Remote Operation of Bioloid Using Apple iPhone and Google Android (March 2010)

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Abstract— **This study implemented remote operation and automation through the use of existing technologies today like the Internet, Wi-Fi, and smart phones. With remote operation and automation, data can be gathered and collected with a click of a button even if the user is not in the immediate vicinity where the robot resides, and it is also possible to send the robot to places deemed dangerous for human beings. Through existing technologies, it is possible to implement an inexpensive method for automation since the technologies used are already readily available in the market.**

The study used two of the most popular smart phone platforms of 2009, the Apple iPhone OS and the Google Android, and the system used for automation is the Robotis Bioloid. While the module used for interfacing is the Lantronix WiPort G which bridges the gap between Wi-Fi and serial port.

The group implemented software, which would not only be able to give the user control over the robot, but also be able to provide a simple and intuitive means with which to control the robot. To implement the software, the group used various features of the smart phones such as the multi-touch, accelerometer, geomagnetic sensor, and Wi-Fi.

***Index Terms*—Robots, Smart phones, Wi-Fi**

INTRODUCTION

THIS paper implements an alternative way of controlling a robot, for currently, the two most popular ways of controlling a robot is through a control pad or through interfacing it with a computer.

Using a control pad has the advantage of being extremely portable and light weight as opposed to a laptop, but is limited by the simple fact that it can only send a set number of data which are a combination of the 10 buttons found in the control pad. Furthermore, the use of a control pad is not novice friendly nor intuitive since it does not represent in any way natural human motion. Proof of this is how Wii dominated the console market by introducing a controller (Wiimote) which mimics natural human motion as controls for its games like Wii Sports.

The next alternative is to use a personal computer, but its disadvantage is that it is not portable enough and is limited by the number of sensors present in the computer. Although one can use USB devices to increase the sensors of a laptop, one has to find a way to implement the device in one's program.

Given the reasons above, the group chose a smart phone since it has the sensors, the portability, and an ample amount of computing power to control the robot. Add to that, the recent rise in popularity of smart phones, it really does bridge the gap between control pads and laptops. Furthermore, this study can become a ground work to further expand the study by adding features like a camera, implementation of the GPS and improving on the implementation of the remote control by the group. This study allows the researchers to think creatively and critically as how to control all aspects of the robot using all the features of the smart phone. By implementing a creative way to interact with robots, this can spark a child's interest to pursue further studies in robotics.

The paper will next talk about the methodology on how the group implemented the study followed by the Results and Discussion.

METHODOLOGY

The technologies used were a robot, a Wi-Fi module, and smart phones. Figure 1 shows the Wi-Fi module used, the Lantronix WiPort G. It allows users to interface any electronic

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device with serial or Ethernet connectivity with Wi-Fi through 802.11 b/g.

Fig. 1. The Lantronix WiPort

The robot constructed was the Robotis Bioloid which has the CM-5 module powered by an Atmega128 microcontroller. It can accept up to 28 servo motors and 10 sensors, and also has a wireless link interface that can be connected through serial. The robots configured were a walking droid and a humanoid. Figure 2 shows the constructed humanoid.

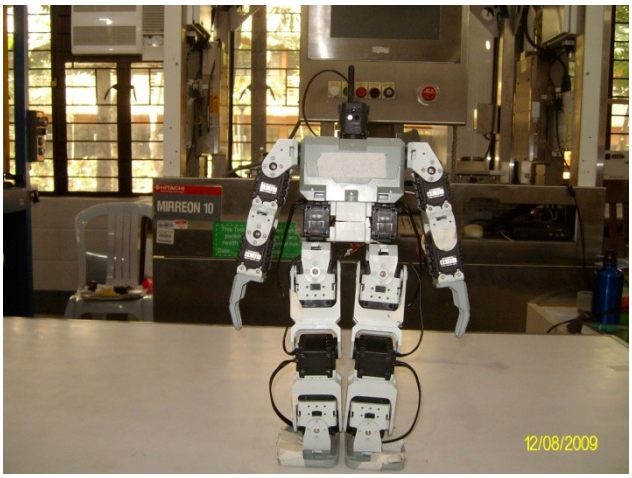

Fig. 2. The Robotis Bioloid

Lastly, the smart phones used were the Apple iPhone and the HTC Magic. The two smart phones used the Apple iPhone OS 3.0 and Google Android respectively. The programs were written using Objective-C and Java, for the iPhone and the Magic respectively. Figure 3 and Figure 4 shows the smart phones used for development, the HTC Magic and the Apple iPhone

Fig. 3. The HTC Magic

Fig. 4. Apple iPhone

The first part of the study is to make the robot Wi-Fi capable, and this is achieved by interfacing the Wi-Fi module with the robot. The advantage of using the module is that it can make anything that implements a serial port or Ethernet become Wi-Fi capable and as a result, the system can now be controlled with the smart phone, or any Wi-Fi enabled device. The system architecture for the study is shown below.

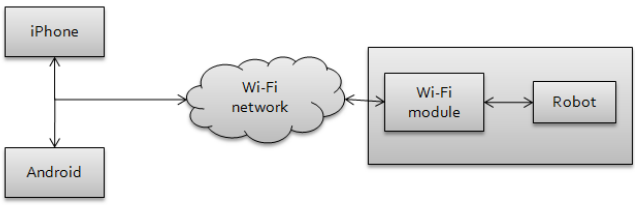

Fig. 4. System architecture for the study.

To guarantee a reliable remote operation, the robot replies with an acknowledgement to the smart phone once it has received and started to do the received action. This ensures that all packets sent by the smart phone are received by the robot, and furthermore, the smart phone only sends data if the acknowledgement was received. A flow chart of the sending and receiving is shown below.

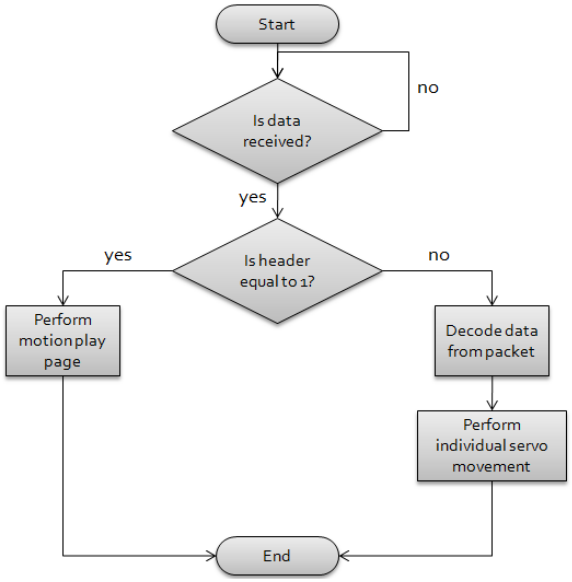

Fig. 5. Flow chart for the implementation of sending and receiving for the system

The implementation of sending data only when the smart phone has received a reply guarantees that the phone does not waste valuable resources trying to send the data. Not wasting resources guarantees that the CPU is used for computing and obtaining data needed by the user while maintain maximum throughput and reliability.

Results

The group was successful in creating a program that was able to control a Bioloid robot for both the Apple iPhone and HTC Magic. The data were sent through Wi-Fi from the smart phones to the robot with the WiPort that was attached to the wireless link interface of the robot. The following images shown below are screen captures from the video showing the study in action.

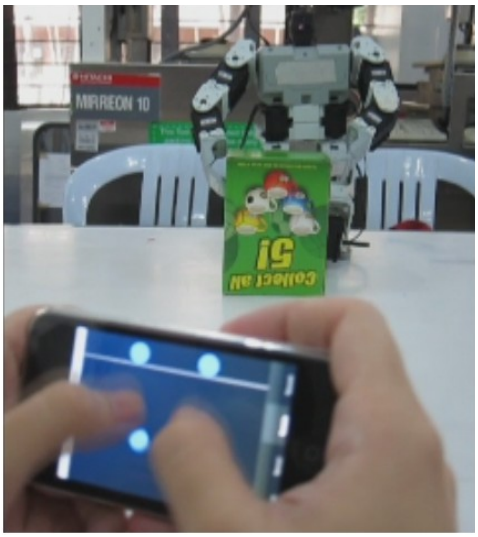

Fig. 6. The Apple iPhone manipulating the robot using the multi-touch screen.

The image above shows how the multi-touch screen of the Apple iPhone can enable a user to interact with objects as if he was the robot himself. But the interaction does not end there; the user can use the accelerometer of the iPhone to make the robot walk in whatever direction the user wishes.

Fig. 7. The Google Android powered HTC Magic manipulating the robot using the accelerometer and geomagnetic sensor.

The image shown above shows the HTC Magic manipulating the robot using not only the accelerometer but also the compass which enables the user to manipulate the smart phone as if it was the robot. The trackball can also be used to remote control the robot.

The system is able to send seventy distinct commands per second for the HTC Magic and thirty distinct commands per second for the Apple iPhone 3G. Even though the theoretical range of the Wi-Fi module is only 100 meters, the system was able to achieve 100% throughput at twice the claimed theoretical maximum distance as shown by the graphs below.

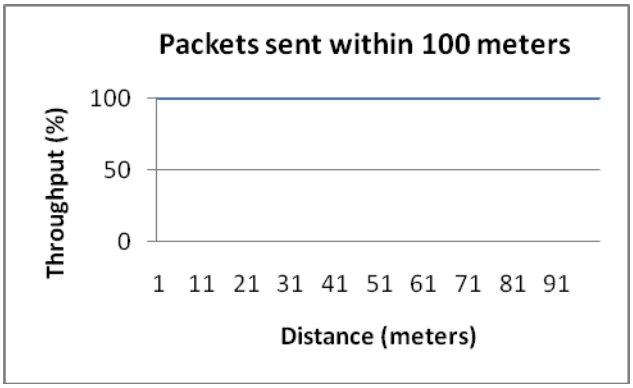

Fig. 8. The graph of the throughput with respect to data of the system.

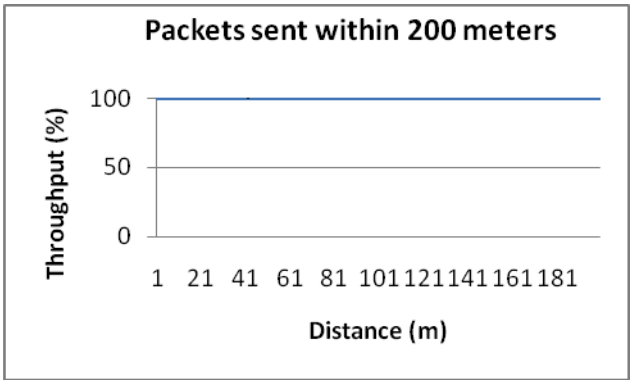

Fig. 9. The graph of the throughput with respect to data of the system.

Discussion

The group was able to construct a robot in a walking droid and humanoid configuration. Next, the group was able to attach the WiPort to the wireless link interface of the robot. Most importantly, the group was able to create a program that controls the movements of the robots using the various features of the smart phones. The succeeding part lists the features of the program that was created:

- A feature to control the arms of the humanoid using the touch screen by dragging circles to different location
- A feature to make the robot walk using the smart phones' accelerometer depending on whether it is inclined forward, backward, left, or right.
- A feature to move the legs of the walking droid by moving the smart phone, depending on the changes on the x-y-z axis of the accelerometer, and where the digital compass points for the Android.
- A feature to move the legs of the walking droid by using the track ball of HTC Magic. The movement is dependent on the rotation of the track ball.
- A feature that allows users to record the movements currently being performed by the robot. These recorded movements are saved to a database which can be played anytime in the future.
- A feature that allows users to record movements even if not connected to the robot. These movements can be saved into the database, which can be performed later on when the smart phone is connected to the robot.
- A feature to play the buzzer feature of the robot by playing a piano interface on the smart phone. This is up to one octave of notes.
- A feature to send any value to the robot that may correspond to other pre-defined actions like dancing.

Conclusion and Recommendations

The group was able to fulfill its objective to interface a robot with a smart phone and create software that will provide a means of controlling the robot through the smart phone's numerous features. Using the smart phone's features like the touch screen, accelerometer, compass, and database, the group was able to remotely control the Bioloid. The group was able to write a program for the iPhone using Objective-C, and write a program for the Android phone using Java.

A lot of features can still be added to the system like implementing more the sensors or using the sensors in conjunction with the user inputs and a lot of room has been left to future researchers like a TCP Server existing in the android or the second serial port available in the WiPort or also the Ethernet port. The cellular phone features can also be added to the implementation of the code, making it possible to control the robot even when the user is not using the smart phone. This study can be seen as a ground work for not only providing an alternative means of remote controlling but also a groundwork for automation where the robot will be put into a specific field of studies.

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