Tkinter App Based Robot for Medical and Domestic Purposes using Raspberry Pi

G. Usha , K. Narasimman

Abstract: A robot is a multifunctional device which is programmed to work like human such as lifting heavy weights, stacking and emptying, and perform the defined tasks with speed and accuracy. The paper consists of the design and construction of a medical and domestic purpose robot. The design and placement of motors, wheels, sensors, and controlling mechanism has been discussed. The proposed robot can be controlled using an Ethernet cable or can be controlled wirelessly by networking. After providing connections this robot is tested indoor as well as outdoor. For medical use, it can be used in detecting the abnormal behaviour of a human and for domestic use it detects intruders, it is used for home automation, detecting temperature and displaying it on the LCD screen, tracking mobile and bringing to the user by finding the shortest path using GSM module. D-link Wi-Fi home camera is used to store the recorded data in cloud so that we can see the required data when usage demands. Tkinter package based application is developed and the robot is made to interface with the Raspberry Pi 3 B+ for its control and performance. The design and the structure of this proposed robot is modified according to our need for future use. We have performed all those features that are mentioned in this paper and equipped them more accurately.

Keywords-Raspberry Pi 3 B+, Sensors, GSM module, D-link Wi-Fi home camera, Tkinter package.

I. INTRODUCTION

Robots are those machines which find extensive use in various fields such as industry, military, household and many others [1]. Nowadays robots are being used in different branches of engineering which includes electrical, mechanical, electronics, biomedical, artificial intelligence etc. They perform different types of activities which depends on the type of task. Some tasks may be quite simple while the other may be so complicated to be performed. Robots are designed because they produce more accurate results and the quality of the work may be so high. Robots are capable of lifting heavy objects without injury or tiring, dismantle bombs, build cars and so on which produces a large amount of work in short time span. In order to operate robot wirelessly, a Bluetooth server application is used and the commands are sent through the Bluetooth network [2]. The DTMF and GSM based robots consume high amount of energy. In this type of robots the control unit and the robot must be in line of sight which is not possible under every circumstances [3]. The proposed system consists of following components as shown in Fig.1.The Rpi is used as the main control system for the robot. Arduino(Uno and Nano) is used to control the sub processes (automated process and GSM). It consists of user interface for operating the robot, DC motors for the movement of the robot.

The commands are sent to the robot through Wi-Fi transmission protocol. This robot consists of IR sensors in order to detect the obstacles and make the robot to move without collisions [4]. Robot is designed to solve a particular task given by the user. For performing two different types of tasks, we require two different robots which increases the cost and requires more complexity to solve a particular problem. In this paper we are building a multipurpose robot which does different tasks at the same time and reduces the cost, saves much of time and produces better results. Thus building a multipurpose robot is a challenging job because it includes the different types of modules and sensors which should work simultaneously and synchronously so that it can save our time and cost.

The main objective of this robot is to perform home automation like switching lights and fans. In medical field it is used for detecting the abnormal behaviour of a heart, used in signal processing for plotting ECG signals by taking measured samples. GSM module is used for detecting the mobile (which are more than 100m to the robot) and bring the mobile to the user by finding the shortest path. It is used to detect the intruder during night times and alarms the home mates. And also it detects the temperature which includes indoor as well as outdoor and display the temperature. We also used D-link Wi-Fi home camera which is used to record video and store it in cloud for future use.
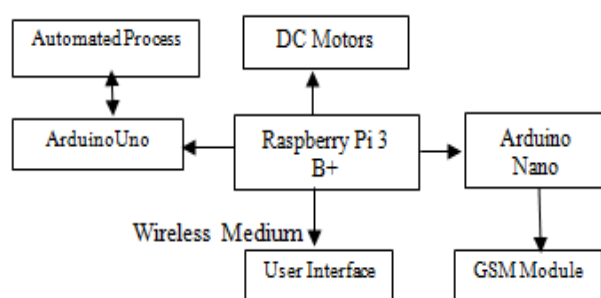

Fig.1. Block Diagram of the proposed system

Manuscript published on 30 September 2019
* Correspondence Author
G.Usha*, Department of Electronics and Communication Engineering, SRC, SASTRA Deemed University, Kumbakonam 612001, Tamilnadu, India, Email: gusha@src.sastra.edu.
K. Narasimman, School of Electrical and Electronics Engineering, SASTRA Deemed University, Thanjavur 613401, Tamilnadu, India, Email: knr@ece.sastra.edu .

II. LITERATURE SURVEY

The micro-controller used for this robot is AT89S52. It has many features such as low power consumption, high performance CMOS with 8-bit technology, high density non-volatile memory technology, 256 bytes of RAM, 8 kilobytes of Flash [5]. This robot uses ATMega328 as its control unit which monitors various sensors such as smoke sensor, LPG gas sensor, temperature sensor. It also uses ZigBee module, GSM module and camera [6]. The main aim of the proposed robot is to perform following line path of the robot, able to rotate 90 and 110 degrees [7]. Robot is designed for performing domestic needs such as home automation, detecting temperature. These tasks are performed using components such as Bluetooth (HC05) for home automation and LM35 for detecting temperature. HC05 module serves as a medium for the wireless transmission of signals from user control device to automated devices (lights, fans etc.). LM35 detects temperature and is sent to the microcontroller for further processing. Raspberry Pi controls and synchronizes all these needs [8].

A multipurpose robot is designed which includes various sensing units such as ultrasonic sensor, gas sensor, temperature sensor, humidity sensor for sensing respective modules function. Robotic arm is used for picking up the objects, GSM module has been used to communicate with the control unit from any distance. For short range wireless communication Nordic VLSI NRF905 radio chip is being used. As a whole three to four Arduino modules are used with inter serial communication [9]. This paper introduces a special type of robot which is Agribot used in agricultural domain. This robot is used to perform tasks such as ploughing the field, sowing of seeds, covering the seeds with soil. PSoc (Programmable System on Chip) controller from Cypress semiconductors used for controlling [10].

III. HARDWARE REQUIREMENTS

A. Raspberry Pi 3 B+

It is a micro-computer that has inbuilt CPU, GPU, USB ports, GPIO, Bluetooth, Wi-Fi, network boot and has the capability of doing functions same as a normal computer. It can be programmed by various languages such as Java, Python, Bash etc. It also has communication modules such as SPI, USART, I2C, UART etc. Raspberry Pi can also be made as a web server. It has various powerful networking tools. The proposed system utilizes Raspberry Pi as a main control centre. It provides various control signals for the working of different modes. Raspberry Pi provides great networking tool, this networking tool is used for wireless operation. Also the user interface is developed in python using Tkinter package in Raspberry Pi.

B. Arduino Uno

An Arduino is a micro controller that is used to perform both hardware and software operations together. The main aim of this is to ease the work of professionals who creates devices that controls things around us at low cost. This Arduino Uno supports programming languages like C, C++, etc. All the automated processes are controlled through Arduino. Various control signals that are received from Raspberry Pi are decoded here and the respective action is switched. The power supply for Arduino is taken from Raspberry Pi.

C. GSM module

The GSM module used in this is SIM 900 GSM/GPRS module which supports quad band width 850/900/1800/1900MHz performance for audio, text messages, data, fax with the low power consumption. It supports voltage in the range of 3.5-4.5V and operating temperature is about -30 to +80 degrees centigrade. This is a closely and neatly packed reliable wireless module.GSM module is switched on when GSM mode is activated. This is controlled through Arduino Nano. Whenever an intruder is detected then a message is sent through GSM to the respective user.

D. PIR Sensor

PIR sensor is used to detect the motion around it. PIR sensor detecting range is about 5-12 m. It is used to detect the levels of infrared radiation because it is made up of pyro electric sensor. PIR sensor is a three pin connection at one side of the module. These actions are monitored through Arduino.

RF module (Transmitter and receiver)

Radio Frequency module is used to transmit the data wirelessly over the frequency range of 30 kHz to 300 GHz. The transmitter / receiver operates with a particular frequency of 434 MHz and this transmission occurs at the rate of 1kbps to 10kbps. The type of modulation used in this module is amplitude shift keying. Home automation can be performed in three ways. Using Bluetooth, Wi-Fi, radio transmission and reception.

Temperature sensor(LM35)

The temperature sensor is a device which is used to measure the hotness or coldness of an object. It is used to measure the temperature more accurately than a thermistor. LM35 sensor maintains an accuracy of +/-0.4C at room temperature and +/-0.8C over a range of 0C to 100C.

E. DC Motor

DC Motor is an electronic device that is used for conversion of electrical energy into mechanical energy. The speed of DC motor can vary with respect to winding of copper coil. The DC motor supports a voltage of 4.5 to 36V.

IV. SYSTEM DESIGN AND ARCHITECTURE

Our robot consists of two types of processes namely automated and controlled processes.

A. Automated process

The heart of these processes is sensors. These processes do not require any type of control action. These are automated through sensors. Sensors are those components that are used to detect a specific action. The actions that are detected by sensors are then sent to the microprocessor or micro controller for further processing. The processing involves detection and performing desired actions that are programmed by the programmer. Processes such as automate mode, intruder detection and intimation come under this type of process.

B. Controlled process

These processes require manual control without any automation. User decides the type of actions to be performed. Processes such as entering power saving mode, semi-automation mode, high performance mode, surveillance mode, pick up object functionality, robot moving come under this type of process. Raspberry Pi acts as heart for the proposed robot. Raspberry Pi controls threaded processes such as wireless monitor accessing, app control, robot direction control. Control signals for the automated processes are provided through this Pi.

Arduino acts as heart for the automated process. All the processes that involve sensors are programmed and controlled through Arduino. Thus providing control of automated processes to Arduino reduces the work load of Raspberry Pi. This involves communication between Raspberry Pi and Arduino.
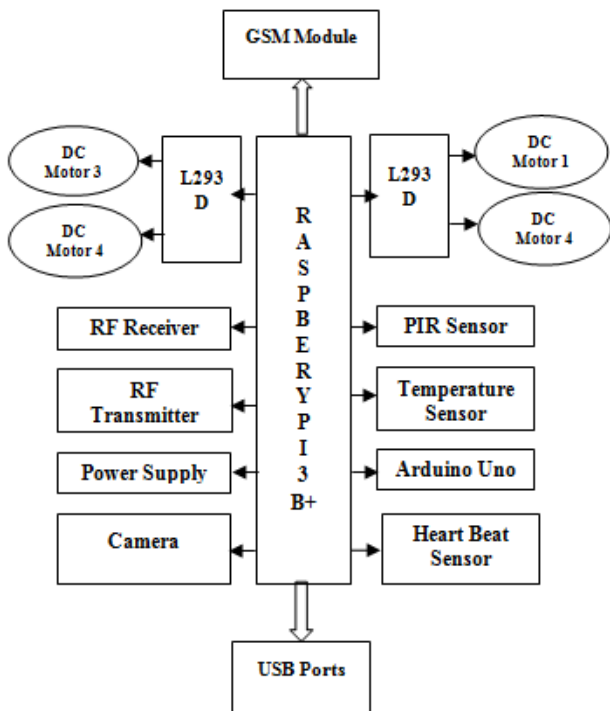
Fig.2. Schematic Representation of an Raspberry Pi 3 B+

This is achieved by linking threads. Raspberry Pi is programmed using python language and Arduino is programmed using embedded C.

All the control signals and controlling actions are provided from Raspberry Pi. Our proposed system involves efficient design in order to reduce the cost of overall system and to avoid the hectic of additional Arduinos.

We came up with an idea of multiplexing the digital pins of Arduino. This multiplexing is achieved by using encoders. These multiplexed pins are then controlled through programs (embedded C). The whole process is controlled using an app. This app is developed using python Tkinter package.

C. Wireless operation

Raspberry Pi provides greater networking capability. Wi-Fi of Raspberry Pi is programmed to connect to the user's mobile hotspot upon providing power. The mobile device that is used to operate Raspberry Pi is also made to

connect to the same hotspot. By using networking tools such as VNC viewer we can access the monitor of Raspberry Pi.

D. Software design
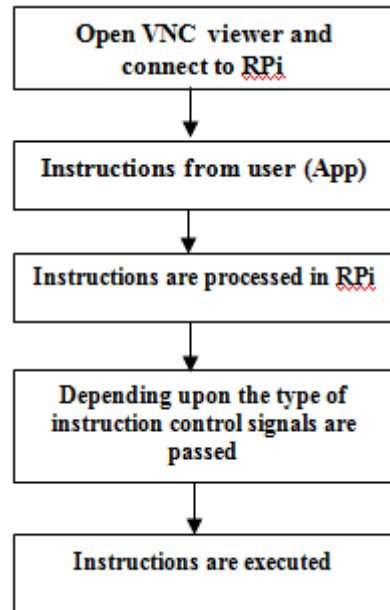
Fig.3. Flow Chart of execution of commands in Rpi

V. ALGORITHM

A. Wireless Display

Power on Raspberry Pi.Open VNC viewer app in the desired mobile phone and connect to the IP address of Raspberry Pi.Now instructions can be provided through app.

B. Modes of operation

Different modes of operations are available in file menu. User can choose his desired mode of operation. Press 'Yes' to enter in to a particular mode and 'No' to come out of a particular mode.

C. ECG Measurement

Measurement of ECG is done when ECG measurement button is pressed, the signals are plotted and displayed on the user interface.

D. Robot Control

The direction of robot can be controlled by using five buttons forward, backward, right, left and stop.

E. Automate/ Semi-Automate

This button is used for home automation. Initially this button will be in automate mode and when it is pressed once it changes to semi-automate and vice-versa. In semi-automate mode ON/OFF button is used for switching.

H. Camera

The camera used for this robot is D-link Wi-Fi controlled camera. It has 720 pixel high definition clarity. It is used to capture live events in surveillance.

I. Tkinter application

Buttons such as forward, backward, left, right, stop are used for respective movements. Different modes of operation are available inside the file menu. In order to enter a particular mode press 'Yes' and 'No to come out of that particular mode. n order to enter semi-automate mode press the automate button once.

In order to go back to automate mode press the same button again. While in semi-automate mode use ON/OFF button for performing the home automation. Pick up object button activates the robotic arm as shown in fig.4.

K. Operation of the system

Connect all the battery caps to the respective batteries provided on the robot. Connect supply from power bank to the Raspberry Pi. Connect android device to the Raspberry Pi as explained in section 4.2. An app is displayed on the screen which is used to control the robot. Different modes of operation are selected from the file menu. In power saving mode all the sensors are turned off. Default home automation mode is semi-automate mode. This mode is used for increasing the battery life. Surveillance mode is used for searching objects where the user can stay where he is and search the entire working place. Under this mode user can control only robot movements. When battery supply is less then user can adapt to the charging mode. In this mode only GSM module can be used. Proposed robot involves features such as detecting intruders and sending messages to the user.

Fig.4. App Inventor Design by using Tkinter

Measures heart rate and if it is normal then green led glows. Pick up object button is used for picking the objects.

VI. RESULTS

The proposed system has been achieved by following the system design as explained above and all the features that are mentioned are achieved.The proposed work result is shown in Fig.5. By using GSM module we were able achieve one way interaction between robot and the user as shown in Fig.6. The ECG measurement was done by taking the samples from the datasets and the results to that samples were as shown in Fig.7.
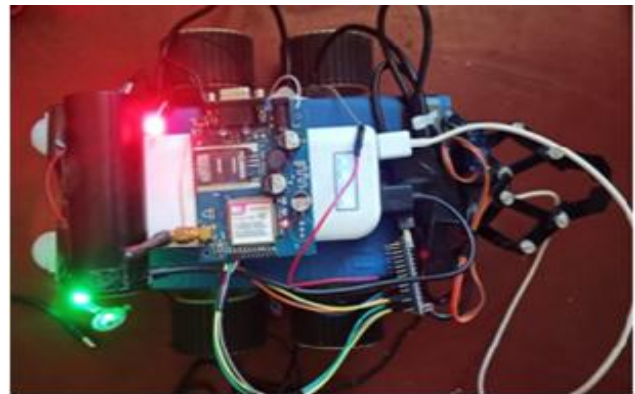

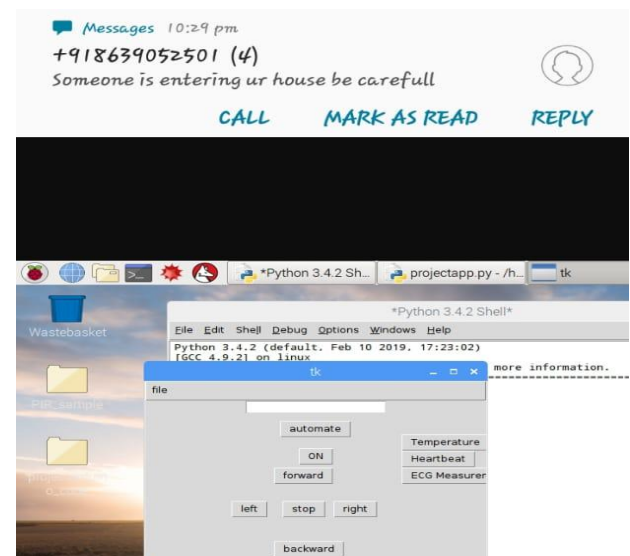**Fig5. Proposed robot**

Fig.6. Working of GSM module

VII. CONCLUSION

This project focuses on improving the life style of people. Nowadays the demand for multifunctional robots has increased rapidly. Industries, hospitals, military find extensive use in robots.
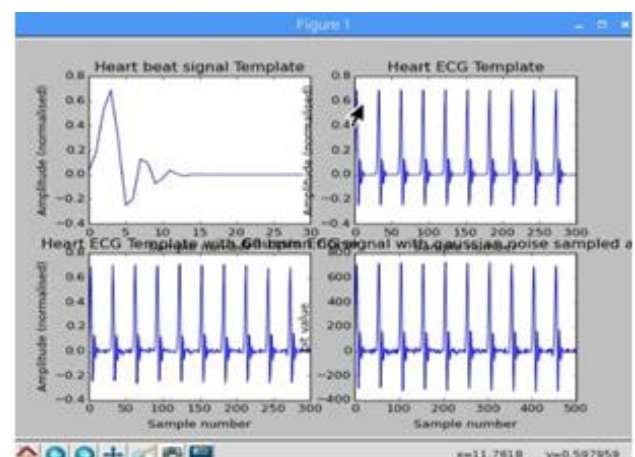

Fig.7. ECG Measurement

Routine works that involve humans to perform a specific action repeatedly are automated through robots. Technology is growing at a faster rate where human work is replaced by robots.

Thus by using Raspberry Pi a Tkinter based application is created that controls the robot. Various features such as intruder detection and indication using GSM module, measurement of heart beat, home automation, measuring the temperature, picking up objects are provided. Design of hardware is done with at most efficiency.

VIII. FUTURE ENHANCEMENT

Future research will be used for testing the proposed robot in industrial areas including factories, shopping malls, hospitals, etc. 5V GSM module will be adopted to include robot driving control mode so that it can be operated wirelessly and controlled in industrial area. Object tracking, detection and picking up object can be performed by finding the shortest path via this GSM module.

REFERENCES

1. Available:http://www.webopedia.com/TERM/R/robotics.html.
2. A Bluetooth-based Architecture for Android Communication with an Articulated Robot- Sebastian van Delden and Andrew Whigham, IEEE2013.
3. M.Selvam" Smart Phone Based Robotic Control for Surveillance Application", International Journal of Research in Engineering and Technology.
4. Development Of A Wireless Device Control Based Mobile Robot Navigation System PheySiaKwek,Zhan Wei Siew, Chen How Wong,, BihLiiChua, Kenneth Tze Kin Teo.IEEE 2012.
5. Ms.s. S.D. Mulla, Ms. A.S. Mali, Ms. S.T. Shibe, Asst. Prof. S.S.Joshi." Android Application Controlled Remote Robot Operation", International Journal for Scientific Research & Development.
6. Vrushali K. Jadhav, Prof. R. G. Dabhade," Smart Home System Using Service Robot and Wireless Sensor Network", International Research Journal of Engineering and Technology.
7. S E M Bajestani, A. Vosoughinia, "Technical Report of Building a Line Follower Robot", In: Proceeding of International Conference on Electronics and Information Engineering (ICEIE), Kyoto, Japan, Vol. 1, 1-3 Aug, 2010, pp. V1-1 - V1-5.
8. Smart Phone Based Robot for Domestic purpose using Bluetooth, Piyush S. Shrungare1, Amit A. Bokde2, Narayan U. Kashte3, Shubham S. Raut 4.
9. Design and Construction of a Multipurpose Robot, M. Taher U. Zaman, M. Sazzad Ahmed, Sabbir H., Shakhawat H., G. R. Ahmed Jamal*, M. KhairulAlam, M. Mobarak Hossain P., M. Abdullah A. Amin Department.
10. A. Gollakota and M. B. Srinivas, "Agribot — A multipurpose agricultural robot," 2011 Annual IEEE India Conference, Hyderabad, 2011, pp. 1-4, doi: 10.1109/INDCON.2011.6139624.