Design and Test of a programmable Multi-standard Connector for Robot Communication

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Abstract- This research work provides a flexible communication medium for robot information propagation. This connector has the capability to make full duplex robot to robot communication or robot to central controller via wires (USB, Wire Internet) or wireless (Wireless Internet – Bluetooth-zigbee). This programmable multi-standard connector designed and tested using arduino with communication shields and C programming language editor. Special software developed and uploaded to the microcontroller memory to read/write the data Through this bidirectional connector and other sub software " or website for the IP communications" designed to run on the other terminal to obtain the share environmental values and generate the control signals required for robots control .

Index Terms-Robotic, , arduino, Bluetooth, USB , Internet communication, wire/wireless , programmable.

1 INTRODUCTION

IN short, a robot is a reprogrammable general purpose manipulator with external sensors that can perform assembly tasks. With this definition, a robot must possess intelligence, which is normally due to computer algorithms associated with its control and sensing systems. With refer to the sensing and control functions, if the management is centralized or multi robots, the obtained data and the control signals should be shared among the system components when communication technique is required. Previous work in the area of multi-robot communication has focused primarily on the 802.11x wireless standard. [1]

With a pressing need for increased productivity and the delivery of end products of uniform quality, industry is turning more and more towards computer-based automation. Most automated manufacturing tasks, at the present time, are carried out by special purpose machines designed to perform a predetermined function in a manufacturing process. The inflexibility and generally high cost of these machines, often called hard automation systems, have led to a broad-based interest in the use of robots capable of performing a variety of manufacturing functions in a more flexible working environment.

This also results in lower production costs to move materials, parts, tools or specialized devices, through variable programmed motions for the performance of a variety of tasks.

An industrial robot is a general-purpose, computer-controlled manipulator consisting of several rigid links connected in series by revolute or prismatic joints. One end of the chain is attached to a supporting base, while the other end is free and equipped with a tool to manipulate objects or perform assembly tasks. The motion of the joints results in relative motion of the links. Mechanically, a robot is composed of an arm, wrist and tool. The work volume is the sphere of

influence of a robot whose arm can deliver the wrist subassembly unit to any point within the sphere. The arm subassembly generally can move within 3 degrees of freedom [1][2].

Providing of multi-standards connector with the capability to communicate with either USB ,IP, zigbee or Bluetooth network increases the communication choices of the Robotic systems, supports the mobility from network coverage to other and introduces the multi standard networks hand shacking to create an Integrated monitoring and control coverage. A module with microcontroller can measure, process and display the environmental values in robotic environment via multiple sources. This system let the robot to monitor then decides what to do .according to what is suitable for the condition round.

2 BACKGROUND

The default solution for mobile robot communication is RF networking, typically based on one of the IEEE 802.11 standards also known as WLAN technology. Radio communication frees the robots from umbilical cords. But it suffers from several significant drawbacks, especially limited bandwidth and range. The limitations of both aspects are in addition hard to predict as they are strongly dependent on environment conditions. An outdoor RF-link may easily cover 100m over a line-of-sight with full bandwidth. In an indoor environment, the range often drops to a few rooms. Walls made of hardened concrete even completely block the communication. Driven by a concrete application scenario where communication is vital, namely robot rescue [3], Wireless Sensor and Actor Networks, ocean sensor network, ZigBee technologies for low power communication, memory management mechanisms in sensor devices, various routing technologies, and the solving the problem of the data distortion due to the Ad-Hoc networking.[5]

Running IP in robotic communications similar to the sensor network has the benefit of interoperability at the network layer required to integrate sensor networks with existing IT systems, the use of Web services has been proposed. Web services are a mechanism that is widely used in general purpose IT systems, such as business logic systems and data bases.

Bluetooth is an emerging communication standard that provides ad hoc configuration of master/slave piconets including eight active units at most. Its normal transmission range is 10 meters and optionally it can be extended up to 100 meters. A Bluetooth chip is designed to Replace the cables by transmitting information normally carried by the cable at a special frequency to a receiver Bluetooth chip, which will then give the information received to a computer, phone or any other device.[4]

Since the Wireless Sensor Network is still a relatively new field, many ideas and models are still being shared and debated. Since some of these models are more correct than others, many of the problems are still not well understood. This in turn leads to making it even more challenging in finding the proper solution for the problems ranging from the physical layer to the routing layer.

Many WSNs would be applied in environments difficult for wireless communications such tropical jungles, densely crowded offices, or disaster sites. One of the metrics for measuring the efficiency of a WSN is to determine the connectivity of the network by counting the ratio of sensor and relay nodes able to reach the base station to the number of nodes that are isolated. In most situations, an isolated node is considered wasted. [6]

Since some WSNs will use up to thousands of motes in environments that are difficult to reach, it would be expensive and labor-prohibitive to be constantly replacing the batteries on the motes.

This can severely limit the capabilities of the sensor motes on several different levels. For example, certain types of coding processes are energy-prohibitive due to the amount of computational power that they demand. Also, the demand to lower transmission power only serves to exacerbate the low SNR issue between two sensor motes. However, it has been surmised that raising the transmission power may have a lower effect on power drainage when compared to the added benefits of a higher SNR. For these reasons we want to use reliability, fast and low cost system.

3 METHOD AND TOOLS

This connector has to provide a Robot to Robot or Robot to center interconnection either via the USB standard, Internet protocol IP, zigbee or the Bluetooth which selected “available” as shown in the block diagram in figure 1.

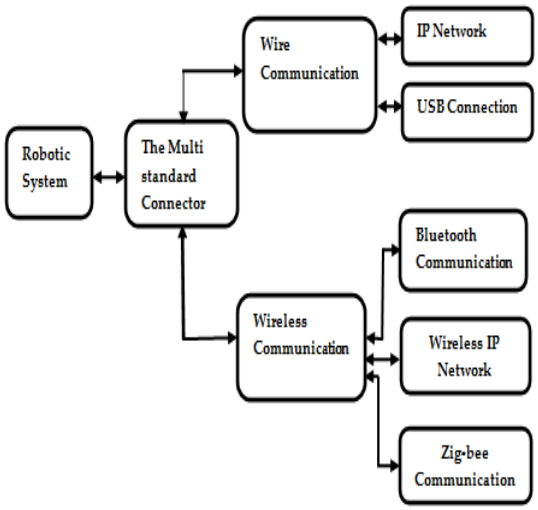


Fig1 Connector positioning

A module for each technology used beside the microcontroller unit to establish the communication via one of them. According to the situation selected for the application environment or available, one of these communication technology should be used at a time as mentioned in figure2.

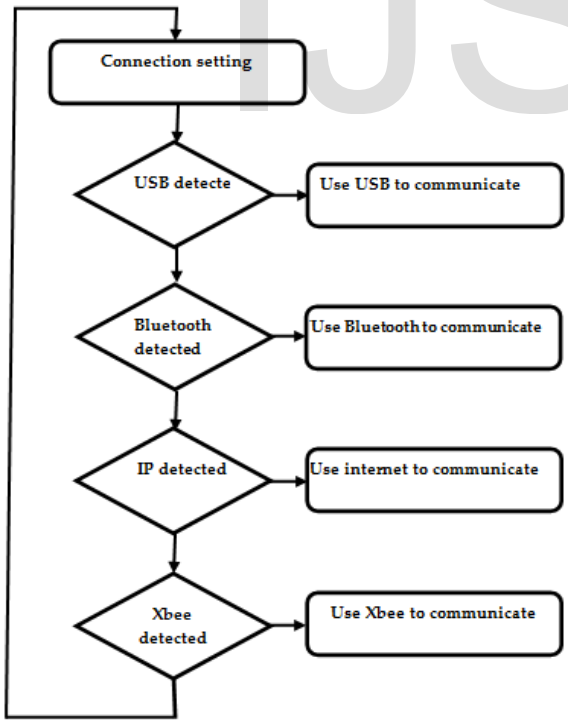
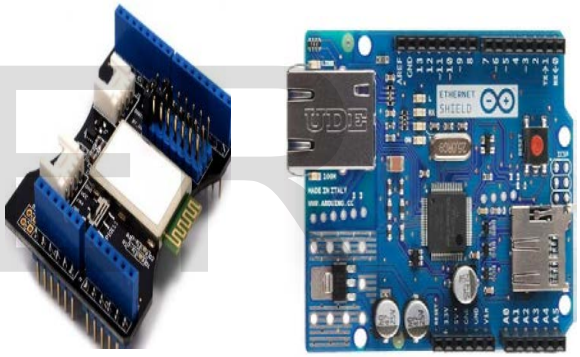


Fig 2 Operation flowchart

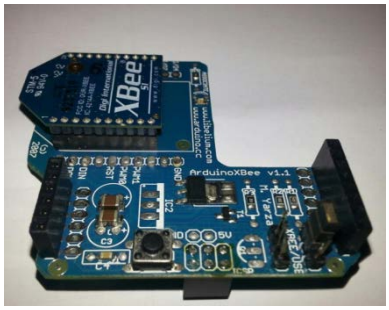
The Atmega2560 available on the arduino in figure 3 Supported with USB module, Internet module and Bluetooth module used for system design

Fig3 The Arduino microcontroller chip

The Ethernet and Bluetooth module In figure 4 are used for design and test .



a b



c

Fig a,b,c Bluetooth ,Ethernet and Zigbee modules

The microcontroller has to run a software to detect the available communication medium and establish the data this software developed in C programming language using the arduino editor in figure 5.

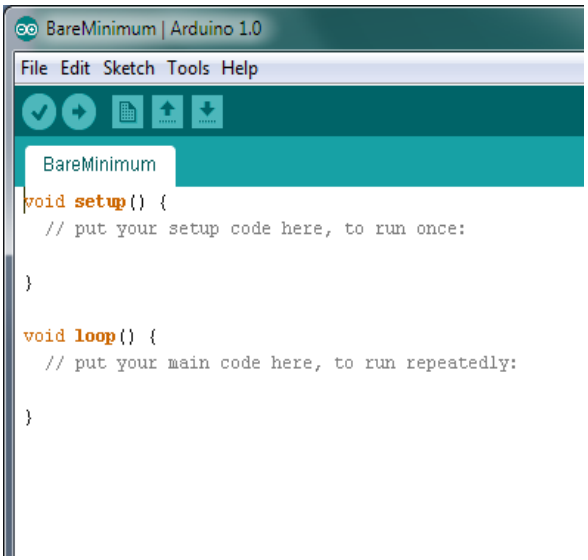


Fig. 5 the Arduino editor main page

4 DESIGN, TEST AND RESULTS

The programmed microcontroller on the arduino supported with USB module Bluetooth, zigbee and

internet modules for system test as in figure 6.

Fig 6 Connecting via interfacing shield

Personal computer is used as controller for test then, the software upload into the internal memory of the microcontroller , power source setted and so the related serial communication port is shown in figure7.

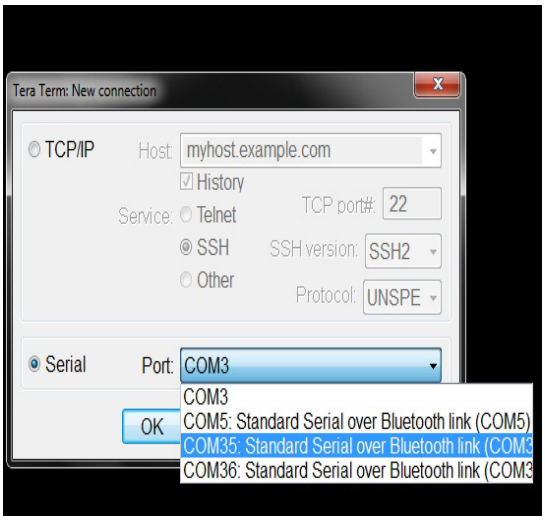


Fig 7 serial port setting window

Wireless connection established via Bluetooth or wires via USB the data obtained from the sensor is shown in figure 8.

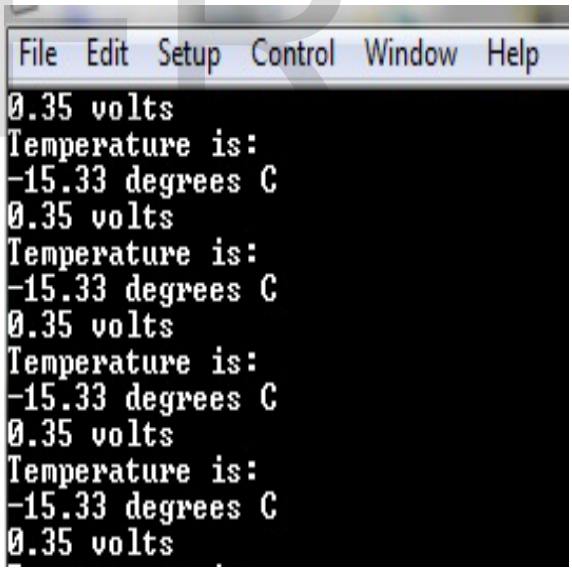


Fig. 8 The USB and Bluetooth test screen

On the other hand, control signals transmitted via Bluetooth or USB to turn on/off light emitting diodes as in figure 9

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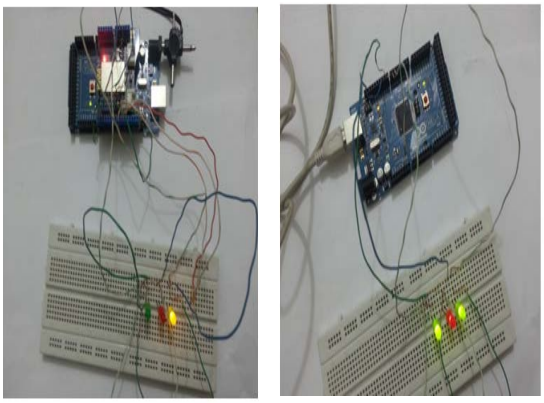
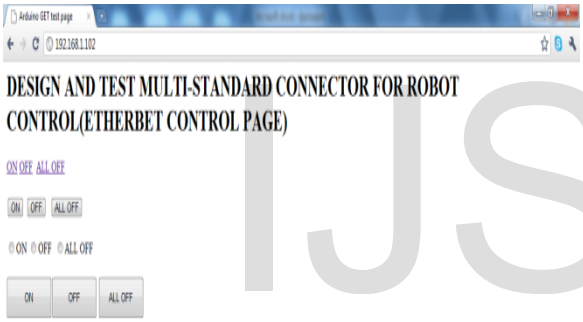
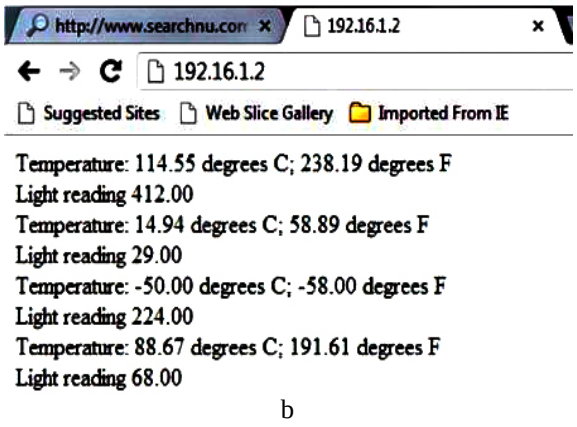


Fig 9 Turn on/off LED via Bluetooth, USB or IP

For the wire/ wireless IP communcation, the connector assigned to a specific IP address "192.16.1.2" as an example then the internet explorer to control/ monitor the environmental values is shown in figure10.



a



b

Fig 10 a ,b IP communication test

5 CONCLUSION

The system is successfully established with the capability to send/ receive data provided/required by the central monitoring/control unit , PC or robots. The system can obtain and transmit the environmental values for monitoring and receive the control data for robot activates. Temperature sensor and light emitting diodes used here for test as mentioned.

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