. SPECIFICATIONS.

- Micro controller : LPC1768.
- Onboard crystal for micro controller : 12 MHZ.
- Onboard on chip RTC : 32,768 KHZ.
- Input power supply options: USB , battery and 5V adapter.
- Touch screen controller : ADS7843.
- Audio coder : SGTL5000.
- Audio coder sampling frequency : 8Khz to 96Khz.
- Tft display : 320x240 pixels with real 262 , 144 colors display with ILI9320 display controller.

4. ACRONYMS:

- I2C : Inter-Integrated circuit protocol.
- CAN: controller area network.
- SPI: serial peripheral interface.
- UART: universal asynchronous receiver/transmitter.
- GPIO: general purpose input / output .
- PWM: pulse width modulation.

4.OVERVIEW OF DEVELOPMENT BOARD.

Figure -1: EduArm Development Board

5. PROPOSED METHODOLOGY AND IMPLEMENTATION.

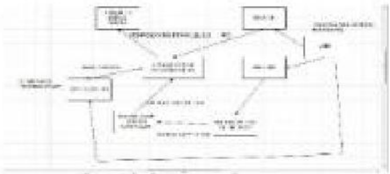


Fig -1: Block Diagram of our system

1. USER:

User will be able to see the functionalities like to display time , set an alarm or to use accelerometer on the UI developed which will be displayed on EduArm display screen.

2. SHOW TIME:

This feature will be implemented by using the RTC module in the LPC1768 micro controller. User will also see day , month , year along with time .

3. SET ALARM :

User can set the alarm on the watch. This feature will be implemented by using RTC module in LPC1768 micro controller which is embedded in EduArm development board.

4. Accelerometer

User will use this feature to count number of steps walked by him. This feature will be implemented by using 3-axis accelerometer which is inbuilt in LPC1768 micro controller.

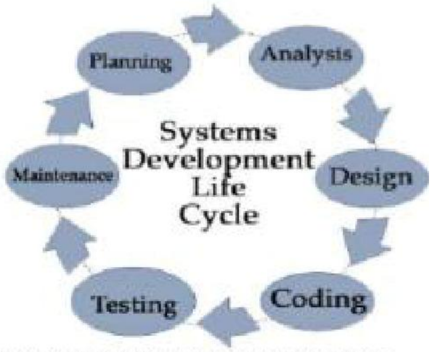
5. LPC1768 Micro controller.

User on selecting the functionality which he wants to use will be processed to the micro controller which has code embedded into it for the required functionality. The micro controller will provide the result of the users request and will display it on TFT display screen.

6. EduArm Touch Screen Controller

For setting an alarm user will have to input the desired time which he wants to set it as alarm. The time will be taken as a input through touch screen controller on TFT display screen which is interfaced with SPI bus .

SOFTWARE DEVELOPMENT AND PARADIGM.



Since SDLC is a risk driven process we have adopted this as a methodology for our project. In our project first we have to analyse the usage of EduArm Development Board and then design the User interface to interact with the user. After designing UI it is necessary to code the functionalities which are mentioned in the UI. After coding we have to test whether the output of the particular functionality is being reflected on EduArm TFT display screen or not.

7. ADDITIONAL FEATURES.

Since the problem with many smart watches is that there is miscalculation in number of steps. This problem is overcome by the use of 3-axis accelerometer which is precise in calculating number of steps walked by the user. Also the problem of discharging is resolved as EduArm development board has 3 options to power o the board. They are USB , battery and adapter of 5V.

8. CONCLUSION.

Smart watch development on EduArm kit will solve problem of interfacing various sensors to micro controller externally. Thus to reduce interfacing problems many features such as 3-axis accelerometer are inbuilt in EduArm kit Development Board. EduArm kit development board makes use of latest ARM cortex-M3 core lpc1768 micro controller which has touch screen display along with inbuilt RTC chip.

9.REFERENCES

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