Automatic Treadmill Speed Control with Heart Rate And Temperature Monitoring

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Abstract- *Treadmill is an exercise machine for walking or running while staying at the same place. The proposed model of the treadmill presents a method to control the treadmill's speed automatically with respect to the person's heart rate. This is mainly useful for the prevention program of the heart patients. Heart disease is one of the causes of death in the current scenario of the world. Reasons for cardiovascular disease or heart disease should begin in the early life, making primary prevention efforts and techniques necessary from childhood. Thus, it has increased the emphasis on preventing heart diseases by modifying the risk factors, for example by healthy eating and regular exercise.*

Running can also reduces obesity which is one of the main causes of the heart disorders. The heart rate varies while performing exercise, according to the medical condition of the patient. Since the exercising of the body causes adverse effect on the heart rate, it is important to control the speed of the treadmill to reduce the stress on the person's health. The two possible modes according to heart rate are set in the system.Which are Automatic and Manual mode respectively.The selection of a particular mode is done with the keypad buttons. The voltage and speed is controlled differently according to the input heart rate range for manual mode.

A DC motor is used for controlling the treadmill. The voltage given to the motor is regulated by a MOSFET according to the pulse width modulated output. Heart rate variation causes the variation in the Pulse width modulated output which regulates the on-off time of the MOSFET, and it regulates the amount of the voltage given to drive the motor. Hence the voltage variation in the motor input causes the regulation of the speed of the motor. A 230 v AC supply is filtered and rectified for the working of the motor. Pulsated DC produced by the microcontroller enables the smooth control over the voltage of the motor. Model based simulation is used for showing the execution of the proposed system. Speed, heart beat and voltage variations are the parameters represented. The real time graphs can be seen on the android software 'Bluetooth Graphics'. Also the temperature is monitored by a temperature sensor and displayed on the LCD display interfaced with the proposed system.

Keywords- PIC Microcontroller, Heart rate monitoring, PWM, MOSFET, Motor speed control.

I. INTRODUCTION

The innovations in different fields like sport training, rehabilitation centers and medical diagnosis lay emphasis on the automated exercise systems. Exercising have revealed their importance in the rehabilitation administered to the patients who went through Cardiac Bypass surgery to gradually build strength into their hearts. Since the Heart Rate can be effectively used as a measure of the exercise intensity, a precise and individual exercise prescription can be expressed in terms of a specific Heart Rate reference profile; precisely controlling the Heart Rate during exercises becomes crucial. Treadmill is an exercise machine for walking or running while staying in the same place. Treadmill machine provides a moving platform with a wide conveyor belt driven by an electric motor or a flywheel. The rate at which the belt moves is the rate of the running or walking. Thus the speed of the running may be controlled and measured.

Health care technology is going through the most sophisticated era of the world. With reference to the cases studied so far in this field, we can say that prevention and rehabilitation of the heart disease is very important in the present scenario. Exercising in the treadmill is very effective because running is a world approved fitness exercise. Running gives exercise to all the muscles as well as heart muscles. Running also reduces obesity which is one of the causes of the heart disorders.

It is also important for patients who went through Cardiac Catheterization or Bypass surgery to gradually build strength into their hearts through exercise. This build up needs to be done in a careful manner since too much exercise may damage the recovering heart. One of the parameters to control in this process is the heart rate. The proposed

system allows the user to set a maximum heart rate he or she can achieve based on the recommendations of a cardiologist. The heart rate of the patient is continuously monitored and fed to a controller while the patient runs on the treadmill machine. If the heart rate is lower than the maximum value, the speed of the motor will automatically increase and vice versa.

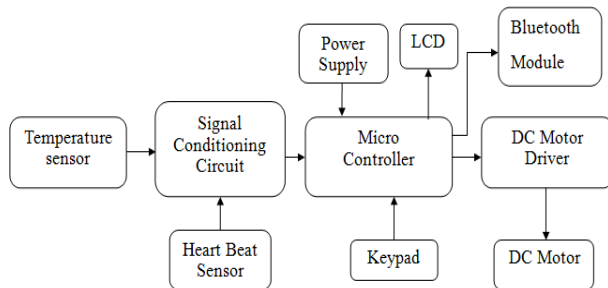## II. STUDIES AND FINDINGS

1. SYSTEM ARCHITECTURE:

Figure 1. System Block Diagram

BLOCK DIAGRAM EXPLAINATION:

HEART RATE SENSOR:

The heart beat sensor is designed to provide analog output of heart beat when a finger is placed on it. When the person running on treadmill places his/her finger on the sensor, the top most LED will blink in unison with every heart beat. The principle behind the working of the given sensor is the technique of light modulation by blood flow through the nerves of the finger at every pulse.

KEYPAD:

A 4x4 keypad is used for loading numeric data into the microcontroller. It consists of 16 buttons arranged in a form of an array containing 4 rows and 4 columns. In this project, keypad is used for selecting the mode of the machine. There are two modes which are automatic and manual.

L298N (DC Motor Driver):

L298N is a dual H-bridge motor driver. It allows us to control speed and direction of two dc motors, or can control one bipolar stepper motor with ease. It can be used with dc motors which have operating voltage range between 5V-35V DC. These motor control modules are inexpensive and easy to work with. The motors used in the current prototype are of dc geared type with 100 rpm.

LCD:

LCD is an electronic display module which finds a wide range of applications. In this project, we have used a 16x2 LCD for displaying the person's age and the heart rate at which he is running. A 16x2 LCD means it can display 16 characters per line and there are 2 such lines.

MICROCONTROLLER PIC18F4550:

PIC18F4550 is an 8-bit microcontroller of PIC18 family. PIC18F family is based on 16-bit instruction set architecture. PIC18F4550 consists of 32 KB flash memory, 2 KB SRAM and 256 Bytes EEPROM. This is a 40 pin PIC Microcontroller consisting of 5 I/O ports (PORTA, PORTB, PORTC, PORTD and PORTE). PORTB and PORTD have 8 pins to receive/transmit 8-bit I/O data. The remaining ports have different numbers of pins for I/O data communications. PIC18F4550 can work on different internal and external clock sources. It can work on a varied range of frequency from 31 KHz to 48 MHz. PIC18F4550 has four in-built timers. There are various inbuilt peripherals like ADC, comparators etc in this controller.PIC18F4550 is an advanced microcontroller which is equipped with enhanced communication protocols like EUSART, SPI, I2C, USB etc.

TEMPERATURE SENSOR DS18s20:

The DS18S20 digital thermometer provides 9-bit Celsius temperature measurements and has an alarm function with nonvolatile user-programmable upper and lower trig¬ger points. The DS18S20 communicates over a 1-Wire bus that by definition requires only one data line (and ground) for communication with a central microprocessor. In addition, the DS18S20 can derive power directly from the data line ("parasite power"), eliminating the need for an external power supply.

BLUETOOTH MODULE HC-05:

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup.

Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Bluecore04-External single chip Bluetooth system with CMOS technology and with AFH (Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx27mm.
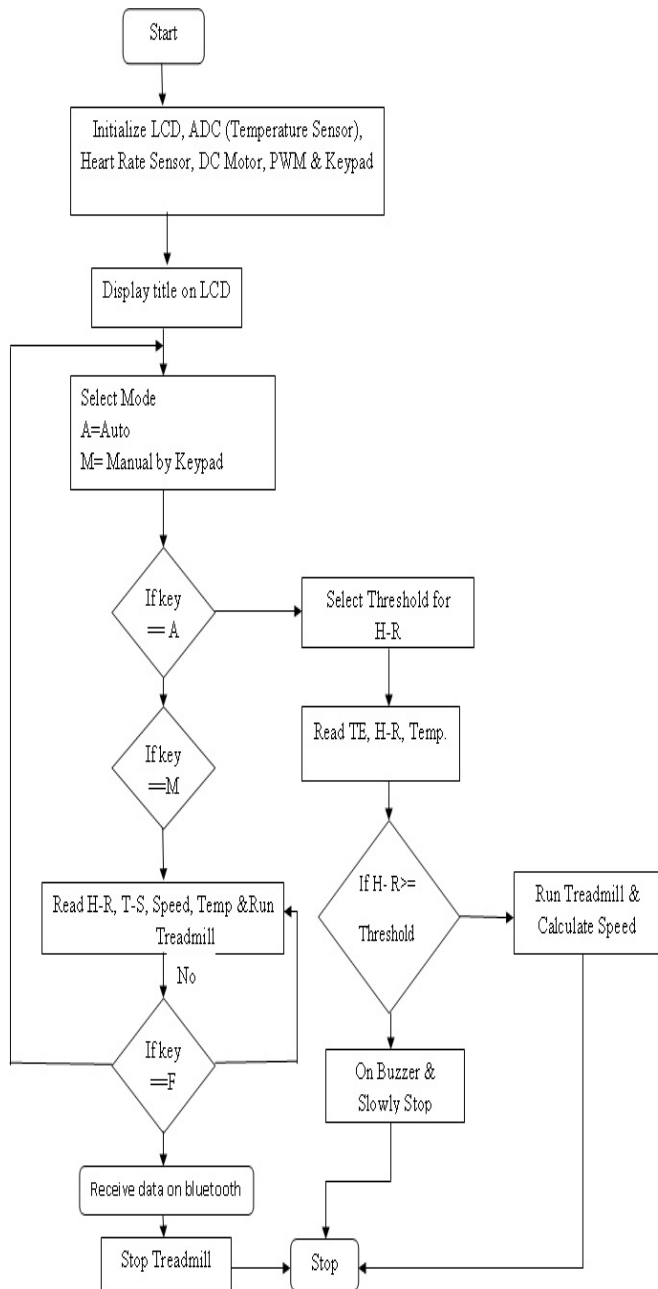
III. SOFTWARE IMPLEMENTATION

FLOWCHART:

Figure 2. Flowchart

ALGORITHM:

1) Start.
2) Initialize LCD, ADC, Temperature Sensor, Heart Rate Sensor, DC MOTOR, PWM, KEYPAD.
3) Display the title on LCD.
4) Select mode A=auto, M=manual, manual by keypad.
5) If auto mode selected set the threshold level.

6) Read the Heart Rate, Threshold level, Temperature Sensor
7) Run the treadmill Calculate speed.
8) If threshold level is greater than set threshold level then Buzzer will be on and treadmill will stop slowly.
9) If manual mode selected Read the Heart Rate, Threshold level, Temperature Sensor.
10) Run the Treadmill and Calculate speed.
11) Data received by Bluetooth module.
12) Treadmill will stop here.
13) The cardio-graph will be shown on android mobile.
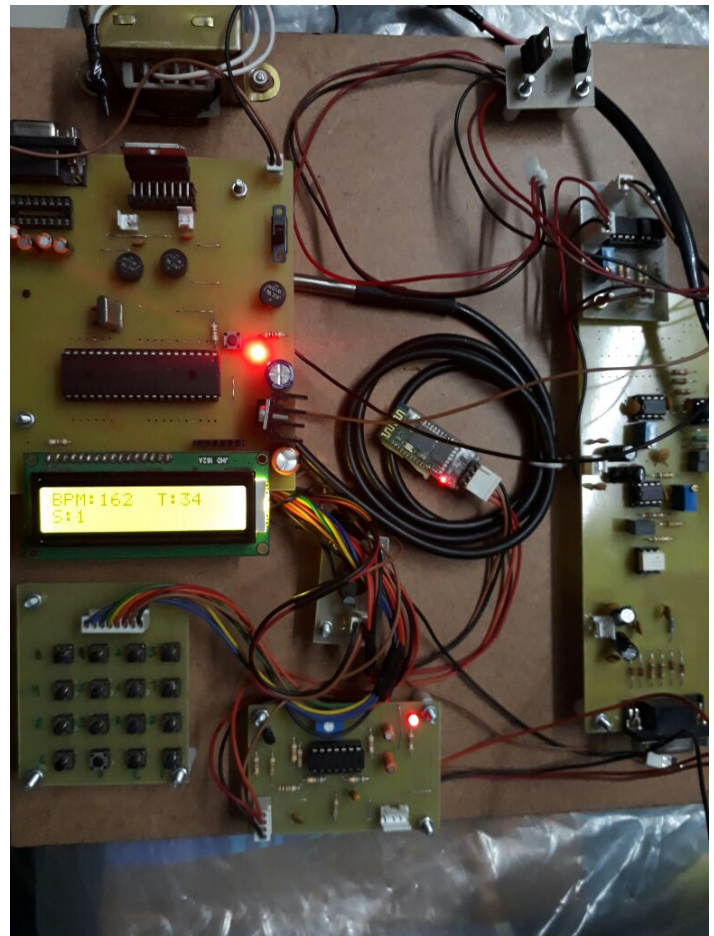
IV. RESULT & CONCLUSION

Figure 3. Proposed system

Figure 4. Graph On Mobile Application

CONCLUSION:

The most sophisticated techniques and development scenario is seen in the present medical field. As the heart related diseases are spreading abruptly worldwide, this approach has great importance in the developing as well as developed nations.It also provides ease for the use as well as is easier for the preventive and rehabilitation purposes.

It reduces the stress on the heart of the patient, and at the same time gives exercise for the heart muscles. Medical field is one of the promising areas of technology nowadays. A lot of research programs have been launched in many countries. The increase of the heart related diseases lead the people to think about the preventive measures. The proposed method is one of the important preventive as well as rehabilitation measure. The main contributions of the proposed method are as follows:

- An effective method for the implementation of a speed control treadmill is done. The voltage of the motor is varied according to the heart rate.
- It is one the simplest as well as cheapest mechanisms involved in the proposed method .
- The components involved in the method are easily available.

V. ADVANTAGES, DISADVANTAGES & APPLICATION

ADVANTAGES:

1. Save human life.
2. The treadmill is a relatively easy piece of exercise equipment to use.

3. The treadmill has a predictable surface that is much easier to negotiate than sidewalks, curbs or trails and the risk of tripping is reduced.
4. All aspects of the workout can be controlled by the user: speed, incline, warm up period, cool down period, and energy spend.
5. Generally, users can design custom programs to fit the time they have to exercise.

DISADVANTAGES:

1. The ECG SENSOR is very expensive

APPLICATIONS:

1. Application of the proposed is not within the limit of patients, it is also useful for the fitness.
2. Performance measurement and maintenance of the athletes.

VI. FUTURE SCOPE

1. Using proposed multiple treadmill systems of such kinds can be connected and data can be gathered on a computer system.
2. So analysis of parameter of multiple systems on a single computer system and storage of it for further analysis could be done.

REFERENCES

[1] Atul Kumar Dewangan, Nibbedita Chakraborty, Sashi Shukla, Vinod Yadu, ―PWM Based Automatic Closed Loop Speed Control of DC Motor‖, International Journal of Engineering Trends and Technology,Volume3Issue2- 2012

[2] Arthur S. Leon, Barry A. Franklin, Fernando Costa, Gary J. Balady, Kathy A. Berra, Kerry J. Stewart, Paul D. Thompson, Mark A. Williams and Michael S. Lauer, ―Cardiac Rehabilitation and Secondary Prevention of Coronary Heart Disease‖, Circulation. 2005;111:369-376

[3] Chen-Yi Chu, Shu-Yun Lu, Kuei-Fu Lin, ―Influences of exercise experience and exercise settings on heart rate responses during self- selected intensity exercises‖, Elsevier J Exerc Sci Fit, Vol 8, No 2, 73-77, 2010

[4] C. H. Hillman, M. B. Pontifex, L. B. Raine, D. M. Castelli, E. E. Hall And A. F. Kramer, ―The effect of acute treadmill walking on cognitive control and

academic achievement in preadolescent children‖, Elseveir ltd, Neuroscience 159 (2009) 1044-1054

[5] Dr Ravikiran Kisan, Dr Swapnali Ravikiran Kisan, Dr Anitha and Dr Chandrakala, ―Treadmill and Bicycle Ergometer Exercise: Cardiovascular Response comparison‖, Global Journal Of Medical Research, Volume 12 Issue 5 Version 1.0 June 2012