Smart Wrist Watch

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***Abstract*—The motivation of the projected work is to design and development of the smart wrist watch which indicates the oxygen saturation(SpO2), temperature of the body along with real time clock and calorie burn calculator also able to keep a record of all these parameters which can be stored in personal computer. This database can be useful to physician for health diagnosis. The system has very small size and low cost. Now a days, every person is suspicious about their health, so this watch gives the real time indications of above parameters. This paper presents a reliable, effectual system which has a great impact on human body. According to the indications of body parameters on watch, people can adjust the temperature of body by drinking the water. Also if the level of oxygen decreases in the blood, human can go to the highly oxygenated area. It can show the daily calorie burn in the body as per the exercise. This device is very useful for those who are working in busy schedule or those who are giving less time to their health. In this proposed work, a genuine effort has been completed to design and development of the smaller size smart wrist watch.**

Keywords*—PIC Microcontroller, TMP 75 sensor, OPT 101 Transimpedance Amplifier, Calorie, Real time clock.

I. Introduction

Nowadays many people are suffering from health diseases due to the many problems like less amount of calorie burn in the body, which results in obesity [1], less drinking of water, insufficient amount of oxygen in the body. Obesity results from overeating and inactivity [1]. The habit of checking the temperature of the body, which helps to maintain the sufficient water inside the body. Daily calorie burn expenditure can help to do exercise and a well-balanced diet to decrease the obesity. If the person is present/working in the less oxygenated area then the percentage of oxygen in the body decreases, due to this it greatly effects on various organs present in the body, so there is a need to maintain and give the continuous status of the oxygen [2]. In this paper, we designed the watch , which indicates the temperature, SpO2, Calorie burn during the exercise. It can show the Real time clock, which shows the real date in day/month/year and time in hour/minute/second. It is very useful to implement a smart wrist watch, because a watch is the only electronic device people carry every day.

Many people who are working in the IT, oil and gas industries, or those who are working in the mines, so this watch helps a lot of their busy, pressure schedule. Smart watch is cost effective. It will help in making healthy body which is disease free [3].

Rifki Wijaya and Ary Setijadi [4] has developed the device, which collects data from the heart rate. This smart watch has features counting body temperature and heart rate data. The data temperature is picked up in the wrist. To collect the data, the environment temperature should be taken in consideration. The data collection by using smart watch can be done with activity tag and time stamps. The watch can also detect the work stress by using heart rate.

G.Karthik Reddy & K. Lokesh Achari [5] discussed non invasive method for calculating calories burned during exercise using heartbeat. They use IR sensor to measure the pulse rate. By using pulse rate, calculate the heart rate. This device estimate calories burn using heart rate. It measures heart rate well in a short time and with less cost and in less time. The pulse detected using this system, and then calculates the calories burned during exercise from measured heartbeat. To keep the device simple, combined the analog and digital signal processing techniques. The results have been compared with the traditional calories estimator which shows the results from measured heartbeat are accurate.

Hasmah Mansor et.al [6] described the measurement of body temperature in the remote health monitoring system. This device measures body temperature and doctor can observe the results in real time as well as the history data via internet. It provides alarm or indication to doctors in case of abnormalities. The body temperature measure by using wireless monitoring system. The temperature sensors detect the temperature and send these readings to the microcontroller using zigbee wireless communication. Wireless local area network (WLAN) has been used to send real-time date to health monitoring database by using arduino by means of Ethernet shield based on IEEE 802.11 standard. The results shows the real-time temperature reading successfully monitored locally (at home) and remotely (at doctor's computer). This system provides the consistent measurements and it is very user-friendly.

In the above research they developed temperature, heart rate, calorie burn and remote real-time monitoring system independently. But in this paper temperature, SpO_2, calorie burn with real time clock displayed together and data has been stored in EEPROM as used further for analysis with respect to time.

The arrangement of this paper is fragmented in V units. Unit II explains the description of the system, whereas subunit 1 explains the block diagram of the system, subunit II shows the calculations of calorie burn calculator and subunit III explains temperature measurement and subunit IV shows the details about oxygen saturation. Unit III demonstrate the hardware implementation of the system. In unit IV reveals

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Results and Discussion where next unit V concludes the work.

II. Description of the System

The detail description of the system is given in below subsections

A. Block diagram of system

Figure.1 shows the basic block diagram of the smart wristband. For this, we use the PIC18F4550 microcontroller, its works on 2.7 V to 5.5 V so it consumes very less amount of power. It has 10 bit ADC and we used the 44 pins thin quad flat package, which is very small of 5mm-5mm-2mm length/breadth/height. We connect the temperature sensor TMP75, DS1307 real time/date clock IC and pulse oximeter sensor circuit to different ports of the circuit, and finally we connect the LCD display to show the results.

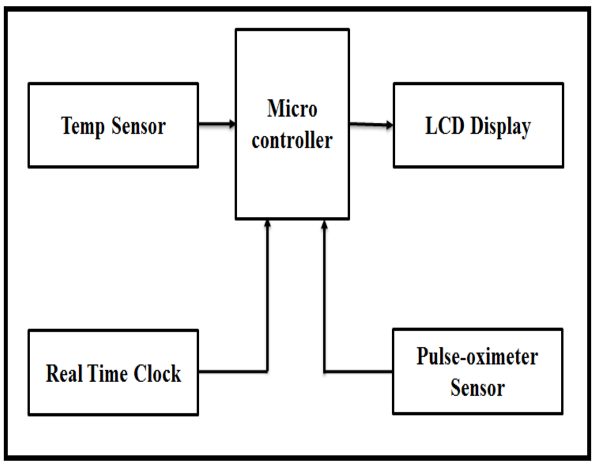

Fig. 1: Block diagram of proposed system

B. Calorie burn calculator

This calorie burn calculator provides an estimate of the total amount of calories that burn during an activity. The correctness of this calculator is intensely influenced by the activity level that you choose, so try to choose an activity level that really reflects how much physical activity you execute on a typical day.

This calculator provides an assessment of your entire daily caloric expenditure by multiplying the Harris-Benedict equations for basal metabolic percentage by an activity level factor that accounts for your daily physical activity levels. The equations of this calculator are shown below.

For men:BMR = 66.5 + (13.75 x weight in kg) + (5.003 x height in cm) (6.755 x age in years) (1)

For women:BMR = 65.5 + (9.563 x weight in kg) + (1.850 x height in cm) (4.676 x age in years) (2)

For this we added the height and weight as per the person. The predictable BMR value is multiplied by a number that relates to the individual's activity level [7]. The resultant number is the suggested daily kilo calorie intake to conserve current body weight. For that we select the following 2 activities

- Moderate exercise: BMR x 1.55
- Hard exercise: BMR x 1.725

C. Temperature measurement

The figure of temperature measurement IC is shown in Fig.2. For the measurement of temperature we used the TMP75 digital temperature IC, which is I2C compatible so there is no need of ADC is required and it is easily available. Its works on 2.7 V to 5.5 V with 8-Pin SOIC Packages. All this setup is developed in the collage laboratory.

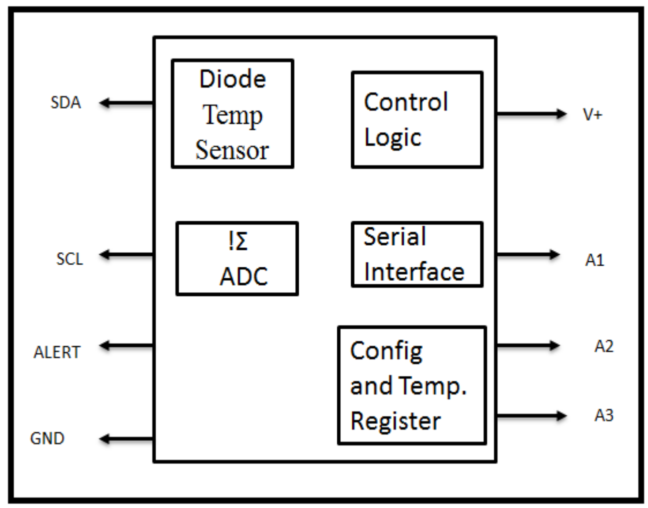

Fig. 2: Hardware assembly of temperature IC

The package of the IC is VSSOP 8 pin and size of the IC is $3.00mm \times 3.00mm$. This IC has many advantages like it comes with very small also it works on very low power.

D. Oxygen saturation (SpO2) Measurement

The figure of oxygen saturation is shown in Fig.3

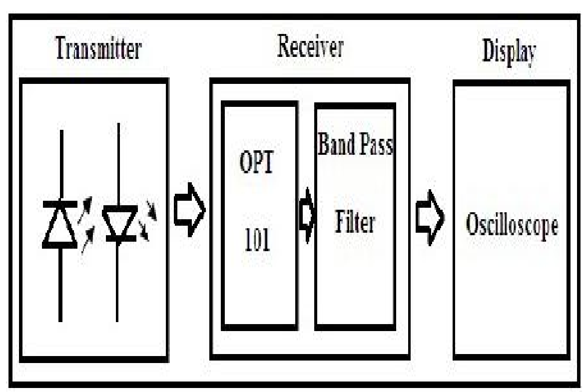

Fig. 3: Hardware assembly

The SpO2 measure the oxygen saturation level in blood [8]. For SpO2 measurement, IR sensor is used as a transmitter and OPT 101 with band pass filter used as the receiver. The oscilloscope displays the result of plethysmograph. The SpO2 measurement gives the oxygen saturation level of the body of the person wearing smart wrist-worn band during his/her daily life activities [9]. From the plethysmograph, the pulse rate can be calculated.

E. Real Time Clock

The real-time clock (RTC) offerings time in Hour:Minute:Second composed with Day/Month/Year and keeps track of current real time [10]. RTC works constantly even when the foremost device power is off and for the period of these times RTC IC's pull power from an auxiliary battery or super capacitor. RTC IC DS 1307 is used with 3 V voltage. The Smart wrist watch shows current time and date by using RTC DS 1307.

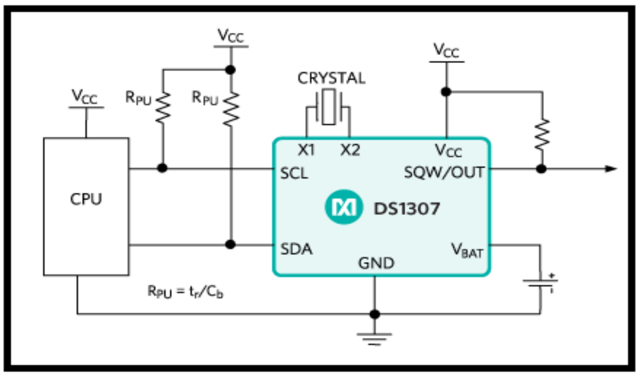

Fig. 4: Circuit diagram of real-time clock

Fig.3 shows the circuit diagram of RTC IC DS 1307. The clock works in either the 24-hour or 12-hour format with AM/PM indicator. Address and data are transmitted serially through an IC, bidirectional bus. The clock/calendar delivers seconds, minutes, hours, day, date, month, and year information. AT the finish of the month, date is automatically adjusted for months with fewer than 31 days, including modifications for leap year. DS 1307 has 8-Pin DIP so reduces necessary space. Hence, gives small package size and it has high accuracy.

The DS1307 has an integrated power-sense circuit that detects power failures and automatically controls to the backup supply. Timekeeping process continues while the part works from the backup supply. The DS1307 serial real-time clock (RTC) is a low-power, full binary-coded decimal (BCD) clock/calendar plus 56 bytes of NV SRAM.

III. Hardware implementation & description

The system implementation shows temperature sensor (TMP75), pulse oximeter, calorie calculator and real-time clock (RTC). All these components and sensors are integrated using PIC microcontroller. PIC microcontroller has additional advantages over other microcontrollers. The PIC microcontroller has inbuilt ADC, I2C, huge amounts (2048 Bytes) of RAM memory for buffering and enhanced flash program memory (32KB). It has USB connection to upload/download the programs from PC.

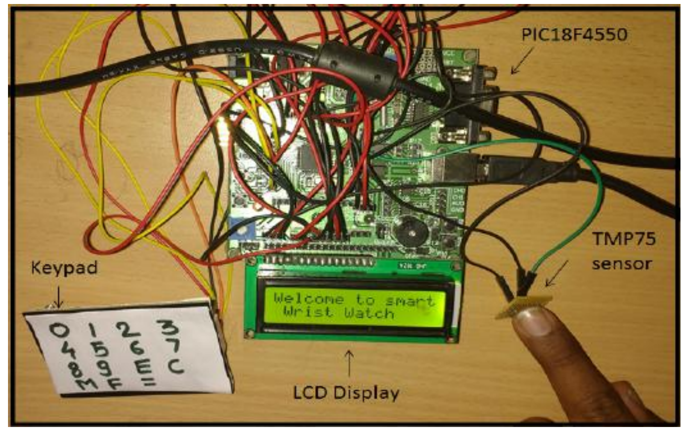

Fig. 5: Initialization of smart wrist watch

In proposed scheme, the temperature sensor TMP 75 is used for real time temperature measurement. Temperature is continuously monitored and is recorded. TMP 75 is interfaced with PIC by using I2C protocol. These analogue signals are then converted into the digitized form by using inbuilt ADC for storing data in EPROM. RTC (Real Time Clock) is used for the synchronization of all data with time and date. RTC is connected with PIC using I2C protocol. All the recorded data is displayed on LCD connected to PIC. The required information such as age, gender, height, weight are entered by using 4×4 keypad.

IV. Result and Discussion

The person gets plethysmograph of his/her oxygen saturation level (SpO2). Plethysmograph gives the indication of SpO2 on the smart wrist watch. Based on plethysmograph pulse rate can be calculated. The results of plethysmograph are shown in fig.6

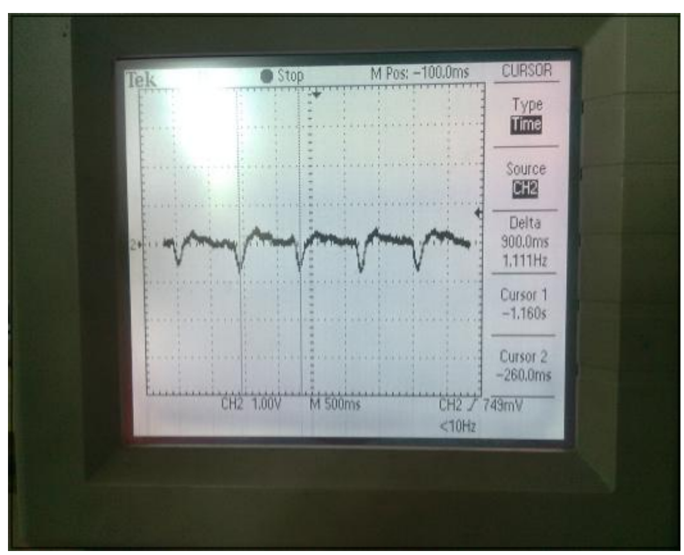

Fig. 6: Result of SpO2 on oscilloscope

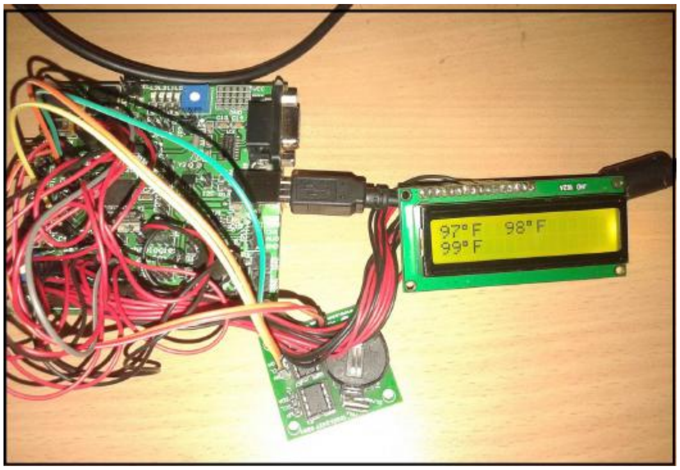

Fig. 7: Stored data on EEPROM

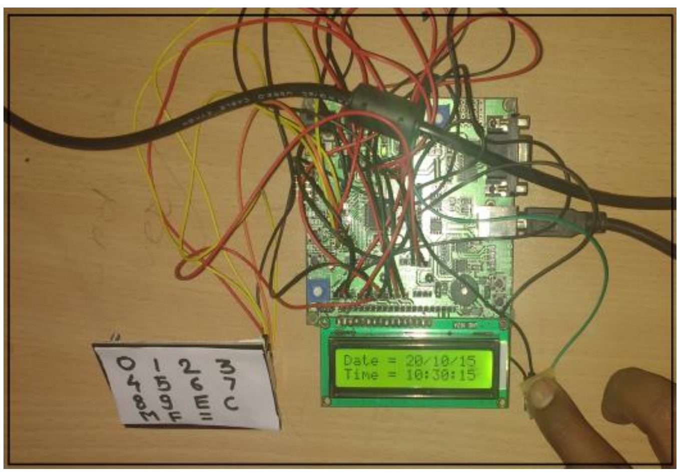

Fig. 8: Date & Time on LCD

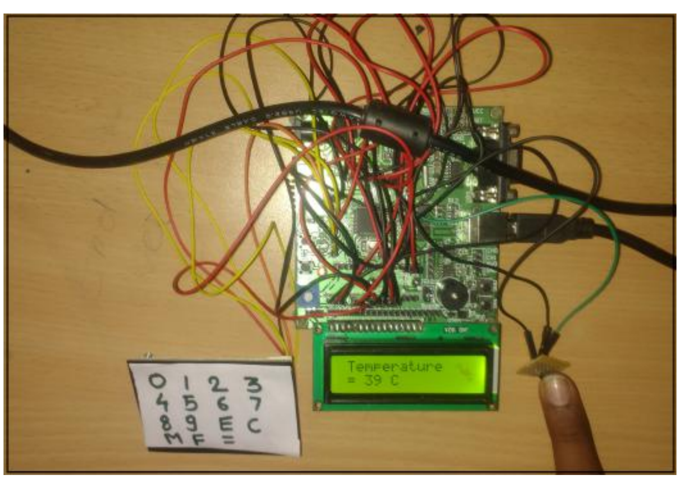

Fig. 9: Temperature Indication on LCD

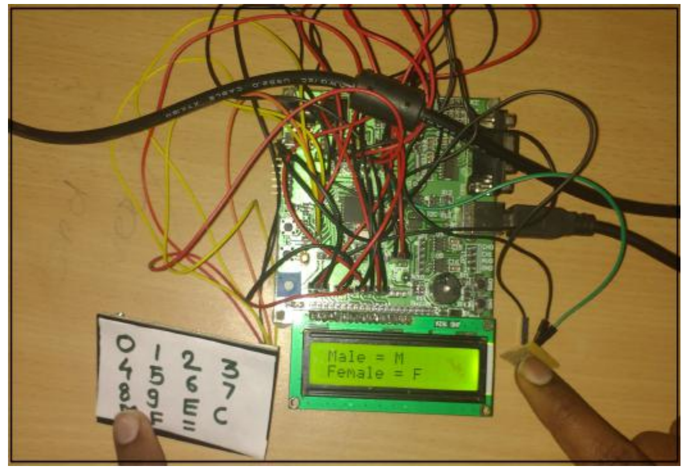

Fig. 10: Selection of Gender using keypad

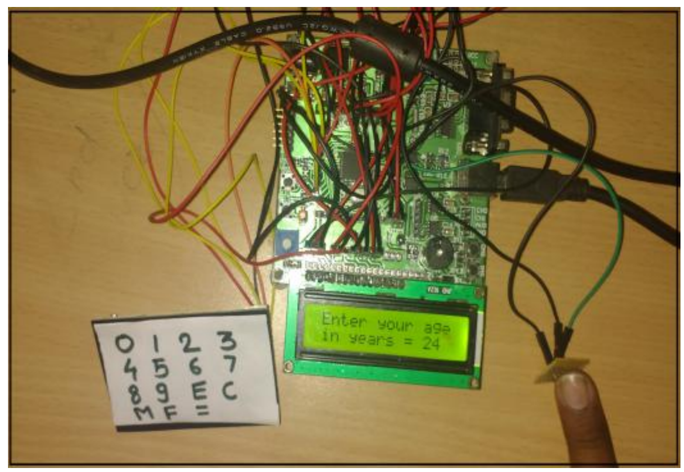

Fig. 11: Selection of age using keypad

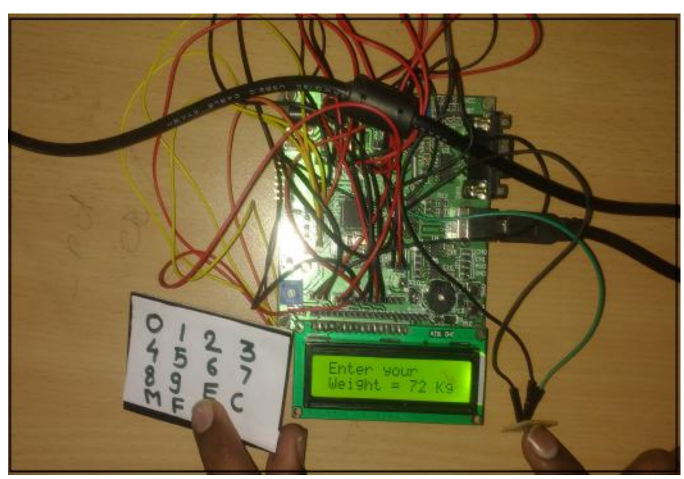

Fig. 12: Selection of weight using keypad

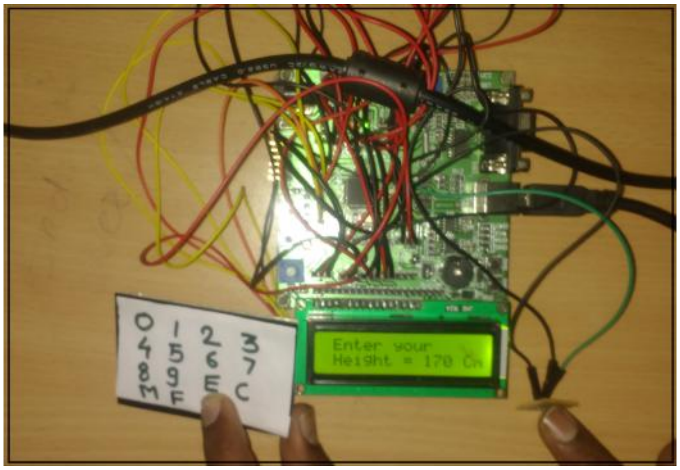

Fig. 13: Selection of height using keypad

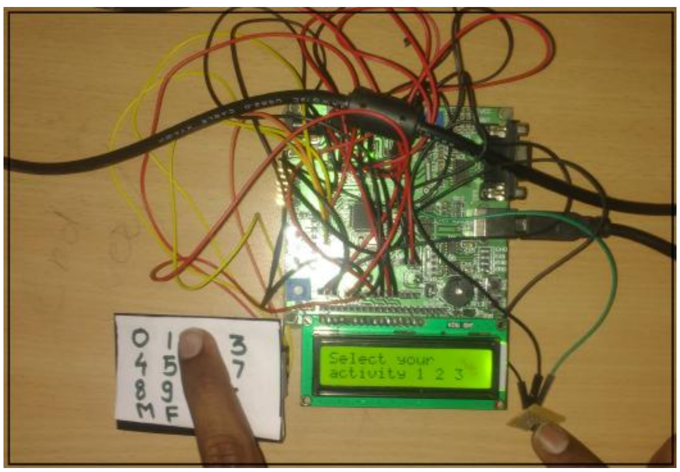

Fig. 14: Selection of activity using keypad

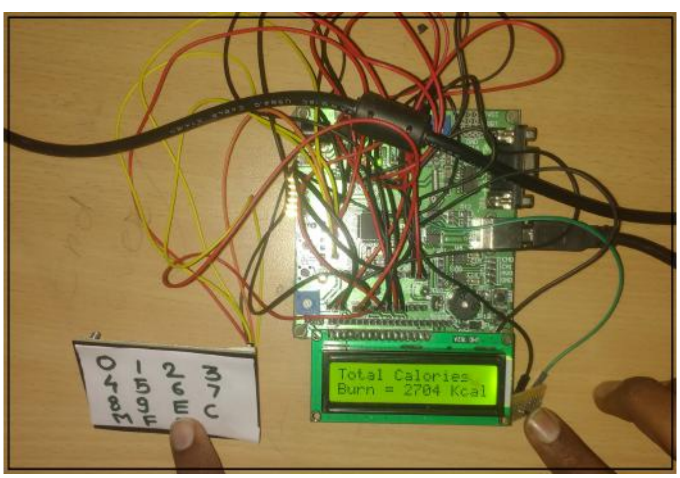

Fig. 15: Total Calorie burns

For the collection of data and to store it in the wrist watch to see the history, EEPROM is used. The data has been successfully stored in EEPROM. The person can check the history report of measurement of body parameters. The results of plythysmograph are shown in Fig.7. The real-time clock (RTC) has displays the current time on LCD. By using DS 1307 with PIC microcontroller shows the date and time in day/month/year and hour:minutes:second simultaneously. RTC continuously gives accurate timing on watch. The results of RTC are shown in Fig.8. For the measurement of temperature TMP 75 IC used which is compact and sensitive. This gives accurate reading of temperature. The figure indicates the body temperature 39 degree Celsius, which is shown in Fig.9. The calorie burn calculator requires body mass index (BMI) of person to calculate calories burned.

Fig.10 directs the selection of gender as male or female. For the selection of various parameters we used keypad of 4 X 4. Fig.11 displays the age of person that is 24 years old as BMI parameter. Fig.12 presents the weight of person that is 72 Kg as BMI parameter. Fig.13 parades the height of person that is 170 cm as BMI parameter. To calculate how much calories have burned according to activity, the activity selection needs to be done. Fig.14 shows the selection of activity. By using the formulas the total calorie burn in Kcal is 2704. The Fig.15 shows the total calories burn for person of age 24 years.

V. Conclusion

This paper gives the details of important body parameters. Parameters like oxygen saturation (SpO2), the temperature of the body and calories burned in the body are continuously monitored and indicated on display. As indication is on the display, one can manage their activities during daily life. This is a very compact portable device so there is no complexity to measure these body parameters. All this measured data is stored in EEPROM by date and time, so that one can reset or read the stored data. This facility gives the weekly or monthly analysis of our body parameters. According to these results one can maintain his/her health.

Blood pressure is also one of the vital body parameter. So the future scope of this work is inclusion of blood pressure in the system.

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