IJETST- Volume||01||Issue||03||Pages 310-316||May||ISSN 2348-9480 2014

Open access Journal

International journal of Emerging Trends in Science and Technology

A Portable Self-Monitoring Fitness System

Authors

Yaram Swarna Latha, Sania Anjum, Roopa Shree B.G

Medical Electronics, MVJ College of Engineering

Near ITPB, Channasandra, Bangalore-560067

Email*: swarnakky@gmail.com*, *sania0007@gmail.com*, *b.g.roopashree@gmail.com*

Abstract

The aim of the project is to make a real time wearable calorie monitoring system. The devices used in this project are 28 pin Microchip 8 bit microcontroller PIC16F1783, an alphanumeric LCD, keypad with four keys, an accelerometer, a buzzer, a RTC and a heart rate sensor. The system is battery operated. The battery can be charged using a 12Vdc adapter. The inputs to the controller are keys, accelerometer, heart rate sensor, RTC and the outputs to the system are LCD display and a buzzer. The user has to enter his/her current weight using the keys on the keypad. The parameters will be saved in the RAM of the microcontroller. Then the system will list out the exercises. The user can select the exercise which will be displayed on LCD by using the keys. The heart beat rate sensor will continuously monitor the user's heart beat and will warn by the glow of green LED if the heart rate is above the normal threshold. If the person's heart rate is in normal range and if he/she is performing the exercise then the red LED flashes. The accelerometer will sense the amount of movement done by the user. After completing the exercise the system will be displaying the amount of calories burned by the user for the current day and a 'Congratulations' message will be displayed on the LCD. The RTC will give the time and date once it is configured. The RTC configuration should be done at the initial startup of the system.

***Keywords:** fitness, portable, physical activity, chronic disease, movement.*

INTRODUCTION

Childhood obesity is a growing health problem. Indicators show that the rate of obesity for children age 12-19 years old has risen from 5% percent to 18% over the last ten years. Strategies to solve this childhood obesity epidemic range from educating children about nutrition to enabling possibilities for physical exercise. These general approaches, although useful, are ineffective when not adapted into the day-today activities of children's lives. Obesity may lead to many diseases such as heart attack and diabetes. Obese children are prone to stay obese after growing up. Not just childhood obesity but even elderly people who suffer from various health related diseases such as diabetes, have to strictly maintain their weight with regard to their health. Youngsters who are supposed to be very active are currently subjected to various health issues and this is due to Smart phone technology, which makes people lazy and deviates them from physical exercises. Kids of this present generation are so attracted towards video games and other smart phone apps which made them to become far for physical exercises and that leads to obesity ultimately in kids which affects their health. A gadget which does not make use of any smart phone or any mobile app is useful for children, Adolescents and elderly people to do their physical activities without any distractions , unlike how it usually happens with smart phone apps such as calls and message interruption and draining of the mobile phone battery because of the use of physical activity apps. Elderly people may find difficulty in using apps in smart phones to check their amount of calories burned during exercises and the heart rate during exercise. So this gadget which does not require much procedure can be helpful for elderly patients also. If kids are provided with any smart phone and asked them to use it for physical activity then they don't go for that option, instead they would like to play some other games where they again get diverted.

SELF MONITORING FITNESS SYSTEM

The Fig 1 shown below explains about the board used for this particular work and the way the components are soldered.

This device is handy and portable to any age group people and can used by any number of users.This can be done even on a Printed Circuit Board(PCB). With very few components this special gadget can be made.

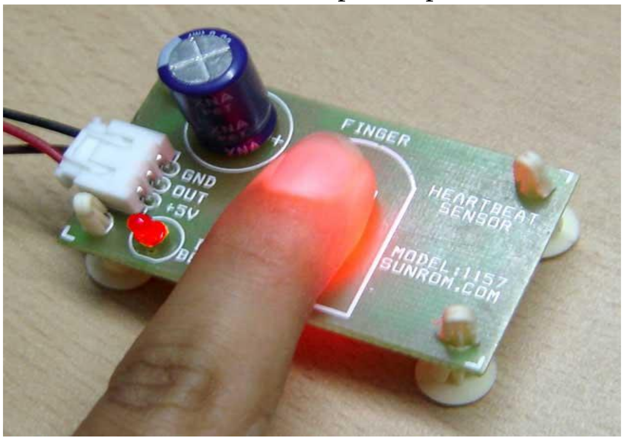
A. Microcontroller

Here we are using a PIC family microcontroller and that is a 28 pin, 8bit, pic16f1783 controller. This controller is used because of the following features:

- High Performance RISC CPU.
- Operating speed:
  - DC - 32MHz clock input.
  - DC - 125ns instruction cycle.
- Extreme low power management.
- Ana log and digital features.
- Oscillator and input, output features.
  - High performance PWM controller.

B. Heart Rate Sensor

A heart rate sensor is mounted on the finger to measure the number of pulses per second.



When the heart rate sensor is working the LED flashes indicating that it is detecting the pulses. Its digital output can be connected to microcontroller directly to measure pulse per second. It works on the principle of light modulation by blood flow through finger at each pulse.

C. Liquid Crystal Display

Here we use a 16 pin 16x2 character LCD. In this LCD each character is displayed in 5x7 pixel matrix, It has two registers, namely:

1)Command:This register stores the command instructions given to the LCD, which performs predefined tasks like, initialising it, clearing its screen, setting the cursor position, controlling display.

2)Data : This register stores the data to be displayed on the LCD, the data is the ASCII value of the character to be displayed on the screen.

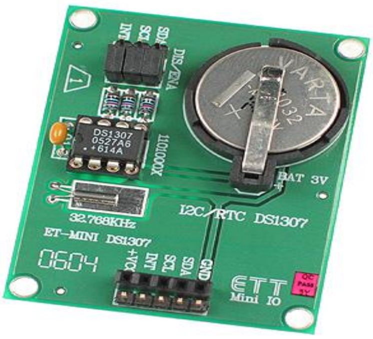
D. Accelerometer

A tri-axial accelerometer is used to measure the movements of the body. Here we use an ADXL335 accelerometer.

The ADXL335 is a small, thin, low power, complete 3-axis accelerometer with signal conditioned voltage outputs. The product measures acceleration with a minimum full-scale range of ±3 g. It can measure the static acceleration of gravity in tilt-sensing applications, as well as dynamic acceleration resulting from motion, shock, or vibration. The user selects the bandwidth of the accelerometer using the CX, CY, and CZ capacitors at the XOUT, YOUT, and ZOUT pins. Bandwidths can be selected to suit the application, with a range of 0.5 Hz to 1600 Hz for the X and Y axes, and a range of 0.5 Hz to 550 Hz for the Z axis.

E. Real Time Clock

A real-time clock (RTC) is a computer clock (most often in the form of an integrated circuit) that keeps track of the current time.



The DS1307 serial real-time clock (RTC) is a low power, full binary-coded decimal (BCD) clock/calendar plus 56 bytes of NV SRAM. Address and data are transferred serially through an I2C, bidirectional bus. The clock/calendar provides seconds, minutes, hours, day, date, month, and year information. The end of the month date is automatically adjusted for months with fewer than 31 days, including corrections for leap year. The clock operates in either the 24-hour or 12-hour format with AM/PM indicator.

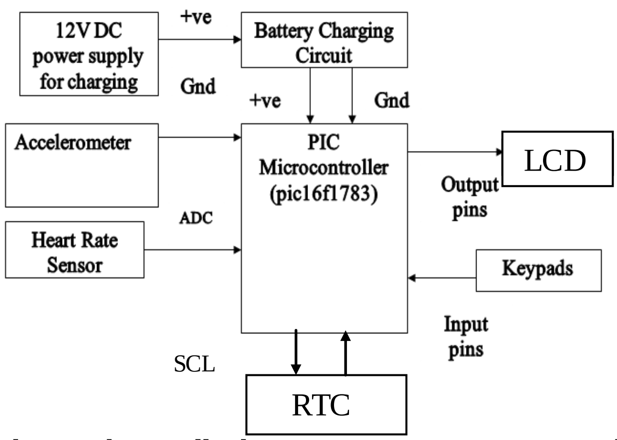
E. Keypad

A keypad is a set of buttons arranged in a block or pad which usually bears digits, symbols and a complete set of alphabetical letters.

Here we use 4 keys keypad to give the input to the system and to have the forward and backward option in the system.

Block Diagram and Software Description

The user has to enter his/her current weight. Then the system will list out the exercises. The user can select the exercise which will be displayed on LCD by using the keys. The heart beat rate sensor will continuously monitor the user's heart beat and will warn by the LED flash if the heart rate is above the normal threshold.



As shown above all the components are connected to the microcontroller through various input/output and other interfacing pins.Here the voltage level for the smooth functioning of the microcontroller is 5V.Apart from these components there is also a voltage regulator.

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A. *Embedded 'C'*

All programming part is done in embedded 'C' here. This programming language is used to write a low level code. The code for all components and interfacing code is all done in embedded 'C'.

A. *MPLAB IDE v8.60*

MPLAB IDE is a Windows based Integrated Development Environment (IDE) for the Microchip Technology Incorporated PIC micro microcontroller (MCU) families. MPLAB IDE allows you to write, debug, and optimize PIC micro MUC applications for firmware product designs. MPLAB IDE includes a text editor, simulator, and project manager.
MPLAB IDE runs as a 32-bit application on MS Windows, is easy to use and includes a host of free software components for fast application development and super-charged debugging.
This software provides various features such as creating and editing source files, grouping files into objects, debug source code.

TABLE I
CALORIE CHART

For Weight loss

Breakfast	Mid-morning	Lunch	Mid-afternoon	Dinner	Evening
3-400 cal.	100 cal	1-200 cal	100 cal	400cal	100 cal

For Weight Maintenance for 1800 cal/day plan

Breakfast	Mid-morning	Lunch	Mid-afternoon	Dinner	Evening
400	200	400	200	500	100

The formulas and calculations used to determine the amount of calories burnt are given as below:

- Male:((55.0969+(0.6309*HR)+(0.1988*W)+(0.2017*A))/4.184)*60*T.
- Female:((20.4022+(0.4472*HR)(0.1263*W)+(0.074*A))/4.184*60*T.

Where

HR=Heart rate(in beats per minute)

W=weight(in kilograms)

A=age(in years)

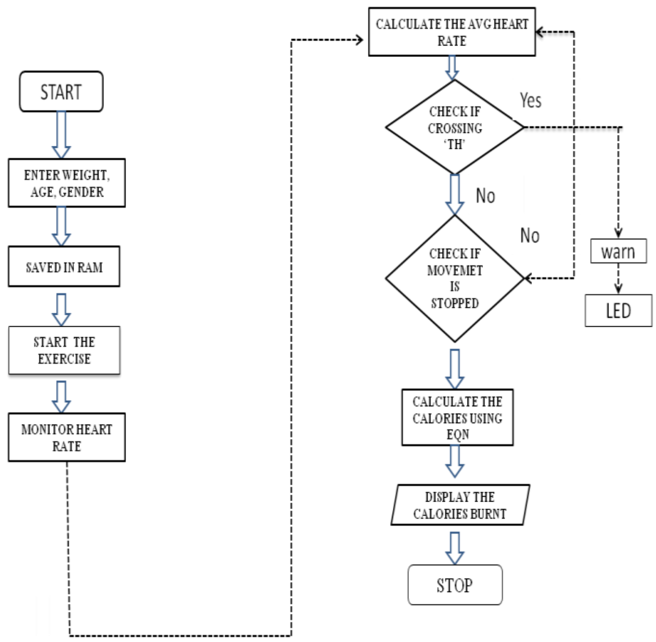
T=exercise duration time(in hours)

- Equation for determination of maximum heart rate based on age.

  Maximum heart rate(beats/min)=208-(0.7*age).

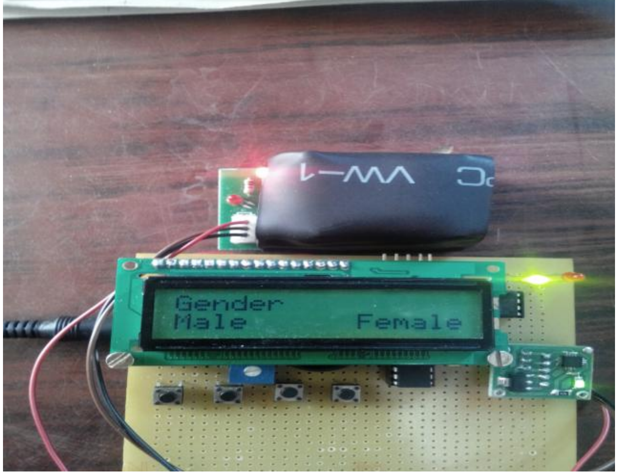
B. *Basic Flow Chart*

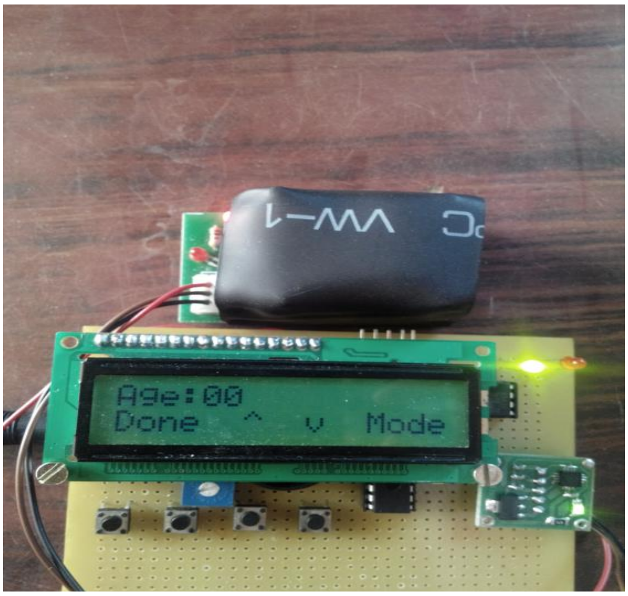
The below figure is the flow chart for this device. Firstly we start the device then the user data should be fed to the system such as age, weight, gender and this data is saved in the RAM. Then from the list of exercises one particular exercise is chosen and they will start the activity. Then simultaneously the heart rate is monitored. Then next it will check if the heart rate is crossing the threshold, if its crossing beyond the threshold then it will warn by LED flash. Then we check if the movement is stopped or not and if it stopped then finally the total calories burnt and a "congratulations" message will be displayed.

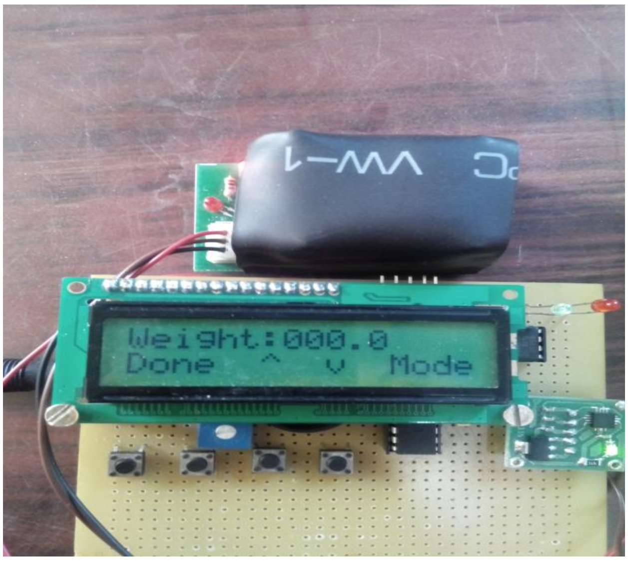


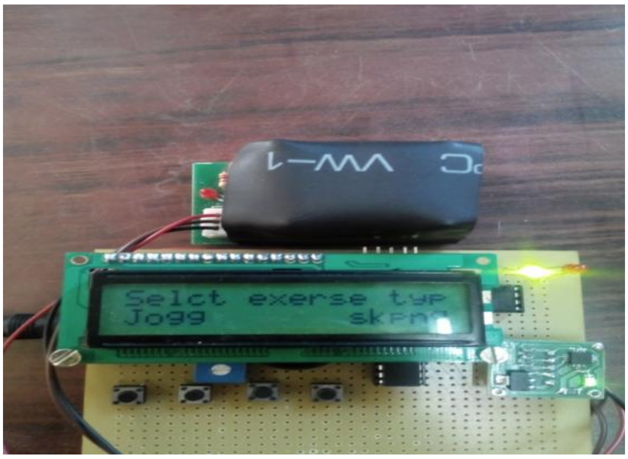
RESULTS AND CONCLUSION

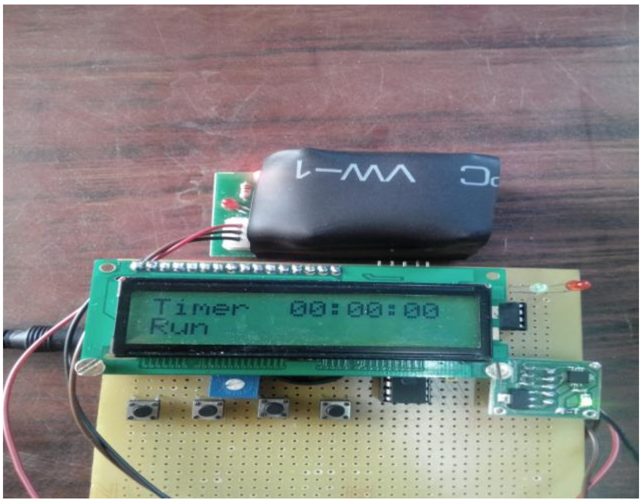
The figures of the final results are as shown below:

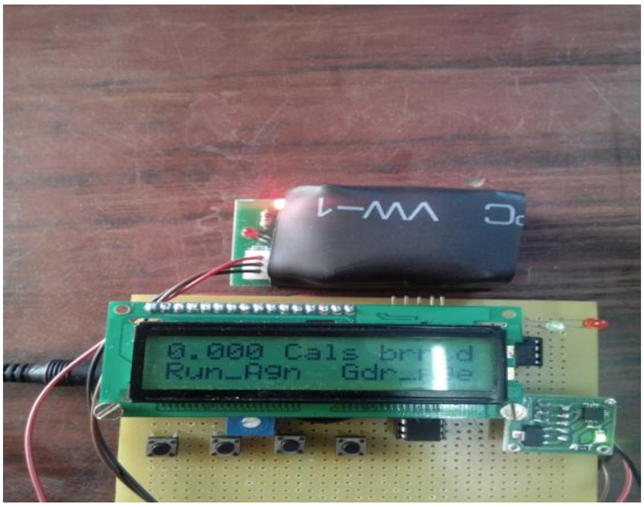




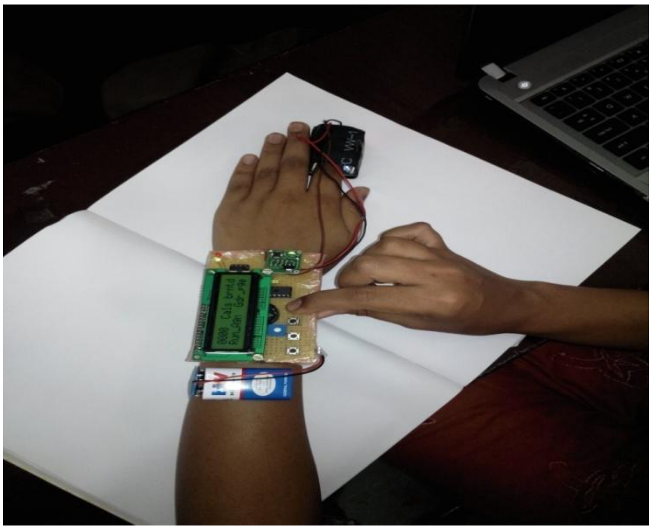








The final model of the device



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