



## Remote sensing using Android Mobile to control Robotics

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**Abstract-**This era is the era of modern technology we have with us around all our parts of day today life and thus everything get modernized due to the influenced of the technology .and no doubt computer and Information technology played a vital part to modernized our life. In 2001 around there was a dot(.) technology was closely associated with the computer technology either in software or in the web or in the data base system, later on E technology overcome to (.) technology and now a day's E technology also getting overlapped with Smart technology ,we see every where term Smart is modernizing the technology so now we have modern but Smart technology we have with us Our phone became Smart, our computer became Smart, our education became Smart, Our City also getting Smart by means of everything getting ideal in terms of Smart. And we design technology to utilize it in our day today life accordingly. Smart phones technology and assistant robotics can be utilized to help us and improve our life efficiency Remote Control system and Remote sensing on of the application of Smart computer system and that is very useful to control and monitor devices smoothly and easily This paper articulates a new architecture for remote control using Android mobile devices it may provide important advantages for testing software and hardware developments in several real devices. The main object of the proposed architecture was the design of a system to be used as a mediator which should provides the services needed to perform remote control of mobile devices. This result into a research, a proof of concept was implemented. An Android application running a group of server programs on the machine, connected to the network or interface, depending on availability. These servers can be controlled through a small client written in Java programmed. In a survey it is found that over a billion people live with some form of disability and million people have very significantly difficulties in their functioning. So it is one of the attempt to utilized the technology of robots to help and assist them, let them feel that they can live in a normal way and feel comfortable in their life ,So it has been decided to help disabled people with movement difficulties by joining the Technology of smart phones and mobile robots to provide them with a system that can control an assistant Robot supported by arm using an Android mobile phone

**Keywords-** Lego MINDSTORMS; Robots; Mobile;

**Controlling, Robot; Android; Remote Control, VN.**

### I. INTRODUCTION

Robots are smart machines that can be programmed and used in many areas such as industry, Manufacturing, production lines, or health, etc [1][2]. These robots perform hard, dangerous, and ,Accurate work to facilitate our life and to increase the production because they can work 24 hours without Rest, and can do works like human but more precisely and with less time. Assistive mobile robots that Perform different kinds of work over everyday activities in many areas such as industry, manufacturing, Production lines, or health, etc. are very commonly used to improve our life. The idea of this research is to explore robotics utilization on healthcare field to help mobility disabled people.The growing popularity and spread of smartphones has changed the design of computer systems as they were known in recent years. Technological developments have enabled the creation of mobile devices with technical features previously only conceived in PC architectures or similar devices. With this evolution comes the need to integrate these devices with others so they can take actions and monitor interaction on mobile devices. To this end, this paper proposes and analyzes different architectural approaches for the implementation of remote control systems of mobile devices using the Android software stack [3], [4].A smartphone is a mobile phone built on a mobile Computing platform, with more advanced computing Ability and connectivity than a feature phone. Smartphones are a more affordable and efficient hand held devices which can be used to support collaborative activities in a community. It is a result of a huge advancement in mobile phones technology [5]. This research combines the capabilities of robots (using 3 Lego MINDSTORMS kits to construct a Prototype) with the Android mobile phone platform via Bluetooth connection offered by Android mobile Phones and Lego NXT 'Brick'. This provides an interactive system by which disabled people can control an assistant robot with simple touches on user friendly

interface, within the range of Bluetooth signals (10 meters) to get objects from the surrounding area. The user will be able to control the movement of the robot and perform actions of catching different kinds of objects. We aim to develop a mobile phone application to control a robot regardless of its capabilities (e.g. robot with wheels and arm). As a proof of concept we built a robot model using Lego MINDSTORMS in order to test our proposed robot controller. The developed Android mobile application can run on any Bluetooth enabled android device which operates on API level 10 and more. Due to the spread of new 3G networks and the convergence between wireless network and wired network, performing tasks on mobile devices is easier and faster. Because of the easy to access of a network, previous protocols such as WAP have been replaced by the direct connection to the network. This change involves those remote systems are not limited by network protocols with limited features [6]. In addition to enable the execution of tasks remotely, it is intended that the architecture allows performing software management tasks on the device and forensics tasks [7,8] in order to analyze the current state of the system and analyze the traces of previous executions to analyze the state of the device. To perform communication between mobile devices and control equipment wired connections (using USB communication) and wireless connections are utilized. Communication standards will be analyzed with the aim of establishing a stable, optimal and safe communication. An important consideration in designing the architecture of remote control of devices is the security within the system [9]. Personal information of the user will be exchanged by the device and operations on the mobile device will be carried out remotely, and it therefore must be ensured that no external element is able to both access the data exchanged, and to take control of external access. This research combines the capabilities of robots (using 3 Lego MINDSTORMS kits to construct a prototype) with the Android mobile phone platform via Bluetooth connection offered by Android mobile phones and Lego NXT 'Brick'. This provides an interactive system by which disabled people can control an assistant robot with simple touches on user friendly interface, within the range of Bluetooth signals (10 meters) to get objects from the surrounding area. The user will be able to control the movement of the Robot and perform actions of catching different kinds of objects. We aim to develop a mobile phone application to control a robot regardless of its capabilities (e.g. robot with wheels and arm). As a proof of concept we built a robot model using Lego MINDSTORMS in order to test our proposed robot controller. The developed Android mobile application can run on any Bluetooth enabled android device which operates on API level 10 and more.

## II. LITERATURE REVIEW

### 2.1 Android Platform

Android devices are powerful mobile computers and they become more and more popular smart phones used worldwide. They become more and more popular for software developers because of its powerful Capabilities and open architecture, also it's based on the java programming language. Because Android uses the Java programming language getting started with the Android API is easy; the API is open and allows easy access to the hardware components. Android devices provide numerous communications interfaces like USB, Wi-Fi and Bluetooth, that can be used to connect to the robot. We think it is a great platform for a robotic system control, because it's much cheaper than any other ARM-based processing unit. We use android platform because it is the widest used in the world and runs the largest number of smartphones worldwide [10],[11].

### 2.1 Lego MINDSTORMS

The Lego MINDSTORMS NXT series of kits contain software and hardware to create small, customizable and programmable robots. The Lego MINDSTORMS NXT system becomes very popular in universities [12],[13] because is cheap compared to other advanced robots platforms, the NXT kit is very flexible to construct because it consists of hundreds of mechanical building units, gears. Also, it contains motors and sensors that can be used to build many models of robots, the main kit component is the CPU NXT 'Brick' computer that acts as the heart of the robot. This 'Brick' can be connected to 3 servo motors and four sensors (ultrasonic range sensor, light sensor and two touch sensors) via RJ11 wires and will take care of the processing, USB or Bluetooth communications to make control over robot actions. The robot motors are flexible and powerful enough to move the robot, and can move a robotic arm within the accuracy of one degree [14],[15],[16].

### 2.2 Connectivity and Communication

This section discusses the communication protocols available and how they are used by the system.

### 2.3 Lego MINDSTORMS NXT Communication Protocol

The Lego MINDSTORMS NXT product includes the communication possibilities that will enable higher communication speed and wireless communication. The Lego MINDSTORMS NXT includes the following communication possibilities: □ Bluetooth Communication, V2.0 with EDR. USB Communication V2 [17]. The main Lego MINDSTORMS NXT Communication Protocol contains a sub-protocol specifically designed for direct commands which make it possible to control the NXT brick from outside devices. These outside devices may be other NXT bricks, a PC, or any other Bluetooth capable device. the main intent behind including this sub-protocol is to provide simple interface for this outside devices to utilize basic brick functionality (i.e. Mo-

tor control, sensor reading, and power management), without the need to write or run specialized remote control programs on the brick. All the communication that occurs between the robot and the mobile application are subject to the Lego MINDSTORMS NXT Direct Commands Communication Protocol. Remote control architectures offered by manufacturers cover only a part of the features required for an effective use, and usually are designed as internal solutions. For instance, one manufacturer of Android devices, as Samsung, has a tool called Kies [18] (a commercial software), that allows the user to upgrade the firmware, control the contacts, music, photos and videos and control the whole system. But it does not allow controlling applications, processes, services, etc. Other aspect to be considered is the remote visualization mechanisms that are useful for achieve a remote display of the devices. The most popular system designed to perform remote control of devices is Virtual Networking Computing [19]. There are a large number of implementations to this solution including applied to Android software stack. It has an open protocol and it is widely deployed in the open source community. This solution adapts very well to provide part of the functionality of the architecture, and it will be studied further. Skurski and Swiercz [20] propose a control system based on VNC for Symbian OS smartphones. This system was designed to improve application testing systems in mobile devices due to the lack of resources in mobile devices and the high cost of test environments. Also the solution proposed could be used to perform remote configuration. As part of the Android platform exists the Android Debug Bridge (ADB) protocol [21] to provide debug functionality on device.

#### 2.4 Bluetooth

Bluetooth is a wireless communications protocol running at 2.4 GHz, with client-server architecture, suitable for forming personal area networks. It is designed for low power devices such as mobile phones [22].

#### 2.5 Software

This section discusses programming languages and software that used for the development of the NXT mobile controller application.

#### 2.6 NXT Firmware

The Lego MINDSTORMS provides a programming environment called NXT-G. It is a graphical programming language which is suitable for simple robotic programs the NXT Brick operates on this firmware by default. The NXT-G support simple functionality such as accepting Bluetooth connections, receiving LCP messages, process and execute LCP Direct commands, and move motors or read input from sensors. There's a wide range of alternative firmwares, development environments and libraries for various languages (C, Assembler, Java, Matlab...). We use NXT-G firmware because we

used LCP Direct commands to control the robot actions [23],[24],[25].

#### 2.7 Android SDK

Android is a software stack for mobile devices that includes an operating system, middleware, and key applications. The Android SDK provides the tools and libraries necessary to begin developing applications that run on Android-powered devices [26],[27].

#### 2.8 DESIGN

This section introduces the system requirement, system architecture, the design of the front end interfaces, and the robot model that is constructed [28].

#### 2.9 Requirements

Table 1. System Requirements

ID	DESCRIPTION
R1	The System shall run on any Bluetooth enabled android device that operates on API level 10 or more.
R2	The System shall store the MAC address and robot configuration for the current connected robot.
R3	The System shall allow the user to connect and control a pre connected robot directly.
R4	The System shall allow the user to start scanning for new robots and make a new connection to any found robot.
R5	The System shall prevent the user to navigate from the main interface to the robot controlling interfaces if the Bluetooth is not enabled.
R6	The System shall allow the user to control the power of the robot motors.
R7	The System shall provide a list of common objects that the user may frequently need that will set the catching speed to the appropriate value for the selected object.

This protocol is integrated in the platform and others a service of server when is configured on the device. To manage the communication with this protocol, the Android Development Kit [29] others the ADB Client tool [30]. Some of the features of this tool are the installation and deinstallation of applications, downloading and uploading files, opening a shell console, starting applications, etc. The development of the Android platform is constantly evolving and therefore the features it offers are continuously expanding. For example, in current versions of the platform (Android 2.3.3) the USB Host Support [31] feature is not available, but it has been announced that this will be included in the next versions. The USB Host Support will allow attaching different devices such as key-boards, mice, etc. Also it is supposed that it will allow native control of the USB interface, avoiding the mandatory control of the Virtual Ma-

chine over the interface. This improvement will significantly increase the communication performance and other a broader range of features. This paper focuses on the control of Android platforms. This is an open platform that allows to use other technologies (also open). In addition, Android platform allow the development of new ideas easily and test them with a set of open standards [32]. The prototype generated as implementation of the proposed architecture will be provided also as free software. According to data released by Nielsen [33], half of the consumers who recently purchased a smartphone chose an Android smartphone.

## 2.10 Remote Visualization

the graphical visualization subject represents the most important aspect in a remote control system when a human supervisor is controlling the system. To achieve proper control of a mobile device supervisor need to watch the results of his actions and the best way is the graphical visualization. The display should be smooth and have a good quality to provide the best benefits to the user. This requirement is conditioned by the problems in the transfer of information, and therefore requires manage resources efficiently.

## 2.11 VNC System

An alternative for displaying graphics and having graphic control of the device is the graphical desktop sharing system VNC (Virtual Network Computing). It offers a controlling functionality by using a graphical screen update from the remote device and capturing events like mouse or keystrokes [33]. VNC system is based on RFB (Remote Frame Buffer) [34] protocol to transmit all information between connected devices. There are VNC clients available for all of the most common systems, and it therefore can be considered a multiplatform system. This feature, along with the power of the protocol used by VNC, establishes it as a great choice for incorporation in the proposed architecture. Encodings Study The way of working of the RFB protocol consists of responding to a request from the client about a specific on-screen rectangle and the server sends an update consisting of an encoding of the variation between the moment of the request and the last time the client requested data about this rectangle [35]. This action implies a high consumption of bandwidth in sending information, with the consequent delay in the process. In order to solve this problem different encodings have been developed. Encoding refers to how a rectangle of pixel data will be sent. Every rectangle of pixel data is preceded by a header giving the position of the rectangle on the screen, the width and height of the rectangle, and an encoding type. This encoding type specifies the encoding of the pixel data. The data itself then follows using the specified encoding [35]. These encodings are methods to determine the most efficient way to transfer graphical information. Adding new encodings developed by third parties does not affect compatibility with VNC applications that do

not contain that new encoding. When the client establishes communication with the server, both parts negotiate the encoding to use. If the client requires a non-existent encoding, the server will appropriate the next encoding available. Below, the following VNC encoding will be studied, Raw, RRE, Hexile, Zlib and Tight. RAW is the simplest encoding. It sends all graphical pixels to the client. This method must be supported by all clients. The process time used is minimal and the performance is very high when the server and the client are on the same machine. If the client is hosted in a remote device the performance is reduced due to the transfer of large amounts of data. RRE (Rise-and-Run-length-Encoding) consists of grouping consecutive identical pixels in order to send only the information of one pixel and the number of replications. It is an effective method when large blocks of the same color exist, like in patterns. There is a variant of the protocol, called CORRE, which uses a maximum of 255x255 pixels to reduce the size of the packages. Hexile divides the information into 16x16 items.

## 2.12 Native capture

The VNC system is known for its high performance due to the power of its protocol, as was previously mentioned, and for being compatible with almost all systems. But its use requires including a VNC server inside the device and also providing "superadmin" permissions to the Android application to use all the features. There is an alternative that allows the architecture to provide a remote visualization without including a VNC system, the native capture. This system consists of access to the framebuffer device of the mobile device to extract bitmap data representing

the screen surface image. Once the data has been extracted the system sends it to the clients that will display this data, showing the same information that visible to the mobile device user. Of course, this must implement different mechanisms to improve the performance, because when sending the raw information, the latency of the system will be high. However, it's clear that the remote visualization can be done implementing a native application and linking using JNI (Java Native Interface) with an Android application. As will be discussed later, the ADB Client implements a method of retrieving the remote visualization using this System.

## 2.13 Sensors

Another way of interacting with the new mobile phones is through the use of sensors (movement, geolocation, closeness . . .). These sensors allow the user to get data from device's environment or to modify the behavior of the device. Using the remote control the physical interaction with the device is not possible, making it impossible to use those sensors. Also, the sensors that provide data can be interesting for the purposes of remote control architecture. To integrate the use of these sensors

two systems need to be created. First, a mechanism to operate with the physi-

cal sensors should be created. This system could simulate, for example, the rotation of the device. Including this control, the dispatch of events will be completely covered. And second, the remote server must be able to send the information from the environmental sensors, allowing the client, for example, to request GPS data.

#### 2.14 Connectivity assessment

The different methods to perform the connection determine the scope that the architecture can reach. This chapter presents a review of different types of possibilities establishing connectivity between the clients and the mobile device. The performance and security are conditioned by the communication channel used and therefore should be reviewed each environment to implement the necessary mechanisms.

#### 2.15 Java sockets mechanisms

Java offers some features like networking support, multithreading, multiplatform and portability that converts it in a suitable platform to be implemented in a distributed system. However, it has a problem of performance due to lack of efficient communication middleware, thus penalizing sync speed. Sockets are a low-level programming interface to manage networked communications in most of the network protocols. The Java Sockets can be used in every system that has Java Virtual Machine, but they are limited to the TCP/IP protocol. In systems with high-speed networks this communication system is not appropriate because it does not make use of the benefits of the environment. To create this communication system, the Android application will have a Server Socket running and awaiting client requests. To manage clients in a parallel manner, it will implement a system of threads that will serve each client concurrently, making use of the shared resources. On the other hand, clients will have Java client sockets that will open communication with the server and will exchange messages with the server until the connection is closed [36]. Because the Java communication mechanism consists of the exchange of binary data; an interface of communication will be implemented. This mechanism consists of defining a set of objects that contains a subset of objects representing both requests and responses. Thus both, client and server can use the channel of communication and understand the data they receive. To send objects over a network the system force us to save and restore these objects on both ends of the channel. To solve this problem, the Serializable Java Interface will be used making the process easier.

#### 2.16 Android Debug Bridge Client

Android Debug Bridge Client is a tool existent in the Android SDK that allows to the developer to exchange

data and requests with an Android device. These features can be adapted to be used inside a remote client. Originally, the ADB client was only an application to be used by a developer controlling a device or an emulator, but now its features have been packaged into a library, allowing its use in a Java application. This library has been created and given the name of "ddmlib" by the Android SDK Team. It provides a great number of features for controlling a device with USB. Some of the features implemented in this library are:

- \_ Executing shell commands
- \_ Forwarding ports
- \_ Dumping device data
- \_ Managing the file system
- \_ Managing applications
- \_ Checking the state of the device

#### 2.17 System Architecture

Fig shows the overall architecture of the system, and with which components the different types of users will interact.



Fig:1 System Architecture

### III. METHODOLOGY

#### 3.1 Construction of real time robot model

It takes 3 Lego to construct the Robot machine MINDSTORMS Kits [37]; by using 3 kits such model can be built because each kit require only three servo motors and one brick and the proposed model . it also required seven servo motors that also need 3 bricks to handle them because each brick can control at least three



servo motors. Depending upon the functionalities that the system shall provide; and the robotic model must have three parts; 1)Wheels, 2)Arm, and 3)Hand, each one having motor(s) that is used to carried out a particular movements and each part contribute its contribution, also each part having an independent brick to control these motor(s).

### 3.2 Implementation

This phase carry the actual implementation of the model which is divided into several sections, one for each component of the system.

### 3.3 System's Sequence of Events

Fig. shows the typical sequence of events when a user runs the application. This sequence diagram assumes the user already has the software on his phone and the robot and it represents an abstract level of the interaction between the system components (mobile application and the robot).

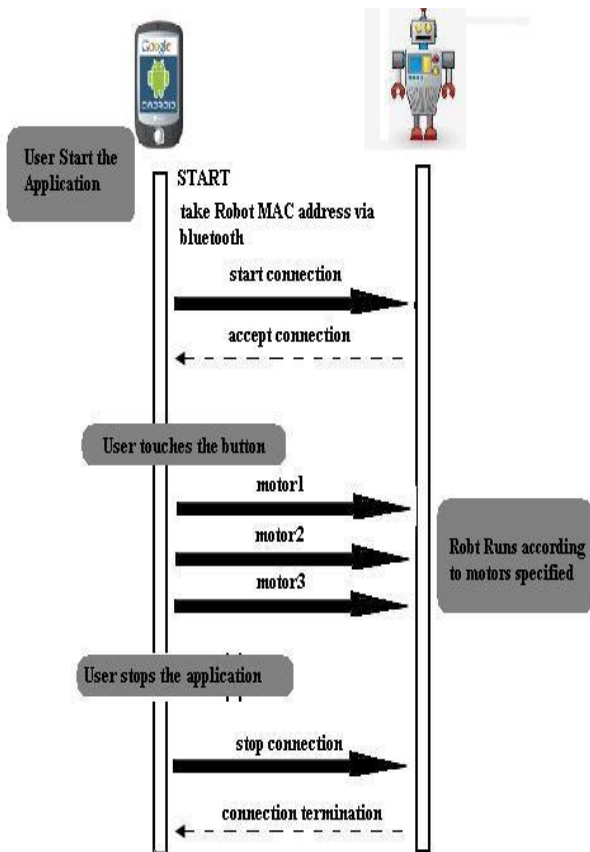


Fig:2 Working Flowof the system

### 3.4 Mobile Interfacing

The mobile application consists of many User Interfaces connected to each other, each interface Specialized to control a specific functionality on the robot side, each button will send different command to the NXT Brick that will process and execute the command. Fig shows

one of the interfacing of Application.



Fig:3 Interfacing of Application

### 3.5 Establish Connection

At first set up a connection between the two components, Fig. shows a sequential diagram that shows how to set up a connection.

### 3.6 Controlling the Robot

After setting up the connection the user will start controlling the robot using the direction buttons in the Application GUI when pressing a direction (controlling) button, an LCP Direct Command will be sent from the mobile to the robot. Fig.show the sequence of actions that occurs in the communication between the application and the NXT.

### 3.7 Testing & Evaluation

It intends to discuss the real-time testing for the model and gives an evaluation of the functionality and user interface of the system.

### 3.8 Procedure and Result

To test the model in real time system environment, we had gone through into a real time practical session carrying of some bottles, end-user, and some reviewers that monitor and observe the application work, robot response and construction, control the robot, after the testing finished. All participants were asked to record their questions and feedback and answering some ques questions about system usability and reliability. From the system evaluation we came a crossed in the mobile application and in the robot, where, end-user may need many steps to move arm, make (Catch, Drop) operations

and return to control arm, wheels of tions about system usability and reliability. From the system evaluation we came a crossed in the mobile application and in the robot, where, end-user may need many steps to move arm, make (Catch, Drop) operations and return to control arm, wheels of

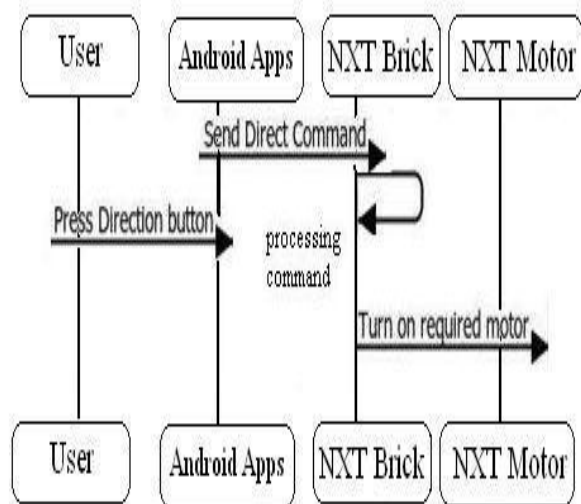


Fig:3 Interfacing and Communication between Application

robot. Another comments like user-interface need some alteration like remove some buttons, add some buttons that move user from hand controlling to wheels controlling without need to return in sequence way. Robot arm construction like add three motors to provide more power and ability to carry the object, made robot more fixed and balanced. Even it can handle the weight if we put some more motors to move.

#### IV. CONCLUSION

In this paper we have tried out to represent Robotic model with a particular Arm and that is controlled and handled by Android enabled application mobile using its Bluetooth signals. Due to the various versatilityes we used MINDSTORMS NXT to developed Robot model and thus we could reach nearer to our target.

The main object to develop such model to used technology beneficent for human being in this way we can help people with motor disabilities in controlling different widgets in daily day today life using mobile phone.

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