GUIDING ROBOTS USING MOBILE PHONE

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Abstract

Communication via mobile phones is becoming increasingly common among humans but next in the pipeline is communication between human and robots. This project promotes wireless connectivity which makes it hassle free affair. In this paper we propose the concept of controlling a robot by a mobile phone from a remote area. The robot supports two ways of communication as it can receive commands by a mobile phone and in other way round it can send data through cell phone to the user. This prompted us to use a PC and its serial port with RS232 protocol. The user sitting at a distant place can send sms's to control the robot placed far away from him (even in another continent). The sms is decoded in a PC by a program which then sends command to the robot via serial port. Similarly the robot can send information about the working environment condition received from its sensors. This data is converted to proper PDU or TEXT mode as needed by the mobile phone which is forwarded to the operator by a sms. This involves a NOKIA 6020 phone and an 8051 microcontroller (AT89C52). A RF module, connected to a computer's serial port, can operate at two frequencies, one for communicating with the robot and another for the mobile. The cell phone's TX and RX pins are connected to the serial port by the RF module and a MAX232 IC. The RS232 protocol does not support TTL logic so a line driver such as MAX232 has to be used to convert TTL logic levels to RS232 voltage level .The phone converses with the computer by AT commands sent through the serial port. A practical implementation of this project may witness applications such as home automation and security.

KEYWORDS

Mobile, AT Commands, Serial Port

1. INTRODUCTION

In this paper we present control of a robot by a cell phone via a computer. It suits many needs as it provides an implicit wireless communication between the user and the robot notwithstanding the distance between the robot and the user. It has certain advantages over other wireless modes as the user can control the robot and monitor applications like home automation and security without being physically present near the robot.

The user sends instructions from his mobile to another mobile connected to a PC.The memory of the latter is continuously scanned by a programme running in the PC .The instructions received in form of sms is compared with any predefined instructions in the programme.If a match occurs then computer sends appropriate commands to the robot via serial port. Simultaneously the user receives the desired information from the sensors.

2. COMPONENTS OF THE AUTOMATED SYSTEM

The entire automated system can be divided basically into two parts:

1. Hardware
2. Software

The hardware of this project is divided into two parts:

1. Cell phone interfacing with the PC: The cell phone is directly connected to the serial port of the PC via RF module. It can also be connected to the

usb of the PC as it facilitates faster data transmission and supports the connectivity of as many as 128 devices simultaneously.

2. Robot interfacing with the PC: The robot is interfaced with the PC's serial port via RF module. An 8051 microcontroller (MC) forms the heart of the robot controlling and servicing the various sensors of the robot. A MAX 232 chip is used to facilitate communication between the MC and the PC to commensurate TTL logic of the MC with the RS 232 standard of the PC's serial port. The sensors form a link between the MC and the surroundings whose input data is forwarded to the user.

The software demands of this project are:

1. A programme running on the PC to continuously scan the phone/SIM memory of the cell connected to the PC and to send (instructions) and receive data (sensors) from the robot.

2.A programme for the MC to control the robot, send instructions to the actuators, receive data from the sensors and send data to the PC that the user requests .
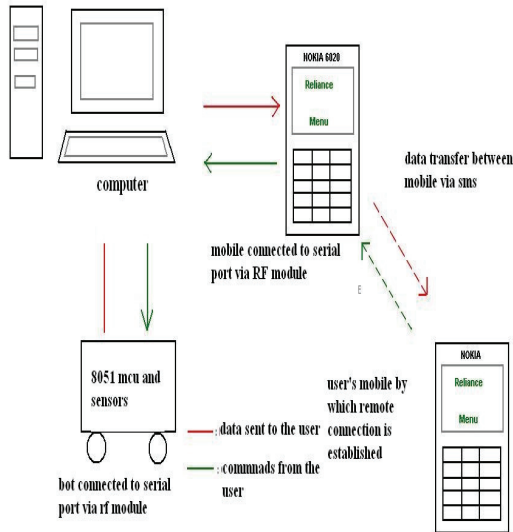

Figure 1

3. HARDWARE

The heart of the circuit is an 8051 MC (AT89C52) and a dc motor driver BA6209.The block diagram

is given below. Sensors like heat, obstacle sensors are connected to it which can send information about environment to the pc which is forwarded to the user via sms.But since hardware of robot is very common thing this paper concentrates on the controlling method of robot by mobile phone rather than the hardware of robot.
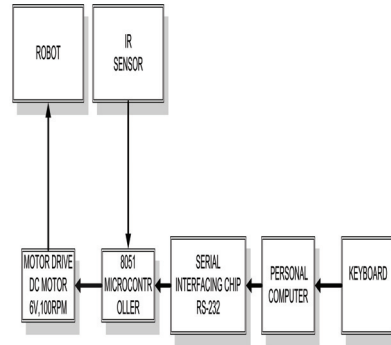

Figure 2

4. MOBILE COMMUNICATION

For communication of mobile to a PC one first needs to know the mobile's IO capabilities. If it has IrDA or Bluetooth then things are much easier because no cables are needed, but if the mobile (or the PC) has no such features then an appropriate data cable may be used provided the cell has port for USB data cable. However the most common IO capability is the serial line, though it is not in the form of the well known RS-232-C standard of PC's serial port but in the form of what is called as FBUS and MBUS.The MBUS is a half-duplex method used in older Nokia phones. With MBUS it is possible to interface with almost all Nokia mobile phones for service and adjustment purposes. The FBUS is a newer solution and offers high-speed full-duplex communication link between the phone and the computer. The service and adjustment operations which are traditionally made over MBUS are available in FBUS too, but usually much faster.

4.1 Mbus Method of Communication

The communication methods called FBUS and MBUS are used in Nokia mobile phones for data transmission, service, and adjustment. The MBUS method that uses only a single pin is a half-duplex method used in older Nokia phones. With MBUS

it is possible to interface with almost all Nokia mobile phones for service and adjustment purposes. The FBUS is a newer solution and offers high-speed full-duplex communication link between the phone and the computer. The service and adjustment operations which are traditionally made over MBUS are available also in FBUS, but usually much faster.

4.1.1 Details of Mobile Phone Hardware

The figure below describes the pin outs of data cables of NOKIA phones.

Figure 3

The 14 pin pop-port contains signals for hands free microphone, stereo speakers, FBus Rx/Tx or USB signals for the phones supporting them, power output for feeding the accessories that don't have their own batteries, and the Accessory Control Interface (ACI), a bidirectional serial control bus for connection of phone accessories, with a proprietary protocol.

Table 1

Pin Number	Pin Name
5	**USB Vbus**
6	**FBus Rx/USB D+**
7	**FBus Tx/USB D-**
8	**GND**

4.2 The Circuit Diagram

The whole project is implemented using NOKIA 6020 mobile so fig 4 shows the detailed circuit connection.

5. AT COMMANDS

After connecting a mobile phone to a computer, it can be controlled by sending instructions to it. The instructions used for controlling the mobile phone are called AT commands. Commands are to control the sending and receiving of SMS messages.

The following table lists the AT commands that are related to the writing and sending of SMS messages:

Table 2

AT command	Meaning
+CMGS	Send message
+CMSS	Send message from storage
+CMGW	Write message to memory
+CMGD	Delete message
+CNMI	SMS Alert
+CMMS	More messages to send

The AT commands are written in vb6.First any message received on the mobile is read. Then they it is decoded into a user friendly format. From that command is read and it is issued to the microcontroller through serial port for further action.
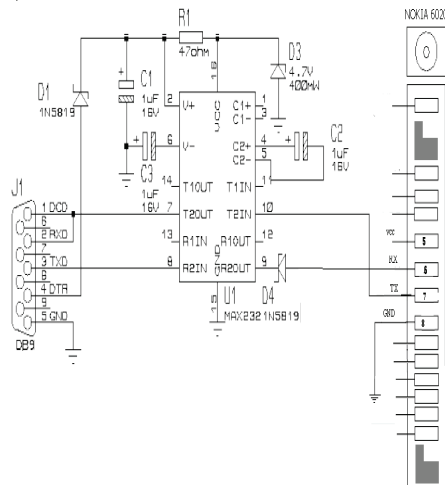
Figure 4 The Circuit Diagram

5.1 Use of SMS

Since short text messaging popularly known as sms is the most widely used and the cheapest service available in mobile service, it is used to control our robot. The SMS message, as specified by the Etsi organization can be up to 160 characters long, where each character is 7 bits according to the 7-bit default alphabet. Eight-bit messages (max 140 characters) are usually not

viewable by the phones as text messages; instead they are used for data. There are two ways of sending and receiving SMS messages: by text mode and by PDU (protocol description unit) mode.

5.2 The PDU Format

The text mode (unavailable on some phones) is just an encoding of the bit stream represented by the PDU mode. Alphabets may differ and there are several encoding alternatives when displaying an SMS message. The most common options are "PCCP437", "PCDN", "8859-1", "IRA" and "GSM". These are all set by the AT command AT+CSCS, when some one reads the message in a computer application. If you read the message on your phone, the phone will choose a proper encoding. An application capable of reading incoming SMS messages can thus use text mode or PDU mode. If text mode is used, the application is bound to (or limited by) the set of preset encoding options. In some cases, that's just not good enough. If PDU mode is used, any encoding can be implemented.

5.2.1 Message in the PDU mode

The PDU string contains not only the message, but also a lot of meta-information about the sender, his SMS service center, the time stamp etc. It is all in the form of hexa-decimal *octets* or decimal *semi-octets*. A PDU looks like a long hexadecimal string, representing the number of the network operator's SMS central (Service Centre Address, SCA) chained to the whole packet used in the SMS transport layer (often referred as Transport Protocol Data Unit, TPDU). The latter includes many sub-fields in addition to the message text itself. Most data is packed to save bits.

The first packet is the SMS-SUBMIT, used for sending a message; the second is the SMS-DELIVER packet, for receiving. The subfields are detailed in the following table:

5.2.2 Phone numbers packing

Phone numbers start with the number's length, intended as field length in *bytes* for the service centre (SCA), and *digits* for the remaining numbers (DA, OA). The second byte specifies the numbering plan: 80 = unknown, 81 = national number, 91 = international number.

Table 3

SCA	Service Centre Address	Network operator's Service Centre number. Not required by some mobiles. An hex value of 00 or 01-80 means "unknown": the mobile will use the default number stored in mobile's settings.	1 or 2 to 12 bytes
ID	TPDU type identifier	SMS-DELIVER or SMS-SUBMIT identifiers and flags (e.g. request of a status report or presence of VP field) .	1 byte
MR	Message Reference	Progressive number (0 to 255).	1 byte
OA or DA	Originating or Destination Address	Sender's or destination phone number. Note that a different number encoding from that of SCA is used.	2 to 12 bytes
PID	Protocol Identifier	Nature of data transported (FAX, voice, etc.), used by the Service Centre for a better routing.	1 byte
DCS	Data Coding Scheme	Format of the data transported (7 or 8 bits, alphabet, etc.) and where to store it (Mobile memory, SIM module, or for immediate display).	1 byte
SCTS	Service Centre Time Stamp	Year month, day, hour, minute, seconds and time difference with respect to GMT.	7 bytes
VP	Validity Period	How long the network operator service centre will hold the message, if undelivered (A7=24 hours).	0, 1, or 7 bytes
UDL	User Data Length	Length of data, prior to encoding (e.g. 11 7-bit characters fit into 10 bytes).	1 byte
UD	User Data	message data	0-140 bytes

Then follow the digits, swapped in pairs and each occupying a nibble. If the length is odd, the unused nibble (*semi-octet* in ETSI language) is padded with $F. Some mobiles don't require the SCA, or accept 00 or 01-80 as valid values for the service centre address: in that case the mobile will use the default service centre number.

5.2.3 Message packing

A SMS message, according to ETSI specification, can be up to 140 bytes long (*octets* in ETSI terminology). The usual GSM alphabet requires only 7 bits per character (a *septet*), allowing for the packing of up to 140 * 8 / 7 = 160 characters. So the received sms is packed as explained above. So the mains algorithm keeps scanning the whole PDU string containing hexadecimal numbers. Then it separates out the sender's no and then compares with previously stored values. If the sms is sent by authenticated person then it searches for the message part. After saving the message into a variable it compares with the previously stored message. If the received message is exactly what is stored then it issues commands accordingly to the robot through serial port.

6. RADIO FREQUENCY COMMUNICATION

Due to the need of controlling robots and cell phone simultaneously through one serial port RF communication is used. Details of RF communication are explained below.

6.1 RF Transmitter Interface

For communicating the robot with pc TX-4-PC is used. It connects the Holtek HT-12E remote control encoder IC, Ming TX-99 RF transmitters. It is connected directly to PC's serial port. The advantage of using these transmitter modules is the loop antenna designed into the RF module. The loop antenna allows operation between 30-50' [or more] without the addition of the external wire antenna. Now since it's connected to the PC's serial port it's fully controlled by the serial commands written in our program.

Serial Commands to Control the TX-4-PC:

The Transmitter waits for a serial command string consisting of three data bytes from the PC serial port as shown below.

• Byte #1 = Synchronization byte [170]

• Byte #2 = 8-bit address of receiver to control [0 to 255]

• Byte #3 = 4-bit data [0 to 15]

The synchronization byte 170 consists of an even number of 1s' & 0s', or 10101010 in binary, and is used to synchronize the transmitter with the PC serial port. The address byte selects the receiver at a specific "address" to control. Data packets not preceded by the synchronization byte of "170", will be ignored. This helps the TX-4-PC ignore any noise signal that may otherwise be interpreted as a beginning data packet. The 250mS pauses in the VB application software is given to take into account the 200mS time frame in which the transmission occurs. An additional time of 50mS per pause ensures the transmitter has returned to the data input routine, and is ready for the next inbound data/control packet. This causes four transmissions from the TX-4-PC to help ensure data packets reach the receiver in case of interference.

6.2 RF RECIEVER

For receiver purpose the RX-5 receiver board is designed for use with the TX-4-PC RF transmitter board. The RX-5 receiver board is used with RF receivers. Ming RE-99 RF transmitter module. The advantage is that for instant remote control we just need to plug-in the RF receiver modules .For decoder purpose HT-12D is connected.

Address Feature:

The RX-5 receiver has an 8-position DIP switch used for setting the receiver/decoder address. Addresses from 0 to 255 are possible, allowing control of up to 256 individually addressed receivers, or combinations with multiple receivers set to the same address.

A7 A6 A5 A4 A3 A2 A1 A0

All of the HT-12D decoder IC address pins are at ground with each DIP switch in the ON position for an address of "0". Switches in the down position represent logic "1". In the up or ON position at logic "0".So by the help of these switches the address of the particular receiver is set. Now if this receiver is connected to the robot required for the job then accordingly this address is sent through the transmitter by control software in vb6.

7. CONCLUSION AND FUTURE WORKS

In this paper control of a robot by a mobile phone kept at a remote distance is described. This eliminates the necessity of physical presence of a operator at the working area .With the help of this one can easily control robot or any automated device from anywhere in the world.

- The control software is written in vb6 so that it'll work as a standalone application.
- This algorithm is implemented with microcontroller with low computational power (e.g.8051/31) since they don't contain any tedious calculation.
- In order to get more information about working environment sensors are connected to the robot.

Future work:

- It can be also carried out for the home automation system as hardware requirement is same, the difference being some relays connected to the switches of home appliances.

- A cellular platform can be developed where user can himself set the commands to be sent through serial port.
- This technology can be empowered with computer vision where with the help of image processing pictures and videos of remote areas can be sent to the user via mms.

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