Mobile Robot Temperature Monitoring System Controlled by Android Application via Bluetooth

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***Abstract* – Temperature is a common variable in many systems and processes. In most industries there are several equipments to sense the temperature, but it is preferable to automate the measurement process. This robot can be used as an early detector of fire in forest and also as a sensor kit in warehouses, hospitals, etc. In this project, we have a mobile robot which is used for autonomous temperature measurement. It is controlled by the instruction of the user from mobile. The sensed temperature data are sent to a web server via Bluetooth. It is also possible to view the temperature details in a mobile phone with the use of a simple Android application. The control range of this mobile robot is around 10m and it can measure temperature up to 150°C.**

I. INTRODUCTION

The field of robotics have influenced almost all areas and it reduces the work of humans. This easiness provided by robot has made it to become more widespread across various industries ranging from manufacturing to health care. The benefits of these robots seem to be most noticeable in terms of productivity, safety, money and time. One such advancement is this project. This Robot is a mechanical device which has a wheeled platform that is capable of interacting with its environment [1]. A sensor present on the device is able to sense the environment and give useful feedback to the device.

We have also added the comforts provided by the new emerging mobile technology, Android. Android is an open source operating system, this platform will continue to evolve as everyone builds innovative mobile applications time to time. It includes a full set of tools that offers the developers with high productivity with deep insight into their application. Getting started with the Android API is easy; the API is open, i.e. developers can access almost every low – level function and are not sandboxed. In addition, the Android API allows easy access to hardware components. An Android robot is an autonomous robot [2]. Android makes interesting use on robotics by providing numerous communication interfaces like Wi-Fi, Bluetooth [3].

The use of these two technologies makes our mobile robot to have various applications. This mobile robot is applied in places that acquired monotonous temperature measurement such as in an airport and hospital. This mobile robot can also be used by fire-fighter to have early detection of the hot temperature for a burning case before the cause of action is consider [4].

II. RELATED WORK

While we were working on this system, similar approaches showed up. Most of them focus only on the connection between Android and microcontroller. There is no approach to make the sensed details display in any server or in an Android mobile. Serial Communication between devices is most popular and use of wireless technologies is not much adopted in those systems [5]. Some of the works are listed below.

A. Amarino:

The Amarino is a library to connect Android devices to Arduino boards. This library doesn't provide any return channel; it doesn't seem applicable for our purposes. As there is no return channel the display of details Android mobile is not possible.

B. MicroBridge:

MicroBridge is an Android Debug Bridge (ADB) implementation for microcontrollers [6].MicroBridge allows stock, un - rooted Android devices to talk directly to USB host enabled MCUs,

thereby enabling phones to actuate servos, drive DC motors, talk to I2C and SPI devices, read ADCs, and so forth. MicroBridge works on Android 1.5 and upwards. The ADB protocol supports opening a shell on the phone or issuing shell commands directly, pushing files to the phone, reading debugging logs, and forwarding TCP ports and UNIX sockets. Using TCP sockets it's possible to establish bidirectional pipes between an Arduino and an Android device. The Android application listens on a port, and the Arduino connects to that port over ADB.

C. Mobot RC car:

Mobot is a simple modification of the RC car which uses Arduino, Bluetooth module and Android. But this is not capable to carry the sensor kit and cannot be used in industries where monitoring is done. There is no speed control as it uses only the default digital I/O in Arduino.

III. PROPOSED SYSTEM

Environmental Temperature measurement mechanism is most common and there are a number of techniques available for it. Microcontroller based temperature sensing methodology has been adopted for this project. Many additional features are appended to our design.1) Navigation of Robot, 2) Android mobile usage and 3) Uploading in PHP server are the features proposed in our system. Also the whole system uses the Bluetooth Wireless Technology.

Our design is divided into three modules. First module is the sensing of environmental temperature and displaying it in PHP server and in addition to that it can be viewed in an Android mobile, next is to make the mobile robot move in all possible directions, then final step is to make Robot move by users commands using an Android apps. Figure 1 shows the complete block diagram of overall system.

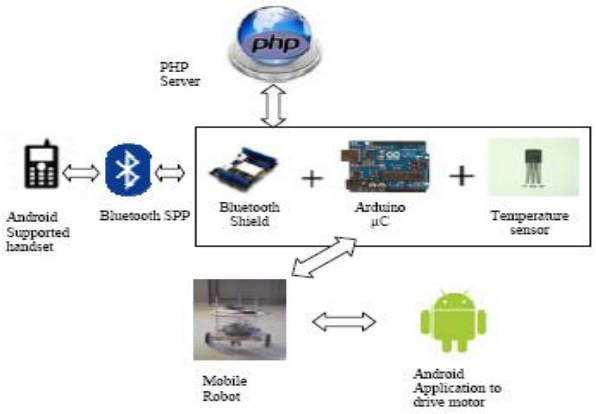


Fig. 1: Block Diagram of Overall System

a) Temperature sensing application

Arduino microcontroller is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. Arduino projects can be stand-alone or they can communicate with software running on a computer [7]. There are several AVR series of Arduino boards available and we use ATmega 328 microcontroller. LM35z temperature sensor is used to sense the environmental temperature. A simple wiring is done to connect LM35z to Arduino. We write the program to measure the temperature in the Arduino software. The results can be displayed in the serial port software temporarily.

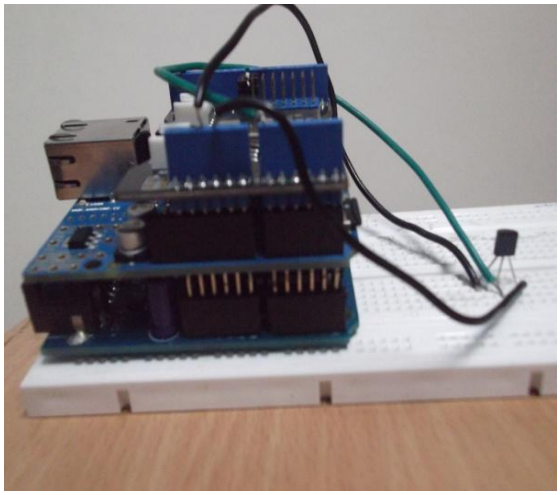


Fig. 2 : Ethernet shield and Bluetooth shield mounted over an Arduino and connected to LM35z temperature sensor

For displaying it in a PHP server and mobile we need two more hardware tools. One is the Arduino Ethernet shield which connects our microcontroller to the internet in mere minutes. Bluetooth shield is used for the data transfer [8]. These three are mounted over one another as shown in Figure 2. For the data transfer we simply pair the Bluetooth shield and computer‘s in built Bluetooth. The Gobetwino is a kind of a generic proxy for Arduino that will act on behalf of Arduino and can do some of the things that Arduino can’t do on its own. The terminal port number and a log file (here .csv file) is added to the Gobetwino. Using this log file the details can be uploaded to the PHP server where the details are updated frequently.

Bluetooth SPP (serial port profile) Android application which pairs Bluetooth shield and mobile Bluetooth and the same temperature details are displayed in mobile phone.

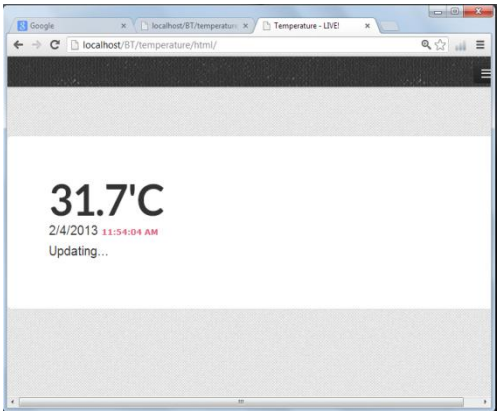


Fig. 3 : Display of measured temperature in PHP server

Fig. 4 : Display of measured temperature in mobile phone

b) Driving mechanism :

A variety of electric motors provide power to robots, allowing them to move material, parts, tools, or specialized devices with various programmed motions. Here we use DC motor which is mechanically commutated electric motor powered from direct current. It has 200 rpm (revolution per minute) and it is powered by a 12 Volt power supply. The two DC motors are connected to the Sabertooth motor driver. The Sabertooth 2X12 is one of the most versatile, efficient and easy to use dual motor drivers on the market. It is suitable for medium powered robots [9]. This Sabertooth can supply two DC brushed motors with up to 12A each. Sabertooth is the first synchronous regenerative motor driver in its class. The regenerative topology means that your batteries get recharged whenever you command your robot to slow down or reverse. Sabertooth also allows you to make very fast stops and reverses - giving your robot a quick and nimble edge.

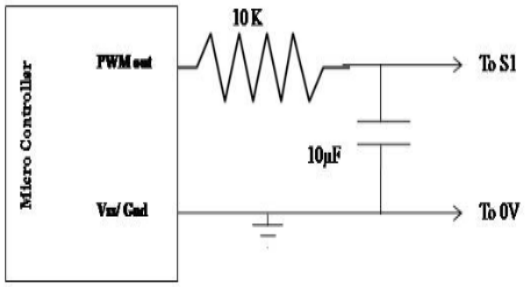


Fig. 3: Filtered PWM

Arduino is capable of giving digital outputs; PWM (Pulse Width Modulation) is a technique for getting analog outputs with digital means. Filtered PWM signal from a microcontroller is made using an R/C filter with component values 10k ohms and at least .1 µF. A larger value filter capacitor such as 1µF or 10µF will result in smoother motor operation. Figure 3 shows the arrangement of filtered PWM.

The motor direction is controlled based on the voltage readings with different analog write values given in the Arduino coding. List of those values and corresponding voltage readings are tabulated in Table 1.

Table 1: Motor direction Control Values

Values	Voltage Readings(in volts)
0	0
64	1.27
127	2.51
192	3.96
255	5.01

PWM using analogWrite () will only work on pins 3, 5, 6, 9, 10 and 11. The following are steps to move robot in different directions.

i. Set the PWM pins for left and right motor.

ii. To make the robot move in specified direction following are the analogWrite() values:

Forward : $0 < x < 127$
Reverse : $127 < x < 255$

iii. In order to make right or left turn, the left and right motor values are varied i.e making one to move faster and other slower and vice versa.

iv. When x=127 the Robot is passed with stop command.

c) Android App Development

This is the final step of our project where the movement of the robot is controlled by the Android application. To develop it we use the eclipse for coding (java) and Android SDK for development of the apps. In this we write two set of coding. One is Bluetooth adapter coding to connect Bluetooth shield with mobile Bluetooth. And next is sending commands to the Robot to move in user desired direction.

IV. System Integration

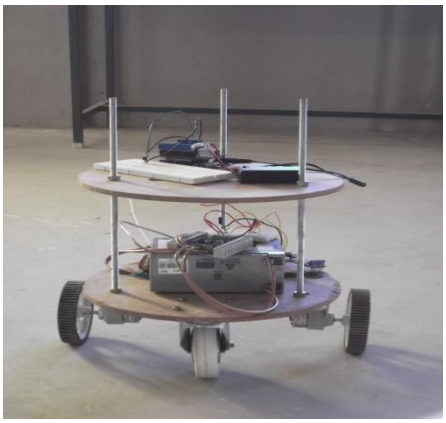
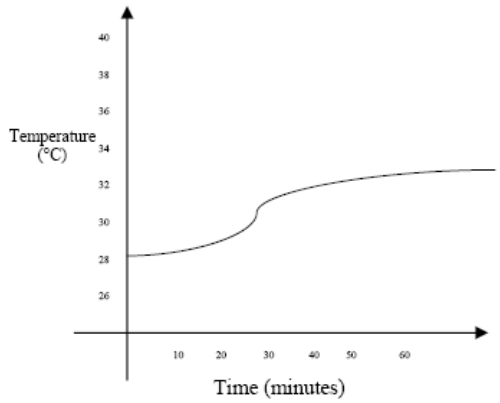


Fig. 5: Mobile robot with temperature sensing kit

All the above modules are integrated and implemented shown in Figure 5. The temperature sensing kit is kept on the mobile robot which moves around and senses the environmental temperature [10]. The Arduino microcontrollers are loaded with the temperature sensing coding and motor movement coding. We do not require a computer to be connected always with the Arduino as the program once written in the microcontroller stays till we reset it. But it should be powered using a 9V power supply. The Graph 1 shows the varying temperature in certain duration



Graph 1: Varying temperature in an hour duration

V. Conclusions

This paper has presented a method to measure the environmental temperature using a mobile robot. Serial communication is done between Arduino microcontroller, Bluetooth shield and LM35z temperature sensor. LM35z will obtain the measurement and the data is send to the Arduino microcontroller. The Arduino microcontroller processes the data and displays it on the screen of the mobile phone and PHP server. Bluetooth technology can be used to perform various applications. The prototype of this project has been successfully completed where the mobile robot can move and measure according to the user instructions from the mobile phone. The idea of implementing Bluetooth technology is for safety purpose and is very useful especially in application where risk is a concern.

VI. Future Enhancement

In this paper we present initial experiments towards environmental monitoring with a mobile platform. Many interesting future extensions are feasible with our current setup. One such thing is uploading the system output (environmental parameter) in appropriate modes such as clouds. In addition to temperature analysis other environmental parameters like humidity, air quality, etc., can be measured using sensors [11]. Also the use of Bluetooth shield can be altered by using a Wi-Fi or some other equipment with higher control range.

VII. References

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