

**International Journal of Innovative Research in Science,
Engineering and Technology**

(A High Impact Factor, Monthly Peer Reviewed Journal)

Vol. 5, Issue 2, February 2016

Design and Development of Digital Proximity Type IR Thermometer Based on Arduino unoR3

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ABSTRACT: this paper introduces a novel design method of digital IR thermometer to achieve temperature display, which uses Arduino unoR3 as the main control device, MLX90614 as the Infrared (IR) thermometer sensor. It's hardware circuit includes the main controller, IR temperature measurement circuit and display circuit. Compared with the traditional thermometer, it has some strong points such as convenient reading, wide range of temperature measurement, and accuracy. Its temperature output is displayed digitally. With the feature of easy-handling, it's mainly used in medical, research laboratories and industrial applications where medium contacting is not easy and requiring accurate temperature measurement.

KEYWORDS: digital IR thermometer, Arduino UNO board, IR- temperature Sensor

I. INTRODUCTION

Always Proximity type instruments [1] have its own advantages where contacting with medium is difficult while measurement of physical parameters. And also it is safe and secure to measure the parameters in crucial conditions. For example, to measure hot bodies' temperature in industries and research laboratories. And in medical field, where badly virus infected/burned patient's body temperature measurement is unsafe and insecure. For this we need novel approach to measure. Keep in mind these facts we made an attempt to novel design and develop a proximity type Infrared (IR) thermometer. This paper describes the design and construction of a digital proximity type IR Thermometer. Aurduino unoR3 microcontroller, MLX90614 IR- thermometer and 2X16 segment LCD with backlight, is used for hardware construction. Arduino IDE is used for software development. Wide -70 to 380 °C range temperature measurement with accuracy of 0.5oC. The digital display system for the output of the temperature is simple and economic, operation reliable and environmental friendly. It will be mainly used in various fields such as daily life, medical, industrial, science and research laboratories applications.

II. DESIGN PRINCIPLES

Here design of proximity type IR-thermometer circuit is presented. The traditional way is to use the temperature sensor sensing the temperature and gives the current/voltage as output. And for measurement of analog values it should be interface ADC with microcontroller software programming for controlling this ADC. It is complicated and time consuming. Therefore, in our design the IR-thermometer is adopted. The IR-thermometer MLX90614 having accessible by 2 wire serial SMBus compatible protocol (0.02°C resolution) or via 10-bit PWM (Pulse Width

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Modulated) output of the device is used. The measured temperature can be read directly and easily, and then be converted to meet the design requirements. The block diagram and circuit diagram is shown in figure-1 and figure-2 respectively. Which describes the detailed design of the system along with various components present it.

III. SYSTEM HARDWARE STRUCTURE

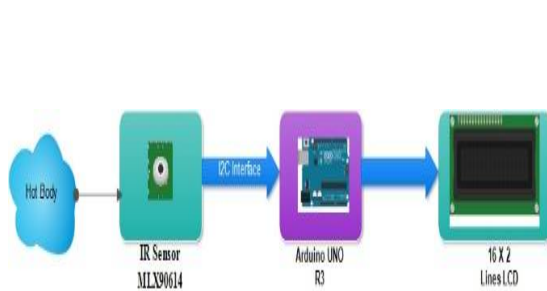


Figure-1 Block diagram

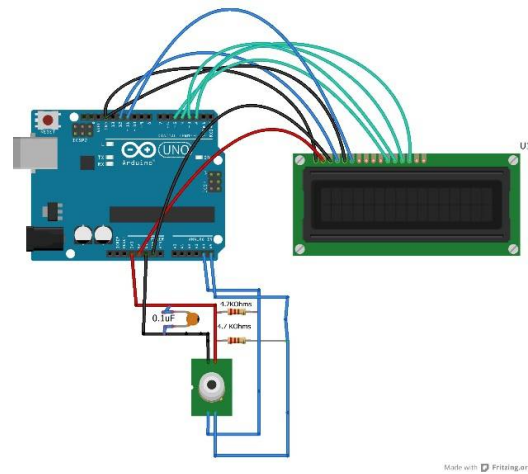


Figure-2 Circuit diagram

A. Arduino unoR3

The Arduino Uno R3 is a microcontroller board based on the ATmega328. It has 16 MHz crystal oscillator, 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a power jack, a USB connection, an ICSP header, and a reset button [2-6]. It simply connects it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. It is solution for many embedded control applications system and meet different demands. Figure-3 shows Uno R3 Pin Map having its functional diagram.

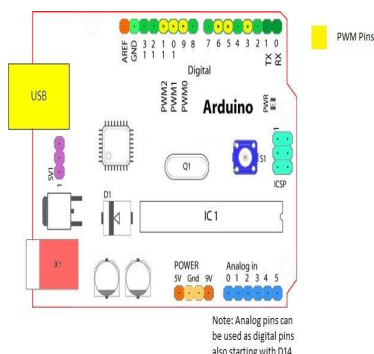


Figure-3 Uno R3 Pin Map

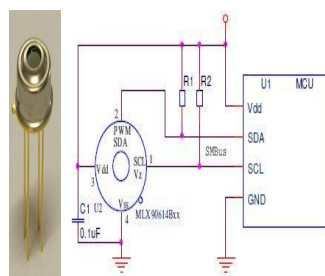


Figure-4 MLX90614 Schematic

Pin Name	Function
VSS	Ground. The metal can is also connected to this pin.
SCL / Vz	Serial clock input for 2 wire communications protocol. 5.7V zener is available at this pin for connection of external bipolar transistor to MLX90614A to supply the device from external 8 -16V source
PWM/ SDA	Digital input / output. In normal mode the measured object temperature is available at this pin Pulse Width Modulated

Table-1 Pin description of MLX90614

Main features:

- Operating Voltage: 5V
- Microcontroller: ATmega328

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- Input Voltage (recommended): 7-12V
- Input Voltage: 6-20V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 40mA
- DC Current for 3.3V Pin: 50mA
- Flash Memory: 32KB (ATmega328) of which 0.5 KB used by bootloader
- SRAM: 2KB (ATmega328)
- EEPROM: 1KB (ATmega328)
- Clock Speed: 16MHz

B. IR-thermometer sensor MLX90614

MLX90614 Infra-Red thermometer is a four pin, SMBus based device produced by Melexis Company [7-8]. It possesses characteristics including simple circuit, smaller size, wider applications and more economical. The on-site temperature is transmitted directly by "bus line" digital mode, which greatly enhanced the anti-jamming system. It's suitable for on-site temperature measurement in harsh environments such as: environmental control, equipment or process control, electronic consumables which need proximity type temperature measurement. Figure-4 shows the MLX90614 Schematic and picture which helps the circuit understanding. And table-1 shows the Pin function description in detail MLX90614.

The main features of products are:

- Only two ports needed to achieve Communication.
- Each component of the DS18B20 has a unique serial number.
- Realize temperature measurement without external components.
- Measuring temperature range between -70 to 380 °C for object temperature
- Digital IR thermometer Measurement resolution of 0.02°
- Having Power saving mode, low noise amplifier, high resolution 17-bit ADC and powerful DSP unit of MLX90302.

IV. SYSTEM SOFTWARE AND DESIGN AND ACHIVEMENT

In present work we used a C – Language to develop the system software in Arduino IDE 1.0.5 [2-6]. The open-source Arduino environment makes it easy to write code and upload it to the I/O board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing, avr-gcc, and other open source software. The source code of the digital IR thermometer is the following source code -1 and the Flow chart depicting the Digital IR Thermometer is shown in the figure-5

```
#include <LiquidCrystal.h>
```

```
int analogPin = 4;  
int val = 0;  
unsigned char temp [25];
```

```
LiquidCrystal lcd(12, 11, 5, 4, 3, 2);  
void setup()  
{
```

```
  lcd.begin (16, 2);
```

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```

}

void loop()
{
  pinMode(analogPin, OUTPUT);
  analogWrite(analogPin, 'END');
  analogWrite(analogPin, 'TEMPR');
  delay(100);
  pinMode(analogPin, INPUT);
  val = analogRead(analogPin);
  sprintf (temp, "Temperature %d'
            C", val);
  lcd.print(temp);
  delay(1000);
}

```

Source code-1

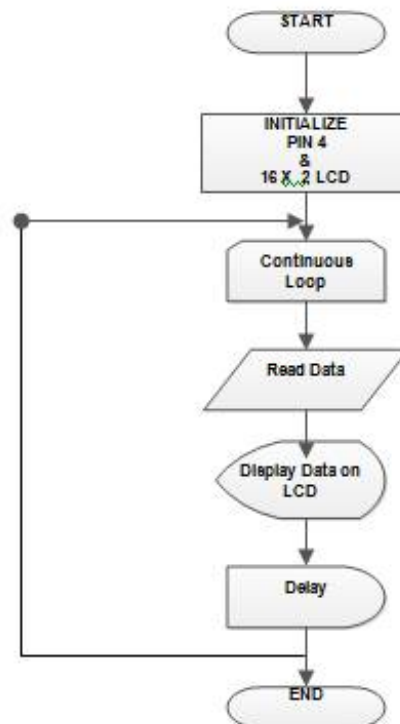


Figure-5 Flow chart of Digital IR Thermometer

V. RESULTS AND DISCUSSION

As the present work is focused on the design and development of digital proximity type IR thermometer based on Arduino unoR3. The result of development system is presented in this paper. The proximity type IR thermometer is more advantageous in application side especially in medical field. In this paper we approached novel method in selection of sensor, simplicity, and fast development method. The instrument is quite cost effective, accurate, portable and easy to operate. Presence of every module has been reasoned out and placed carefully thus contributing to the best working of the unit. Secondly, using highly advanced ICs and with the help of growing technology the project has been successfully implemented and evaluated.

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