

Wireless Controlled Robot Using Raspberry Pi

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Abstract-In the recent years, the increasing utilization of wireless applications and the demand for a system that could easily connect devices for transfer of data over a long distance without cables became worldwide. The proposed paper introducing a robot which is controlled via the internet using protected webpage with a username and password to make sure it cannot be hacked. The webpage is designed to control the mobile robot remotely through the internet by any web browser such as Chromium, Internet Explorer, Mozilla Firefox and text editor like Gedit. Embedded web server is the integration of embedded devices and internet technology. This paper is focused on development of embedded web server based on Raspberry Pi for the communication in automation.

The designed mobile robot can be remotely operated as well as controlled from everywhere across the world without being near the robot. It can be controlled by using any device whether a laptop, a mobile or a tablet. For a specific distance it can move forward, reverse, turn right and left according to the controller specification so robot can access to areas that are unable to be accessed by humans and the robot detect obstacles using IR sensors.

Index Terms-Internet Mobile Robot; Raspberry Pi

I. INTRODUCTION

Wireless communication is very important concept and it plays an important role in various industries of automation field. Today the application of wireless communication in industrial automation is increasing rapidly [1]. Data Acquisition systems with remote accessibility are in large demands in applications of industry and consumer [2]. In some applications human beings have been replaced by unmanned devices that will acquire data and transmit the data back to the base. A single person can monitor and even interact with the ongoing work from a single base station. Wireless based industrial automation is a prime concern in our day-to-day life. The approach to Wireless Network for Industrial Applications standardized now a days. In order to improve process efficiencies, deliver quality products, and ensure timeliness and accuracy of systems, intelligent and low-cost automation of industrial processes are important.

A mobile robot can replace human to do work. The robot is controlled by wireless mode to ensure that it can be used from long distance by the user. Mobile robots are generally those robots which can move from place to place across the ground.

These Robots can work in a human-centered space and cooperate with men by sharing a workspace together and presented an Internet-based tele-control system for a wheeled mobile robot. A real time embedded controller using Lab view was designed to control the mobile robot remotely through the

Internet by a web browser, for example, Internet Explorer or Chromium. The designed mobile robot can be remotely operated from anywhere across the world as additionally there is a set of computers with keyboard, mouse, display and connection to the Internet. This project is a robotic vehicle that can be controlled remotely by Skype text messages. The embedded web server network including advanced processor ARM8- Raspberry Pi. It is having RISC architecture. An embedded web server creates an easy way for controlling any device which is at remote place [4]. We implement a system which is portable, low cost & having less maintenance.

II. LITERATURE SURVEY

As in [10], a wireless sensor network is a system combination of radio frequency (RF) transceivers, microcontrollers, sensors and power supply source. Wireless sensor networks with self-organizing, self-configuring, self-diagnosing and self-healing capabilities have been developed to overcome problems or to enable applications that traditional technologies could not solve. Wireless sensor network consists of various sensors and an ARM controller. In [11], Wireless communication the transfer of information over a distance without the use of electrical conductors. The distances involved may be short or very long. Wireless communication

involves - Radio frequency communication, Microwave communication, Infrared (IR) short-range communication. Applications of this communication may involve point-to-point communication, point-to-multipoint communication, broadcasting, cellular networks and other wireless networks. In the last few years, the wireless communications industry experienced drastic changes driven by many technology innovations.

There are several systems that allow data to be remotely accessed. As a solution to wireless data collection through the Internet, Wi-Fi on Raspberry Pi is a popular choice in several applications [11]. Real-time system correctness depends on the correctness of the logical result of the computation as well as on the result delivery time. The system runs on the Linux operating system and is popular choice for many embedded PC systems [1]. Users can control the remote data and remote system by using the embedded web server. The old system of transmitting the data by using the typical client server system is not so useful as it requires large amount of memory, it requires more space for the overall setup. Thus the cost of old system increases and so it is unsuitable, not so reliable. Thus the old system with central server can be replaced with the help of this advanced embedded web server. All the sensors sense the respective data in the plant and send this data towards the controlling unit such as ARM8 (16). Thus all the data is collected by the ARM8 and is maintained at this location. Here the data is stored in the data base. At this stage signal conditioning is done and only required amount of data is sent forward. Thus a successful communication is achieved between a server and client side by using this type of system. From remote processing unit the personal computer will continuously monitor all the data and compare with the value preloaded process structure. In [1], thus reporting of this real time data corresponding to the process plants can therefore be of great use for future analysis.

III. OVERVIEW OF SYSTEM DESIGNED

1 Microcomputer

1.1 Raspberry Pi

To connect the mobile robot to the Internet and the installation of the various programs, we need a

certain computer specifications. In this project we used microcomputer called 'Raspberry Pi' because of its good specifications and possibilities and high flexibility in dealing with different programs. Fig.(1) shows the Raspberry Pi model B useful in the field of electronics, computer science, computer and related projects of camera, gaming machines, robot, web server, media center.

Different versions available in market are pi-1, 2, 3 with model A, A+, B and B+.

a) Model A & B launched in 2012, Model B+ launched in 2014, Raspberry pi-3 introduced in February 2016.

b) By installing Linux kernel operating system and interfacing corresponding port connections with devices it can be used for numerous operations of industries automation, robot, military spy and rescue, office, hospital, hazardous environment and agriculture, fine tasks, space missions, welding, painting.

c) Intended for education.

d) Really cheap.

e) Used for many hobby projects, strong community.

f) Used even in commercial solutions due to low cost even that it is not intended for such use.

Raspberry Pi consumes less power and can save notable amount of energy in routing computing tasks (2). Other devices consumed power as

Table 1.- Power consumption of different GUI devices

Sr. No.	Devices	Consumed Power(watt)	Energy Consumption (KJ/hr)
1.	Smart T. V.	221	795.6
2.	Desktop	82	295.2
3.	Laptop	50	180
4.	LCD	40	144
5.	Tablet	25	90
6.	Smartphone	5	18
7.	Raspberry Pi	2.25	8.1

Raspberry Pi consumes 22% less power than a laptop. Energy utilization in efficient way causes reduction in pollution from environment, availability of more energy and improves economy. Requirement is of minimum storage capacity of 4 GB or greater to

install Raspbian operating system and can be extended up to 256 GB capacity SD card. In this paper I am using class IV SD card of capacity 16 GB which inserted in micro SD card slot.

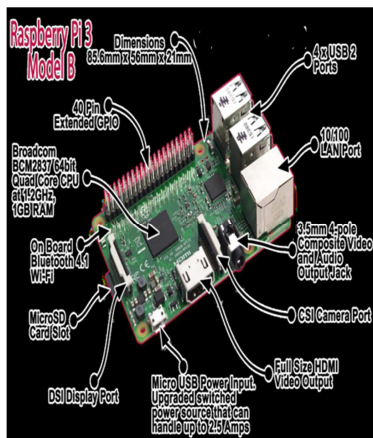


Fig. (1) Raspberry Pi-3 Model B

The Raspbian operating system will use to manage files, data processing. SD-card has greater reliability. It supports GNU/Linux and Root File system.

1.3. Wireless Communication Media

Wireless communication is a transfer of information between two or more points that are physically not connected. With the use of wires it is impractical or impossible to do long distance communication. The solution for this is to implement wireless communication. The distances can be ranging from short (few meters) to large (a thousand to millions of kilometers) across the world. Wireless communication could be found in various types such as fixed, mobile, portable two ways radios, cellular telephones, Personal Digital Assistants (PDA), and wireless networking [10].

1.3.1 Wireless network

For simple installation the wireless network are preferred (10).

1.4 TCP/IP

The TCP/IP suite has become the industry standard method to interconnect the hosts, internet and

networks. It is the engine behind the networks and internet worldwide. Even though TCP/IP supports a host of applications, standard and nonstandard, the applications may not exist without the foundation of a set of core protocols [4].

1.5 Internet Protocol (IP) Addresses

Across the world TCP/IP networks are interconnected and each computer on the internet have a unique address (called an IP address) to make sure that transmitted data reaches the correct destination. Blocks of addresses are assigned to organizations by the Internet Assigned Numbers Authority (IANA). Individual users and small organizations may obtain their addresses either from the IANA or from an Internet Service Provider (ISP). The IP uses a 32 bit address structure [4].

IV. DEVELOPMENT OF THE SYSTEM

2.1 The development of the system consists of following two parts.

A. Hardware Design

B. Software Design

The hardware design consists of Microcontroller ARM8, Quad comparator LM234, H-bridge motor driver L293D/L298D, two IR sensors, Raspberry Pi processor kit and a remote PC or Android mobile phone. All these hardware's are interfaced with each other as shown in fig.2 (block diagram)

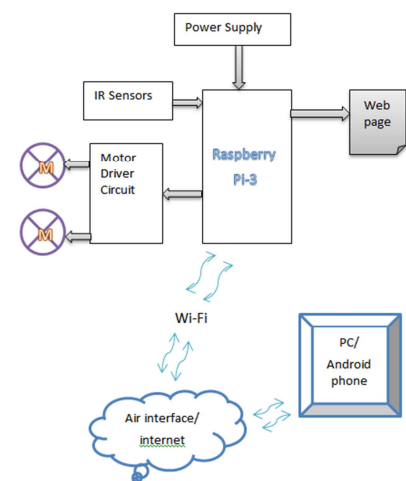


Fig. (2) Proposed block diagram

A. Hardware Design

To develop the overall system we used different hardware's, which are described in this section.

1. ARM8 Microcontroller

This is the main control part of the system. Here we are using microcontroller ARM8. ARM is the abbreviation of Advanced RISC Machines. As it is having RISC architecture it becomes the heart of the overall system.

2. Raspberry Pi Processor

The Raspberry Pi is a credit-card-sized single-board computer developed in the UK by the Raspberry Pi Foundation. A network using an external user-supplied USB Ethernet or Wi-Fi adapter. Generic USB keyboards and mice are compatible with the Raspberry Pi. The Raspberry Pi primarily uses Linux-kernel-based operating systems.

B. Software Design

First, an operating system has to be installed in Raspberry Pi. Linux based OS is the preferred for almost all single board computers and the scenario doesn't change with Raspberry Pi. Popular OS for Pi are Raspbian, Debian, Arch Linux, RISC OS, etc. The Debian distribution based Raspbian is much preferred than any other. It's installed onto an SD card. A mouse and keyboard are required to work with it, and with the 2 USB ports available, it's possible to connect the mouse and keyboard to the system. In order to plug-in another USB device has to Pi, a powered USB hub must be used because the device will draw power from the Pi to work and this will cause Pi to hang. The external powered hub can provide the necessary power for Pi to operate; it will be good to use an external adapter of specified rating.

There are various languages used for web design that have developed over the life time of World Wide Web. Generally web pages are designed using HTML (Hyper Text Markup Language). HTML pages are used for data communication between the client and the server (19). In the embedded web server, web pages are selected as the media of interaction. Here we are developed a PHP page. The PHP Hypertext Preprocessor (PHP) is a programming language that allows web developers to create dynamic content that interacts with databases. PHP is a server side scripting language that is embedded in HTML [21].

2.2 EMBEDDED WEB SERVER

The implementation of embedded internet technology is done with the help of embedded web servers. An embedded web server provides remote access to devices from a web browser. An embedded web server is integral part of embedded network which consists of an ARM processor [18]. ARM processor contains an internet software & application code for monitoring & controlling the systems. Embedded server is a single chip implementation of the WLAN networking standard. The client computer sends/receives data to & from the arm microcontroller using TCP/IP packets. The client has to enter IP address to access this server.

The IP address of embedded devices will be available at client side to directly access the system. By using this IP address people from remote location will access the information on PC or android phone [8]. The operating system manages the request of the client and gives to the LAN (Local Area Network) controller of the client system. The LAN controller sends the request to the router which processes and checks for the system connected to the network with that particular IP address. If the IP address entered matches to that of the server, a request is sent to the LAN controller of the server to the client and hence a session is established between server and the client and the server starts sending the web pages to the client. There are two types of IP address i.e. static IP & dynamic IP. Dynamic IP assigned through a Dynamic Host Configuration Protocol (DHCP) server of the Internet provider for every connection established. The embedded system updates IP information on the server upon every reboot, which causes an IP refresh from the Internet service provider. As in [8], the dynamic IP address is of very great use as it is more flexible and it gives good secured result. Web pages are designed using HTML (Hyper Text Markup Language). HTML presents the user with a page of Information (20). So here we use HTML language to build embedded web pages [12]. Embedded web servers have lot of advantages such as, low cost, supports to real time application, low maintainability; they are user friendly, high reliability, security etc. [6]. Fig 3 shows the system of embedded web server.

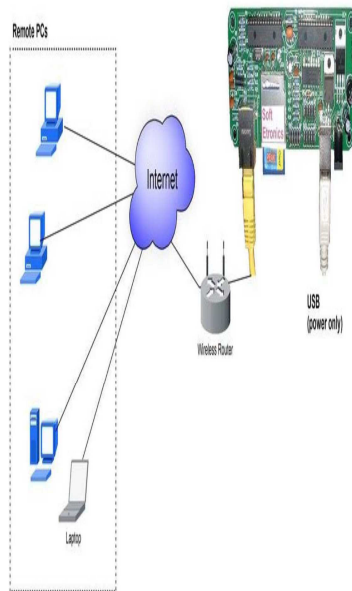


Figure 3 Embedded Web Server

V. SYSTEM RESULTS

The individual testing of different modules are done and the final setup is made by arranging all the devices in proper manner.

After requesting the web pages by the client, the online processing web page for client authentication is opened. Client can interact with the system through its own browser via these embedded web pages. The dynamic web page representing the sensor values in the system maintained by the embedded web server. The client access the data dynamically through this web page send by the server. More than one client can access the data at the same time from different parts of the world. Following figures show the developed system results.

The robot work on two modes:

- Automatic mode**
- Manual mode**

In automatic mode, the robot work automatically without human intermission. Whenever any obstacle is detected then robot automatic changes its path.

In manual mode with the help of human guidance robot work efficiently.

With the Pi set as a web server, it's possible for the client computers to access the data or web pages hosted by the Raspberry Pi server. The GPIO pins enable Raspberry Pi to communicate with various hardware devices and there are 40 GPIO pins, with 9 being multifunctional. L293 motor driver boards are used for the Robotic motion to be controlled from the GPIO pins. A web page is hosted in the server for the robotic motion control.

VI. CONCLUSION

The world is moving towards the automation by using the various techniques for the communication. The Raspberry Pi can be used for the control of a Robotic motion with obstacle detection from a remote end through the web page. This data can be provided worldwide with port forwarding. The wireless solution by using the Raspberry Pi provides fast transmission over long range. It saves resources and time. Thus data can be monitored and controlled at remote locations with much secured manner.

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