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A Robotic Arm That Can Be Operated by Hand

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Abstract

People often assume that robots are primarily useful in manufacturing or in laboratories where innovative technologies are being tested. However, the primary purpose of robots is to assist people in their daily tasks, whether it be in the workplace or around the home. The common belief that "robots are for the industries only" will be bridged with the help of the internet.In this study, we show how a robotic arm may be operated remotely through the web. A computer connected to the internet may direct the robotic arm's motion. This robot may be used to show how easily and effectively robots can do common household tasks. An Arduino Uno, connected to the web through an Arduino Ethernet Shield, serves as the robot's brain. Servo motor analysis and an accuracy test were conducted for this project. The accuracy test demonstrates that the servo motor's real output agrees between 97% to 99% of the time with the input sent to Arduino Uno via the internet. This working robot prototype proved the procedure was a success. It is hoped that this user-friendly robot would finally allow robots to take over mundane domestic tasks.

Introduction

There is a growing trend toward using robots in the workplace as a substitute for people, particularly for menial or repetitive duties. The field of robotics may be broken down into two main categories: industrial and service. Service robots, as defined by the International Federation of Robotics (IFR), are autonomous or semi-autonomous machines that aid humans in someway. Workers and machinery, with the exception of the production process [1]. However, in today's world, the internet is rapidly becoming indispensable. Instead of cleaning their homes, most people choose to spend time online. Unlike the previous decades, when using the internet required sitting in front of a computer and being connested in, the internet is now available everywhere. This is a reward of having a robot help around the home. The mechanical components of the robot were fine-tuned, and the appropriate electrical components were selected for use in the robotic arm. An Arduino Uno serves as the robot's "brain," while an Arduino Ethernet Shield acts as the board's network interface, allowing the robot to be operated remotely. Arduino is a free and open-source electronics prototyping platform with a focus on simplicity and adaptability. Controlling the robot's motion is as simple as entering the required amount of arm movement, at which point the arm will move accordingly. The robotic arm may be configured to move with the press of a button. In this project, an HTML-based webserver is utilized to create the user interface that will be shown to the operator when he or she connects to the robotic arm remotely.

Literature review

Some researchers in the past have utilized the internet to operate their robot; reference [7] recommends using the SOAP protocol and a PC server and PC client both built on the ASP.NET framework. The proposed protocol has a response time of around 30 seconds because of Web service overhead. Due to the request-response nature of web services, they detract from the simulator's computational efficiency. Meanwhile, publications [8] advise using a LINUX-based PC architecture typical for industrial use, and a network interface that allows for a wireless TCP/IP Ethernet connection. The NOMAD-200 robot is equipped with a UNIX server workstation and a LINUX-based industrial PC. The server and robot share a same operating system, making UNIX socket an ideal medium for inter-computer communication. Their approach uses two physical transmission ports to generate two virtual channels. Here, an Arduino Uno embedded system serves as the robot's brains, and an Arduino Ethernet Shield connects it to the internet for remote control. Since the operator has complete control over the robot's arm, training is unnecessary.

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Methodology

The robot's arm is designed to act similarly to a human. Here, you will find a detailed explanation of the robot's hardware, broken down into its mechanical and electrical components.

Project overview

The reliability of the system is ensured by the integration of hardware and software in this project. The project's brains are Arduino Uno boards, and an Arduino Ethernet Shield connects them to the web. The big picture of the project is shown in Fig 1.

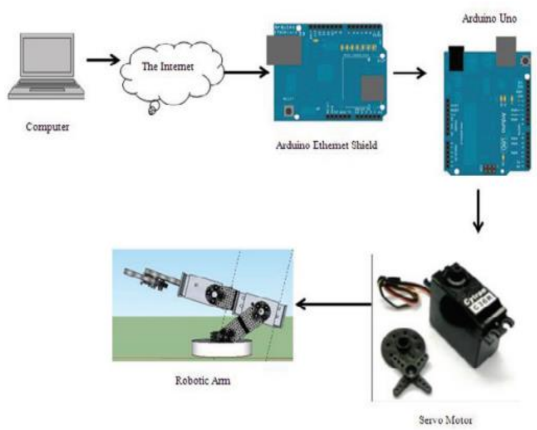

Fig 1: Project overview of internet controlled robotic arm.

Mechanical design

The robot was fifteencentimetres tall and had a circular base that was twenty-twocentimetres in diameter. Servo motors provide direct drive to the robot's degree-of-freedom mechanism. Because of its low cost, high strength, and ability to support the weight and motion of the robot's motors, acrylic is utilized as the robot's foundation. Aluminium servo brackets are used in the design of the robotic arm. because it is lightweight while being rigid, much like a human arm. For the same reasons as the main robot arm construction, aluminium is used for the robot gripper.

Electrical design

The primary components of the robotic arm are shown in a block diagram in Fig. 2. Each of the robot's five outputs—the base, shoulder, elbow, wrist, and gripper—is controlled independently of the others. The robotic arm's detailed block diagram is shown in Fig. 3. A 12V/1.2Ah Lead Acid battery was chosen as the robot's primary power source due to its useful properties and benefits. Next, a voltage regulator LM78XX is used to reduce the output of the primary source to five volts. A servo motor is a form of DC feedback motor that is widely used to regulate systems in the vertical plane. When collaborating with robots, servos are indispensable [2]. The servo motor has a high torque at a low RPM. Given that the high torque is necessary for this task. As a result, servo motor 180 is the best choice for this application.

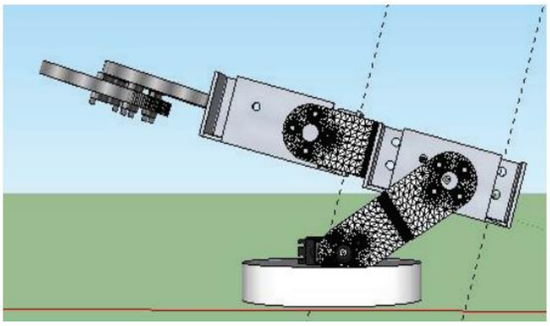

Fig 2: Side view of the internet controlled robotic arm.

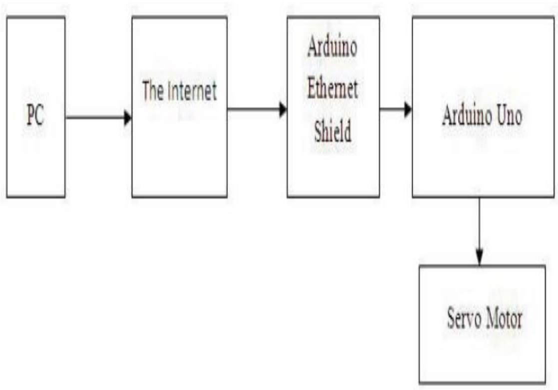

Fig 3: Specific block diagram of internet controlled robotic arm.

Robot control system

The primary components of this setup are the robotic arm and the computer. The Arduino Uno serves as the project's central processing unit (CPU). A LAN cable will link an Arduino Uno to the internet, and an Arduino Ethernet shield will function as an interface between the two devices. Then, any device with an internet connection may get access to the robotic arm and operate it. Relay infrastructure is employed to allow the robotic arm to connect to the internet. Secure Web access for embedded devices behind a firewall or NAT is made possible via relay technology. One firm offers a free relay service (yaler.net) for its customers. The diagrams in Figure 4(a) and Figure

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4(b) demonstrate how relay infrastructure may be used to bypass a firewall or NAT. [6] The robotic arm's process flow is shown in Fig. 5. The robot is put into action by first rotating to its original position and evaluating the servo motor. Once the servo motor has reached its home position, the controller will wait for further instructions. When a computer connects to the controller, it will load a basic graphical user interface (GUI) that was coded into the embedded webserver.

System architecture

This internet-controlled robotic arm's requirements are laid forth in Table 1. The major reason for writing this specification is to ensure the project is viable and suitable for usage in the market, as well as to define certain key components of the project.

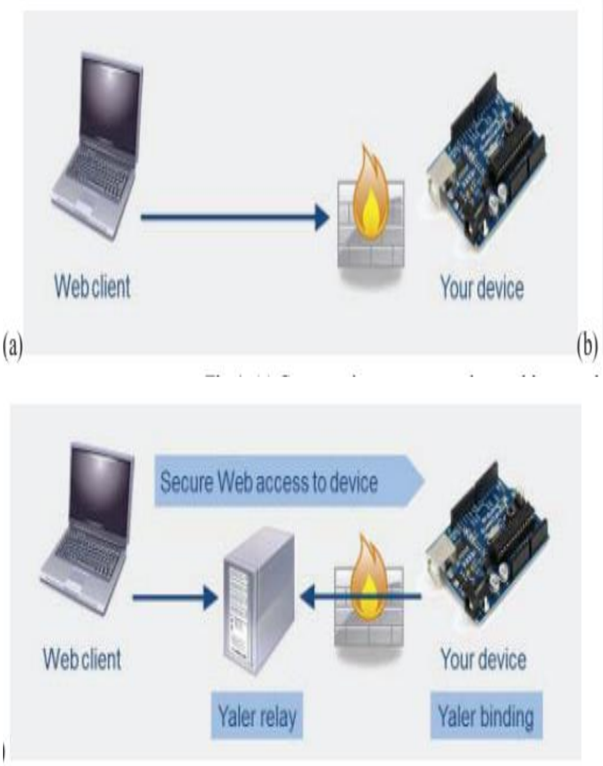

Fig 4: (a) Common internet connection problems to the embedded system and (b) how to solve it.

Table 1: Specification of Internet Controlled Robotic Arm.

Module	Specification
Supply from battery	12 Volts DC
Power Consumption	Volts DC
Controller	Arduino Uno
Internet connector	Arduino Ethernet Shield
Programming language	Arduino language
Actuator	Servo motor

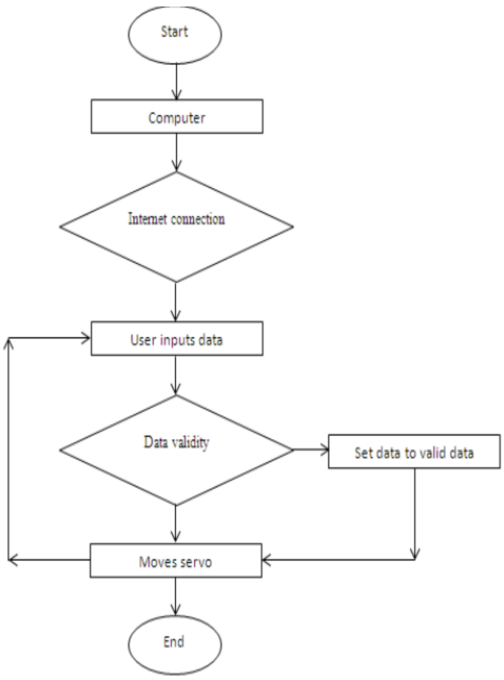

Fig 5: Flowchart of internet controlled robotic arm.

Software robot design

The inspection robot's physical design is complemented by the robot's software, which does things like read the input value from the internet and command the servo motors. The ATmega328 is the foundation of the Arduino Uno, a microcontroller board. Fourteen digital I/O pins (6 of which are programmable) are I included. useable as pulse width modulation (PWM) outputs), six

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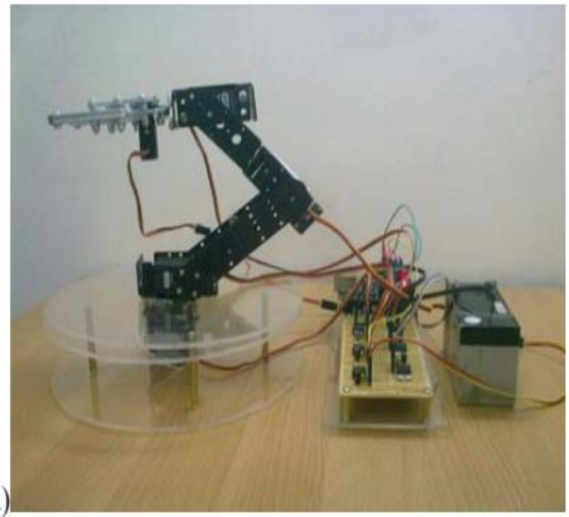
analogy inputs, a USB port, a power connector, an ICSP header, and a reset button. It has everything that is required for the microcontroller to function. The Arduino IDE is a Processing-based integrated development environment used for programming Arduino hardware in the Wiring language (syntax and libraries), which is comparable to C++ with various simplifications and changes. The Arduino IDE is used to write code for the hardware, and it is written in Java and is based on Processing, avr-gcc, and other free and open-source programs [4]. HTML-Kit is an effective tool for developing a web server in HTML. chemical's HTML-Kit is an exclusive Windows-only HTML editor. The program is a comprehensive HTML editor that allows users to create, modify, preview, and publish web pages written in HTML, XHTML, and XML. HTML-Kit highlights HTML code and includes a preview right in the editor [5].

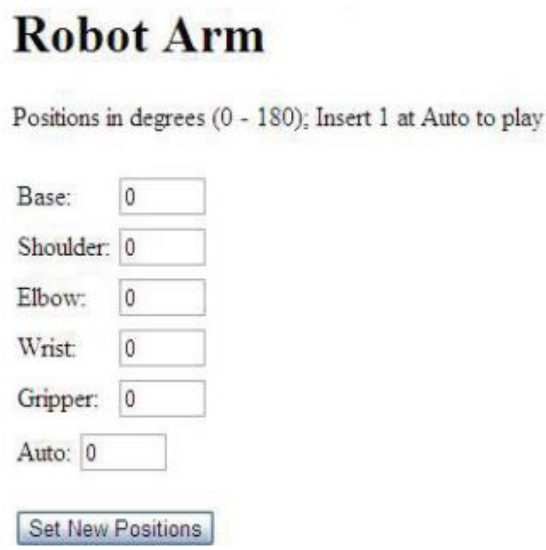
Result and discussion

Fig. 6(a) is a picture of the finished remote-controlled robotic arm. Fig. 6(b) shows the finalized GUI coded in HTML. Without graphical user interfaces (GUIs), users would be forced to struggle via the command line interface (CLI). This project's graphical user interface (GUI) has two distinct sections: "Manual Setting," for direct control of the robotic arm, and "Automatic Function," for automated motion. Fig. 7 depicts a developed Internet-controlled robotic arm that will be used in practical settings. It can do tasks like picking up and placing objects and moving around much like a human arm.

(a)



(b)



Completed GUI for internet-controlled robotic arm (b) and finished robotic arm (a) shown in Fig. 6.

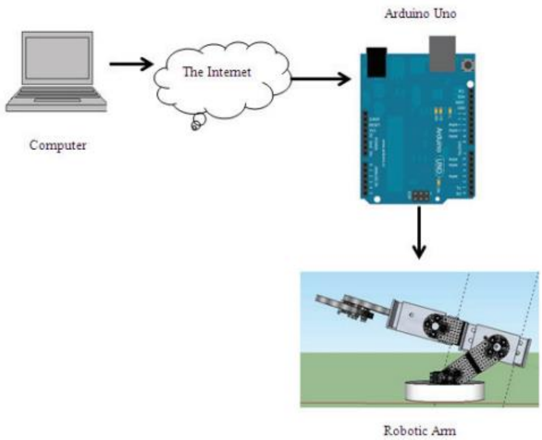


Fig 7: The internet controlled robotic arm.

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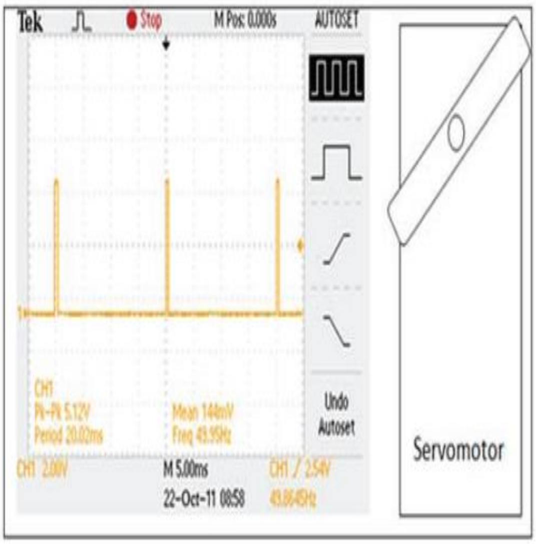
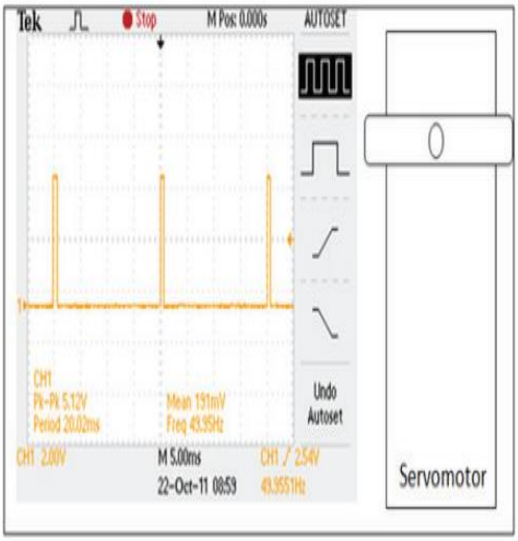
Servo motor analysis

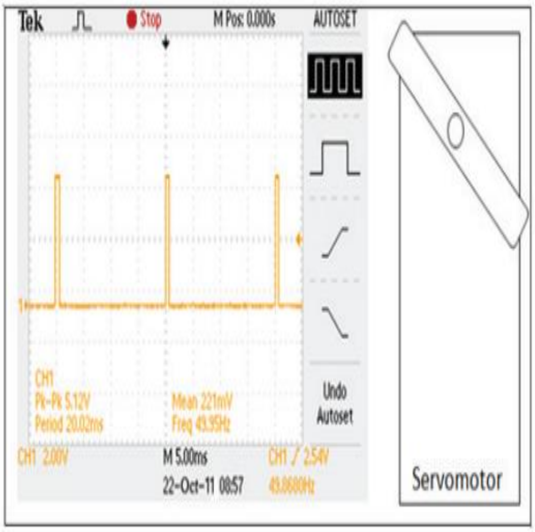
A servo motor may provide signals across three wires. Two of them provide electricity and ground, while the third gives a position control signal to the motor. A servo motor responds to a sequence of pulses, the duration of which specifies the desired position. The pulse and rotation in the neutral position areshown in Figures 8(a), (b), and (c). and the proper observance of the clock's revolution. The servo motor's pulse width and position areshown in Table 2. If the pulse width isincreased by 10 Sec, the output shaft will rotate by around 1°. These figures are arbitrary and may vary significantly across brands and models.



(a)



(b)



(c)

Fig 8: (a) Servo motor rotating counterclockwise and its pulse, (b) Servo motor rotating at neutral position and its pulse and (c) Servo motor rotating at

clockwise position and its pulse.

Table 2: Servo motor pulse width and location

Pulse width	Angle	Comment
0.6 mS	-45 degree	Minimum pulse length
1.5 mS	0 degree	Centre position
2.4 mS	45 degree	Maximum pulse length

Accuracy test

The precision of the servo motors is measured by performing an accuracy test whenever a new position value is sent to Arduino Uno from a computer through the internet. The lowest angle communicated was 45 degrees; the neutral angle was 90 degrees; and the highest angle was 180 degrees. The servo motor's output accuracy is shown as a percentage in Table 3.

Table 3: Servo motor accuracy

Location.	Output accuracy (%)		
	Minimum	Neutral	Maximum
Base	98	97	97
Shoulder	98	98	98
Elbow	97	98	98
Wrist	98	98	99

Conclusion

Overall, hardware development and software development are the two most significant aspects of this project. The hardware procedures consist of creating the robotic arm's link and joint and automating the process of controlling the servo motors. The process of creating software includes coding for both the web server and the Arduino Uno. The results of the studies reveal that servo motor control is straightforward and the output is precise. Therefore, a servo motor should be used for the robot arm's actuator. The goal of this work is to demonstrate that domestic applications for robots are feasible and warrant further research. Robots can be operated remotely without the need for a robot-specific controller because to the ubiquitous nature of internet access these days. The primary characteristics of this robot are similar to [8]. This study demonstrated the feasibility of remote internet control for robots and their use in domestic settings.

Recommendation

The robot's software operates well most of the time, with the base, shoulder, elbow, wrist, and gripper all moving and rotating as intended. However, there is always room for development, such as redesigning the robot arm to better fit a particular activity for domestic use or attaching a camera to the robot so the user can view the robot's movement through the internet.

Acknowledgements

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