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Tele-Operation Systems for Robotic Arm Manipulator using IoT

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Abstract

This paper has style and development of a robotic arm manipulator victimisation net of things with low value. Tele-robotics refers to regulate a mechanism from an overseas finish. The robotic arm has controlled by wirelessly is incredibly useful for broad vary of applications that starting from medical fields, automations in industries. With the recognition and widespread use of net, it becomes a straight forward task for anyone to regulate and monitor the robots from an overseas finish. During this project, a robotic arm is meant to be controlled by a licensed person at any time and from anywhere victimisation the online technology. With an internet server, it becomes simple to regulate devices from an overseas web site. The net based mostly robotic Tele-operations realize nice utility in applications that are dangerous, hostile, and inaccessible to humans and areas of labor no matter geographical locations. Thanks to the growing awareness, technological support, knowledge transmission protocols, easy use and low value the net has well-tried to be the foremost appropriate infrastructure for worldwide access and knowledge exchange.

1. Introduction

New generation Robots have found applications in areas of work which are dangerous and hostile for humans. Due to this remote access, control and monitoring of Robotic systems have been an area of focus. Remote Sensing and Control in Robotics have found applications in areas like Remote Surgery in the world of medicine, Robots working in radioactive environments, undersea explorations, Space and Military [1]. With the growing awareness, popularity and its enormous technological growth, the Internet has proved to be the future of distributed systems. It is now possible to conceive and develop distributed systems that could be controlled and monitored across the globe through the Web Browser.

Over the years the Internet has matured leaps and bounds and is now a conceivable to think future of Tele-Robotics to be controlled and monitored over the Internet via the http protocol [2]. With advances in microprocessor technologies, miniaturization has enabled a high degree of intelligence to be integrated into systems. This has allowed integrating technologies like the Java NM, the TCP/IP protocol to enable Ethernet connectivity and serial protocols to talk to serial devices. Due to these advances we are in a position to build distributed systems which collaborate with each other using various protocols like HTTP, TCP/IP, RS232, etc. This enables us to build distributed, platform independent, reusable, scalable applications that could be built once and run everywhere [3]. It is now possible to build web applications that communicate with other Java technology components like Web Services via the http protocol which is the protocol of the web. This gives us the capabilities to build systems that control intelligent systems such as Robots through Web applications and other components like the serial communication channels.

2. Design & Implementation

This paper mainly focuses on building a framework for embedded Java ingrained into intelligent microcontrollers. This takes a very distributed and pluggable approach of building web components which are user friendly through the development of dynamic web pages. This enables the application to be deployed on a centralized http server located at one location and invoked through the Web Browser from another part of the globe [4]. This paper also makes use of the technologies like web services and Java communication APIs that gives us the ability to develop a Secure (through the use of Authentication), Generic (through the use of web services), Platform Independence (as Java by its nature can be deployed and run on any platform), Scalability (Complex algorithms and core functionality of the control system built in the form of a Web Service), Pluggability (The architecture by its design is loosely coupled which gives us the flexibility of plugging in/out components) architecture that could be used for other applications besides Tele-robotics over Internet [5].

2.1 System Design

Tele-Robotic Arm setup is connected via Ethernet Module in the client side while the control software runs in the control server side [6]. Control server side uses Tera-term pro software to connect to the hardware IP address. Commands are sent and received in the Terminal software once the robotic arm IP is registered in the software. The S2E module transfers the data to and fro from the arm hardware from serial to Ethernet side. Obtained data from the Ethernet is processed by Nuvoton microcontroller and converted into arm co-ordinates.

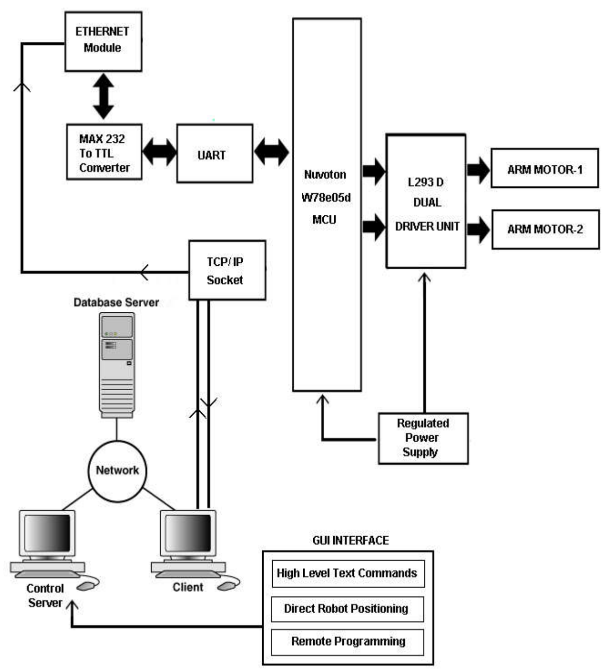


Figure 2.1 System Design of Tele-robotic

According to the calculated co-ordinates microcontroller send the control signal to the L293 motor driver unit. The value for X and Y axis are sends to the motor driver. Then the motor rotates to set position according to the command received. Remote programming combined with an advanced multimedia user interface. Allows only authenticated users to exhibit physical motions of the Robotic Arm. Lets the operator manipulate remote environment by using multiple ways of interaction. Rather than using sensor control, the developed system uses multi-mode GUI & command interface control. Today's Internet provides a convenient way for to develop an integrated network environment for the different variety of applications such as different robotic systems. The system has a standard network protocol and an interactive human-machine interface using a Web browser.

2.2 Robotic ARM Design

During the project development, different configurations were tested in different environments. The aim is to develop a more reliable system framework that can be used in the real world.

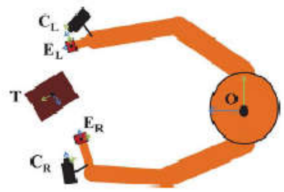


Figure 2.2 Robot Dual Arm Schematic

It is primarily addresses coordinated, task-based control methods for a dual-arm industrial robot. Since there is a large body of work on single-arm robotics, we narrow our scope of related work to only dual- or multi-arm robots.

Figure 2.3 Robot Dual Arms

a) They are faster and can get the work done in seconds compared to their human counterparts.
b) They are flexible and have the appropriate design.
c) They are accurate.
d) They increase the safety of the working environment and actually never get tired.

For autonomous operations, tasks for Dual-arm robots are often pre-solved planning with known geometry information we present a tele-robotics framework for human-directed dual-arm manipulation [7]. The human operator provides input data commands and moving directives, while the control system autonomously locates the object of interest and maintains force. Consider robots with multiple redundant arms. Such robots can tackle a much broader range of tasks than a single arm, but at the same time increased complexity.

2.3 Gripper Force Sensing

It is appropriate, for the gripper joint, to use a force sensor to measure the amount of force the slave is exerting on an object in its grip. To measure the force, a sensor is attached to the inside of one of the gripper prongs.

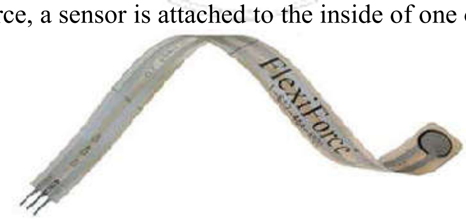


Figure 2.4 Tekscan FlexiForce force sensor

When the gripper closes around the object, the sensor is compressed between the object and the gripper prong. From this the force can be measured. The sensor that has been used is a Tekscan FlexiForce force sensor, pictured in

Figure 2.4. These sensors are mounted on a flexible circuit board and have a small circular dot of force-sensitive ink. The resistance of this ink increases as the force applied increases. By using a simple operational amplifier based circuit this force can be converted into an analog voltage that can be fed into one of the ADC inputs of the transducer interface.

Once the force data is accessible by the coordinator program it could be displayed to the user through the GUI of the coordinator program, or it could be employed to drive a motor attached to the gripper joint of the master unit thereby giving the user a sense of how much force is applied to an object [7]. Several sensors having a different sensitivity to force and catering to different maximum loading were tried. For the reported system the 1 lb sensor has been the most appropriate. The sensor characteristics are shown in Figure 2.5.

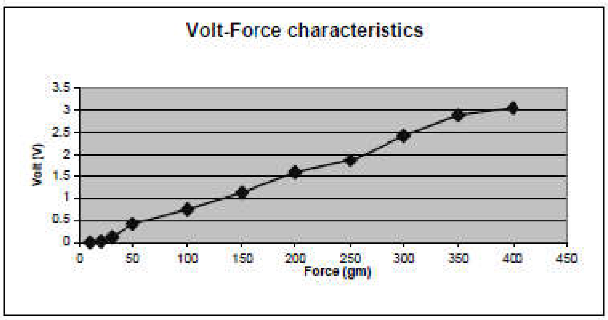


Figure 2.5 Force sensor transfer characteristics

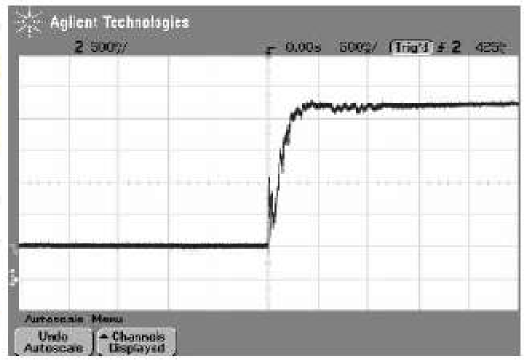


Figure 2.6 Transient response of the force sensor

Figure 2.6 shows the transient response of the sensor when subjected to a step load of 300gm (from 100gm to 400gm). The settling time is approximately 500ms, which is acceptable for the intended applications of the system. The force sensor, which is essentially a variable resistor, is used to change the gain of an inverting high-gain operational amplifier, as shown in Figure 2.7. When using another sensor with a different sensitivity, the amplifier gain may need to be changed [8]-[10]. This is achieved by varying the potentiometer R2.

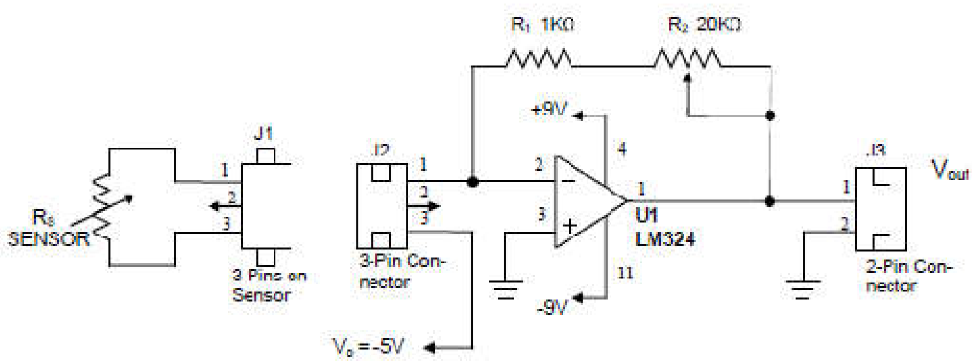


Figure 2.7 Amplifier circuit for force sensor output

3. Requirements and Metric for Hardware

3.1 Serial-To-Ethernet (S2E) Module

S2E module accelerates the product development by providing ready-to-run hardware and comprehensive documentation. The compact design is based on the TEXAS microcontroller, a highly integrated ARM® Cortex TM –M3 microcontroller with integrated 10/100 Ethernet MAC and PHY, 50-MHz performance, and ample single cycle on-chip Flash and SRAM memory for efficient network traffic handling. The S2E module includes one 10/100

Ethernet port, two serial ports and 10-bit,3-channel ADC with flexibility that includes both RS-232 and CMOS/TTL level signaling, flow control, and hardware support for both synchronous and asynchronous serial communication.

3.2 Teraterm Pro

Tera-term Pro Web is the next generation tool for connecting with remote Telnet and SSH hosts. It is built based on the extremely popular open-source. Tera-term (Pro) is a free software terminal emulator (communication program) for MS-Windows. It supports VT100 emulation, telnet connection, serial port connection, and so on. Ability to connect via SSH2.Allow recurring command to be sent to connected hosts.

a) Enhance the TTMacro Language to allow ODBC connectivity and additional scripting functionality
b) Provide HTTP listening on any IP/port combination
c) Have template-based response and error files that could be easily modified
d) Have comprehensive HTTP request logging

3.3 Proteus 7 Professional

This is the simulation software for project. This provides combines mixed mode circuit simulation, micro-processor models and interactive component models to allow the simulation of complete micro-controller based designs. Major features of PROTEUS VSM include:

a) Support for both interactive and graph based simulation.
b) Virtual Instruments include voltmeters, ammeters, a dual beam oscilloscope and a 24 channel logic analyzer.

Virtual Terminal is a tool in Proteus, which is used to view data coming from Serial Port (DB9) and also used to send the data to the Serial Port. In windows XP, there's a built in tool named Hyper Terminal, which is also used for the same purpose but in windows 7 there's no such tool so for windows 7 users this virtual terminal is quite a great comfort.

3.4 Microcontroller W78E052D

The W78E054D/W78E052D series is an 8-bit microcontroller which can accommodate a wider frequency range with low power consumption. The instruction set for the W78E054D/W78E052D series is fully compatible with the standard 8052. The W78E054D/W78E052D series microcontroller has two power reduction modes, idle mode and power-down mode, both of which are software selectable. The idle mode turns off the processor clock but allows for continued peripheral operation.

3.5 Dual-DC Motor Driver L293D

The L293 and L293D are quadruple high-current half-H drivers. The L293 is designed to provide bidirectional drive currents of up to 1 A at voltages from 4.5 V to 36 V.

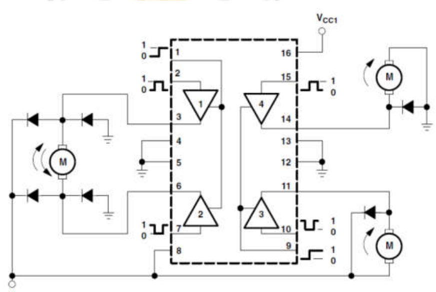


Figure-8: Arm motor Control Section

Both devices are designed to drive inductive loads such as relays, solenoids, dc and bipolar stepping motors, as well as other high-current/high-voltage loads in positive-supply applications [11]. The L293D is designed to provides bidirectional drive currents of up to 600-mA at voltages from 4.5 V to 36 V.

4. Result Analysis

In this paper, we got the output from Proteus simulation software. This software is used for mainly for all embedded based design. First of all we will draw schematic in schematic page after drawn schematic and to upload source program to microcontroller by using source program.

4.1 Schematic Design

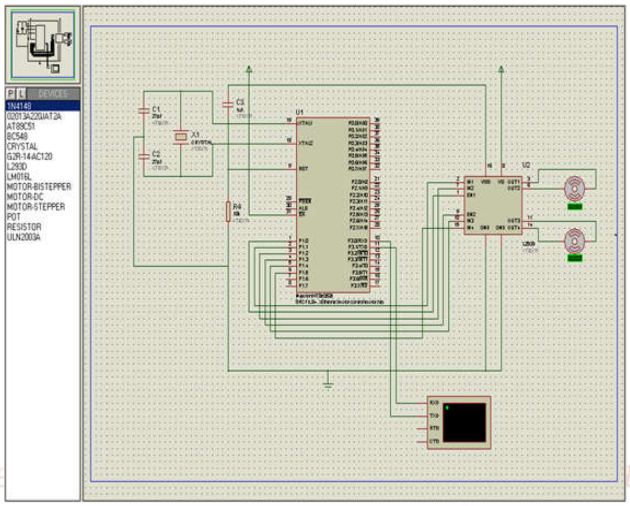
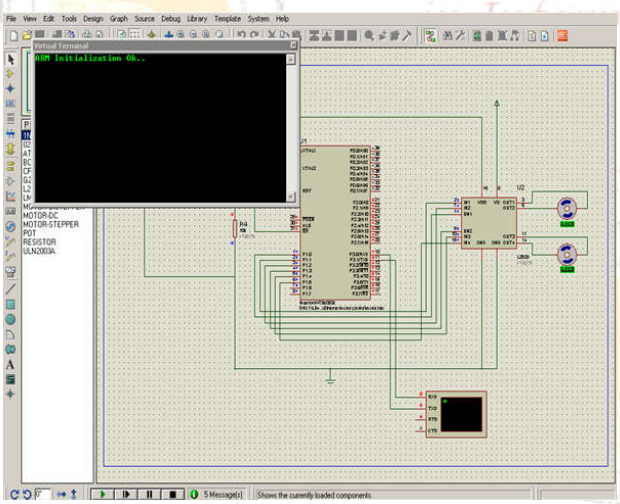


Figure 4.1 Schematic in Proteus

4.2 Execution - Input Commands & Output Response



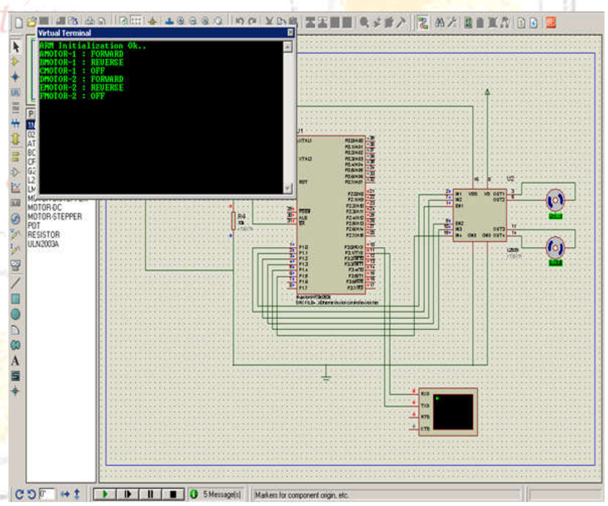


Figure 4.2 Execution **Figure 4.3 Input Commands & Output Response**

Output executed by using virtual terminal and depending upon the input data the arm motor will be performed visually and is observed the position movement.

5. Conclusion

A simulation of the designed Robotic Control system was conducted through the Proteus software with the designed schematic for moving the Robot through a sequence of motions and performing an autonomous motion/task. The following conclusions are thereafter deduced. The user could define a numeric position for each of the Arm motors that constitute a physical position of the Robotic Arm and see it actually move to those coordinates thus making it easy for the user to define a set of positions to achieve a particular task. The user could enter valid range of positions and see the system prompt him for valid inputs. The virtual terminal allows the user to verify & control the motors and thus the Arm position in the terminal window.

6. Future Work

The main focus on future enhancement is placed on how to control the robot with use of visual feedback and provide a high degree of local intelligence to handle the network and how to integrate multiple mobile robots into system to achieve redundancy and robustness. This will the way for other applications such as tele-training, tele-service, and tele-manufacturing.

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