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PROTOTYPE OF SHORT RANGE WIRELESS COMMUNICATION FOR INDUSTRIAL PROCESS CONTROLLER

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ABSTRACT

Electrical equivalent of physical quantities like pressure, temperatures etc are need to transmit over the wired network or buses. These parameters are received by process controller that monitor the processes and send control signals to process again over the wired network or buses. This mechanism leads to a huge number of wires that ultimately increases the complexity of the system and reduce the reliability. Objective of our work to solve this issue using short range wireless technology. We have established communication between 8051 microcontroller and personal computer through Bluetooth module. This hardware-software co-design facilitates any industrial process controller with low cost, low power and reliable communication link.

KEYWORDS: Bluetooth Modem, HyperTerminal, Microcontroller

INTRODUCTION

Objective of our work is to design a prototype to demonstrate the utility of latest wireless technology for industrial automation. This work divided into two phases software development and hardware development. Software is responsible for data interpretation, communication and processing at controller side as well as process side. Hardware development deals with designing of microcontroller board attached with bluetooth module.

This hardware will be connected with process to sample physical quantities of process and convert into digital signals. Industrial process controller involves lot of measurement of physical quantities, processing and communication. Parameters are measured on machine through high quality sensors and equivalent analog signals are then transmitted to controller through hard wired network or buses. This infrastructure leads to complexity of the system as well as hard to debug during occurrence of any fault or during modification or updating to the system.

Bluetooth has pre-written “profiles” which define the standards to which a particular type of Bluetooth device must conform. Due to advancement in the operating system, we don’t have to load a device driver of Bluetooth on phone or PC. The default is the serial port protocol, which is exactly what is needed for most microcontroller projects. When a Bluetooth device is paired with a PC, it will show up as a standard COM port. Bluetooth has become the standard technology for external interfacing to laptop PCs and mobile devices.

In our project, we have used two Bluetooth module one at PC side and other at microcontroller side. We have used HC-05 bluetooth module to interface with microcontroller. The HC-05 is commercially available in the market and popular for these type of researches. The contribution of our work is to establish a wireless connection between a industrial process that may be located at non-reachable location and the control room.

The Rest of the paper is organized as follows. Section II shows details of our design. Implementation of the design illustrated in section III. Section IV deals with the experiments and results. Conclusion and future work of this work explain in section V.

OUR DESIGN

We need to transmit a message from microcontroller to personal computer. For this purpose we interfaced HC-05 Bluetooth module to 8051 microcontroller. Transmitted a message from a microcontroller to PC show in HyperTerminal screen in pc and message transmitted from pc is received on port 3 of microcontroller. We have transmitted messages from host system to different PC connected in a specified range of a Bluetooth module.

The interfacing of UART with 8051 program display a text in PC. Some delay is occurring when a single data is sent to PC. In 8051 microcontroller board contains two serial interfaces that are UART0 & UART1. Here we are using UART0. The Transmitter pins send the data into PC and the receiver pin receives the data from PC. Data transfer rate between the PC and microcontroller is denoted by baud rate. When the baud rates of both PC and microcontroller are same, then only the data transmit and receive correctly. The 8051 has two pins that are used specifically for transferring and receiving data serially. These two pins are not RS232 compatible then line driver chip MAX232 is used. The MAX232 uses +5v power source, which is same as the source voltage for 8051.Generally Null modem connections are used for data transfer between two device serially called TXD and RXD and are part of the Port-3 group (Port-3.0 and Port-3.1). Pin 11 of the 8051 is assigned to TXD and pin 10 is designated as RXD. These pins are TTL compatible; therefore they require a line driver to make is RS232 compatible. Figure 1 shows how a message is transmit to connecting PC through a HC-05 bluetooth module.

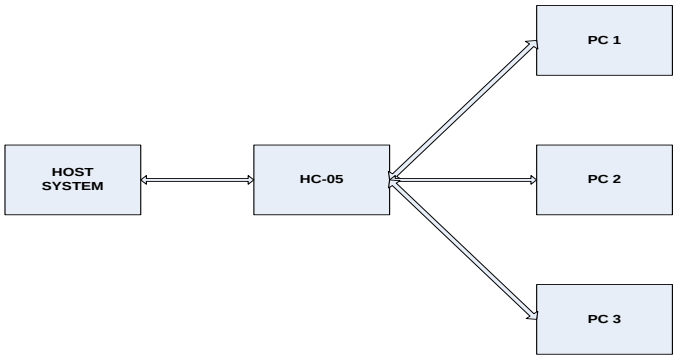

Figure 1: Transmission between Host to Different Connecting PC

Figure 2 Shows how to interface the bluetooth with microcontroller. Bluetooth technology handles the wireless part of the communication channel, it transmits and receives data wirelessly between these devices. It delivers the received data and receives the data to be transmitted to and from a host system through a host controller interface.

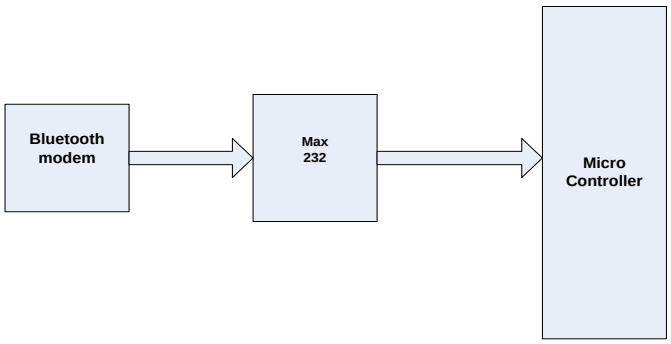

Figure 2: Interfacing UART with 8051 Microcontroller

IMPLEMENTATION

HC-05 module is an easy to use Bluetooth SPP (Serial Port Protocol) module, designed for transparent wireless serial connection setup. Serial port Bluetooth module is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. It uses CSR Bluecore 04-External single chip Bluetooth system with CMOS technology and with AFH(Adaptive Frequency Hopping Feature). It has the footprint as small as 12.7mmx27mm. It will simplify overall design/development cycle.HC-05 embedded Bluetooth serial communication module has two work modes order-response work mode and automatic connection work mode. There are two work roles (Master, Slave) at the automatic connection work mode.

When the module is at the automatic connection work mode, it will follow the default way set lastly to transmit the data automatically. When the module is at the order-response work mode, user can send the AT command to the module to set the control parameters and sent control order. The work mode of module can be switched by controlling the module PIN (PIO11) input level. PIO8 connects with LED. When the module is power on, LED will flicker and the flicker style will indicate which work mode is in using since different mode has different flicker time interval [13].

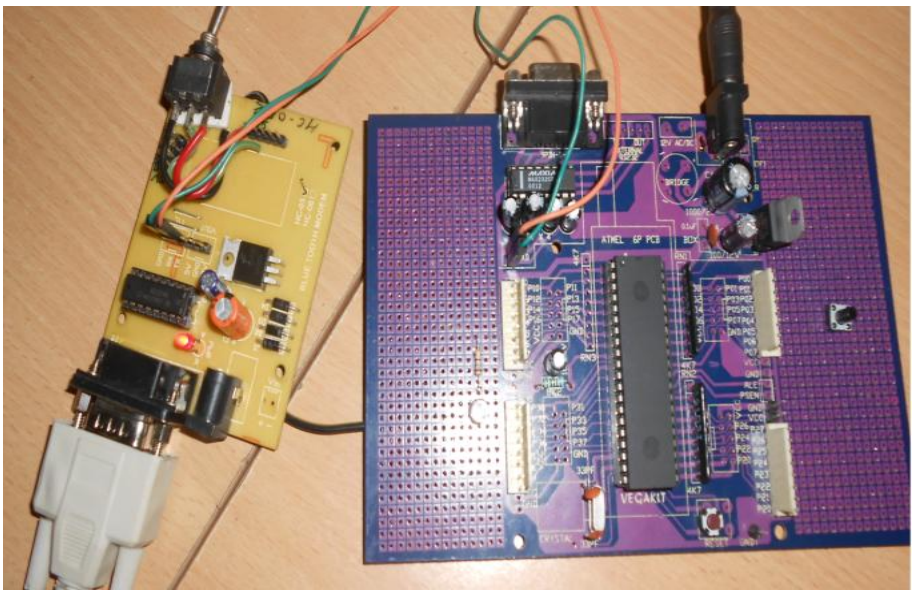

Figure 3: Interfacing of HC-05 Bluetooth Module to Microcontroller

Give a 12v power supply through adapter to the microcontroller board, voltage regulator IC 7805 convert this 12v supply to 5v. This 5v is also given to HC -05 Bluetooth module which convert to 3.3v by in built regulator. ENTER Bluetooth dongle plug in USB port of a PC. We click on add a Bluetooth device option then ENTER device search a HC-05 Bluetooth device modem. Use a PASS key “1234” to connect to each other. When the connection is established between ENTER Bluetooth dongle and HC-05 Bluetooth modem input COM port and output COM port number display in screen.

Figure 3 Shows interfacing of HC-05 bluetooth module to general purpose microcontroller board. PIO9 connects with LED. It indicates whether the connection is built or not. When the Bluetooth serial is paired, the LED will be turned on. It means the connection is built successfully. To enter into communication mode Input low level to PIN34, Supply power to the module then the module will enter to communication mode.

It can be used for pairing. Now to set HC-05 Bluetooth module be the master role input high level to PIO11, Supply power to the module and the module will enter to the order-response work mode. Set the parameters of the super

terminal or the other serial tools (baud rate:9600, data bit:8, stop bit:1, no parity bit, no Flow Control) shown in figure 4. Sent the characters "AT+ROLE=1\r\n" through serial, then receive the characters "OK\r\n". Here, "\r\n" is the CRLF. Input low level to PIO, and supply power to the module again. Then this module will become master role and search the other module (slave role) automatically to build the connection.

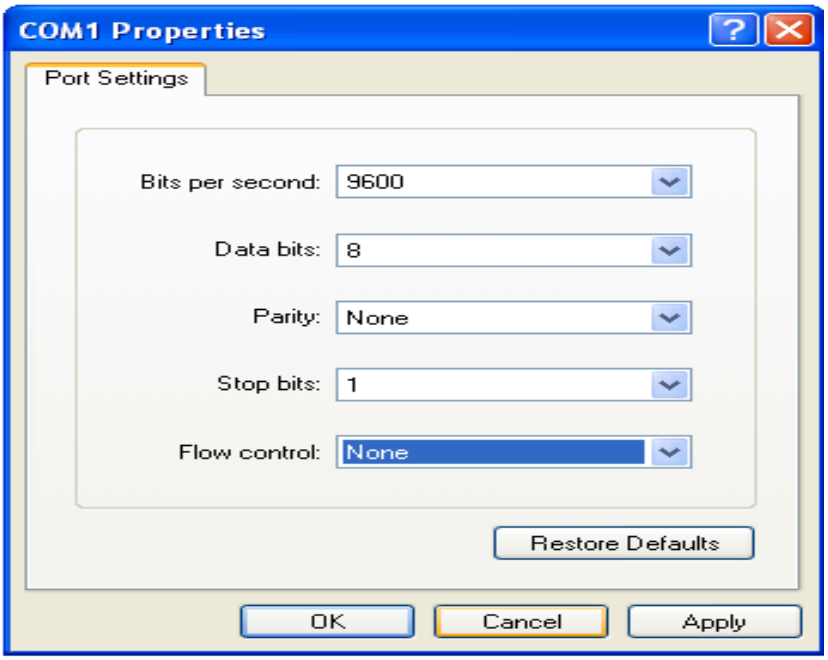

Figure 4: Setting of a Port for Serial Communication

EXPERIMENT AND RESULTS

We have developed C and assembly program for transmitting and receiving a message between microcontroller and PC. We use a KEIL software development tools for compile and debug purpose. It provides several development modules Project Manager, Simulator Debugger, C Cross Compiler, Cross Assembler, Locator/Linker. HEX file generated through this software and this HEX file burned in a microcontroller by a SUPERPRO universal programmer.

For transmitting a message first initialize the port, set timer mode register. SCON register is used to set the mode of serial communication. In program, Timer1 is used with auto reload setting. The baud rate is fixed to 9600bps by loading TH1 to 0xFD.

The value 0x50 is loaded in the SCON register this will initialize the serial port in Mode1.SBUF is an 8-bit register for transmitting a data byte serially, it needs to be placed in the SBUF register. Similarly whenever a data byte is received serially, it comes in the SBUF register.

When a byte is written, it is framed with the start and stop bits and transferred serially via the TxD pin . When the bits are received serially via RxD, it is deframe by eliminating the stop and start bits, making a byte out of the data received, and then placing it in the SBUF. The controller raises the TI flag when the 8-bit character is transferred. This indicates that the next byte can be transferred now.

The TI bit is raised at the beginning of the stop bit. When 8051 finishes the transfer of the 8-bit character, itraises the TI flag to indicate that it is ready to transfer another byte. when the 8051 receive data serially via RxD, it places the byte in the SBUF register then raises the RI flag bit to indicate that a byte has been received and should be picked up before it is lost. This algorithm shown in figure 5.

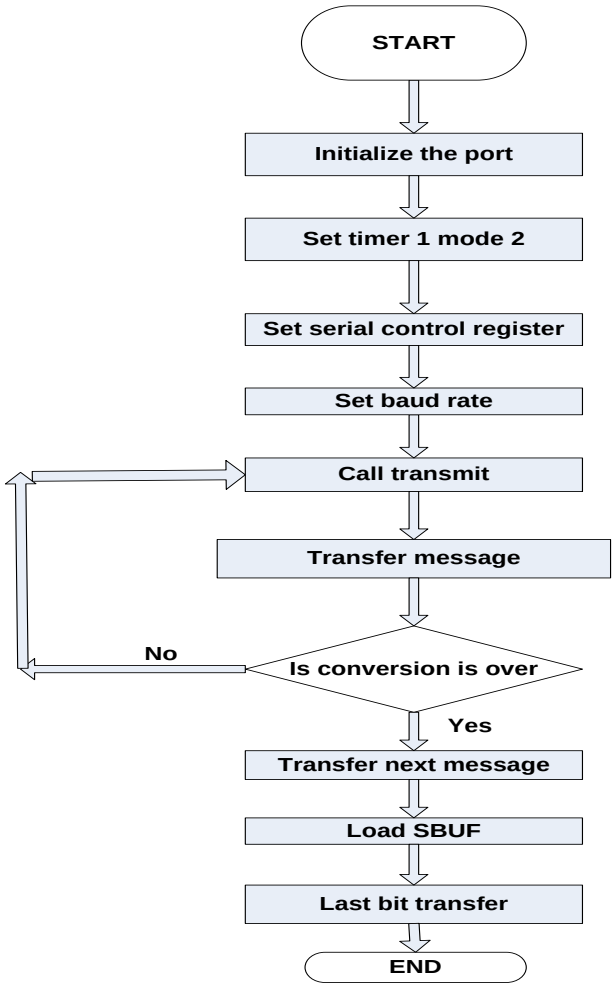

Figure 5: Flow Chart for Transmit a Message

After the implementation of the specified system the testing results are obtained by the hyper terminal is shown in figure 6,7,8. It indicates that data transmission occurred between the microcontroller board and Bluetooth module via serial connection. LED glow after the data received on port of microcontroller from PC.

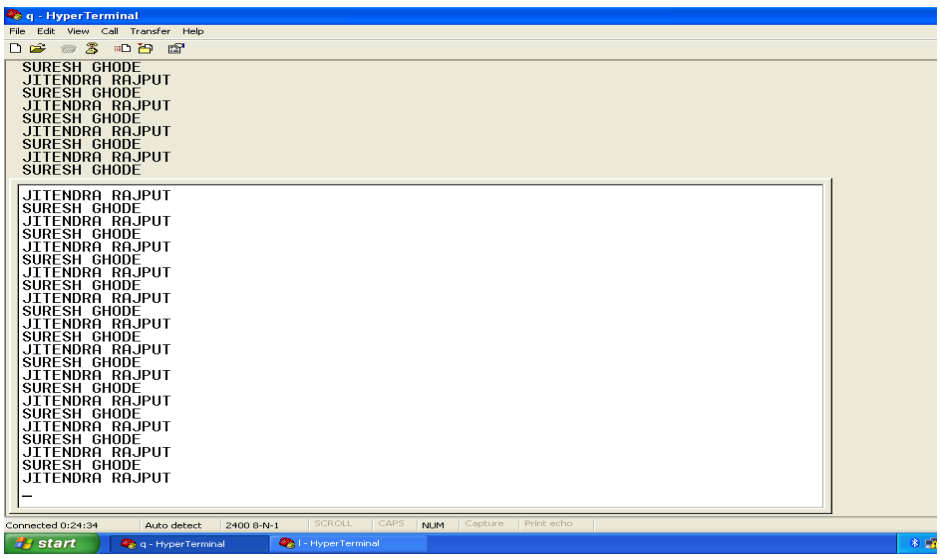

Figure 6: Message Transmit by Using a Switch and Receive in PC from Microcontroller

We use a switch in microcontroller board for transmitting a message shown in figure 6 received on hyperterminal screen from microcontroller by using a switch.

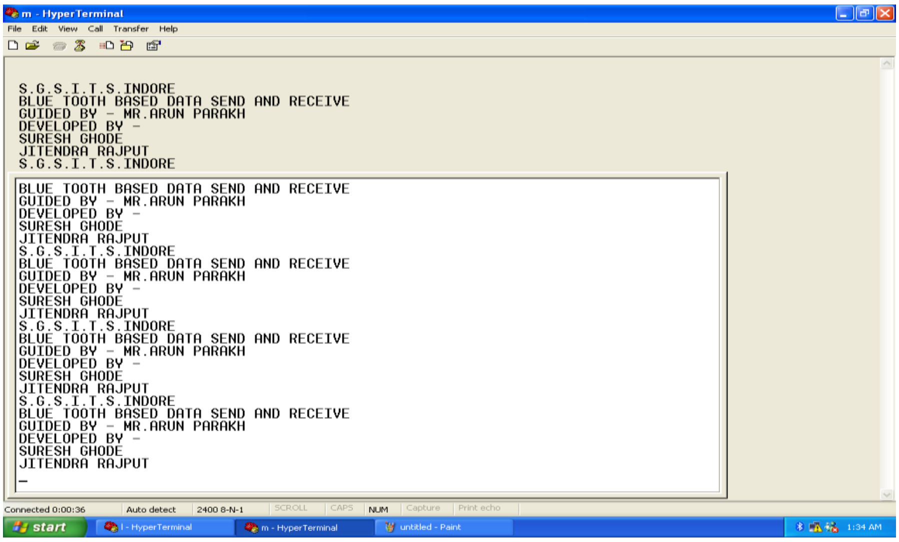

Figure 7: Message Received in PC by Reset Condition

A string of message is received in reset condition on hyperterminal screen shown in figure 7 from the microcontroller after the program compile in kile software and HEX file is burn inmicrocontroller.

A message "hello" is received in hyperterminal screen shown in figure 8 after the program is compiled and HEX file is burn in microcontroller.

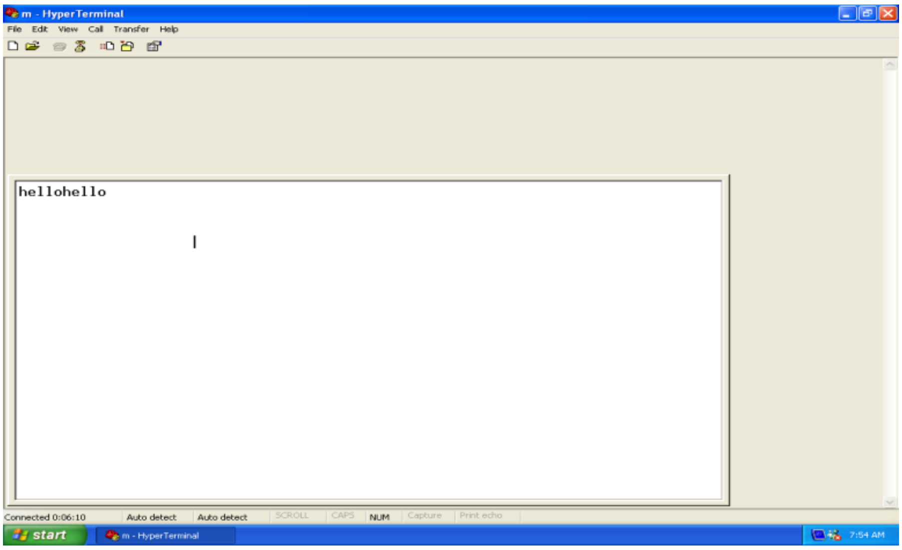

Figure 8: A Message Hello Received from Microcontroller to PC

CONCLUSIONS AND FUTURE PLAN

The goal of presented work to demonstrate the Bluetooth can be used for industrial control applications. Moreover we have successfully established communication between the microcontroller and personal computer. Our prototype demonstrates a mechanism that highly applicable where large number of wires needed to interface process and its controller. It is very cost effective and low power device. We also observed that modification, updating and debugging of this system is much simpler than hard wired or bus based system. There are many enhancements are possible, improving the behaviour of the system, the user interface or the possible operations of the peripheral application. Possible extension of this work is to include web applications and mobile application. We are planning to include both of the above extension in order to access a industrial process remotely anywhere in the globe. A communication protocol will be designed in future to ensure secure and reliable communication where multiple process and controller are involved.

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