A Wi-Fi Enabled Robot

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Abstract- A Wi-Fi enabled robot truly embarks and reinstates the technology by taking it to new level of sophistication. Microchip's versatile PIC microcontroller and WiFi module are used to build Robofi, which is a WiFi-enabled Robot. The Robofi can be navigated from a remote location, from a web-browser over the Internet. Microchip's TCP/IP stack is used to build this application. The application is designed over the HNZG1 Board of Manipal Dot Net which consist of PIC24F series microcontroller and ZeroG-2100 module for wireless connectivity. Additional electronic circuit and PCB are developed by the Team to interface the HNZG1 with the Turtle Robot. The application is developed using Microchip's MPLAB IDE; and programmed and debugged using ICD3. The developed system works as a joystick over WiFi, which moves the Robot in four directions. The control commands go over the Internet, emulating the 'Internet of Things' concept.

I. INTRODUCTION

Wi-Fi enabled Robot is a system, which controls the turtle robot using the web page. To make this feasible we make use of the HNZG1 board with a built in Micro controller and ZeroG-2100 Wi-Fi module. HNZG1 board is developed exclusively by MANIPAL DOT NET PVT. LTD comprises of ZeroG-2100 module for wireless connectivity and inbuilt PIC24F series microcontroller from Microchip Technology Inc.

Switch control mode of Robot is controlled using Joystick and can appropriately be guided to back, forth, left and right directions

So in this project, we extend an interface to the Switch control mode to suit our requirements. Finally we have been able to bridge together the HNZG1 board and the Turtle Robot, and eventually control the Turtle Robot in wireless environment through the control buttons embedded on the custom Web page designed by us.
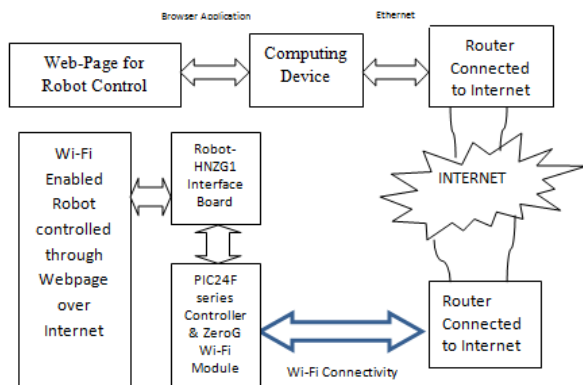

Figure 1: Functional Block Diagram of Wi-Fi Robot

From the figure it's quite evident that control over the Robot can be dictated using a Custom made Web page and Robot can be banked forth, Backward, Left and Right respectively.

When the designated Web address is entered into the web browser of the computing device, the web page for stipulated controls of the Robot is actuated and now visible on the computing device. When we click on the respective direction controls for the Robot on the webpage, the subsequent packets are generated. These packets at the transmitter end via Internet gets into the Router at the Receiver end and eventually gets dumped into the ZeroG module. From the Zero G module via SPI interface on the HNZG1 board, the data is received into the PIC 24 micro controller and specified directions are subsequently assumed.

II. SOFTWARE PERSPECTIVE
Custom Made Webpage

Here, as a first step we had to build a custom made webpage to dictate control over the Robot movements. This custom built webpage is uploaded into PIC controller. In this webpage Controls have been specified for forward, backward, left and Right movements.
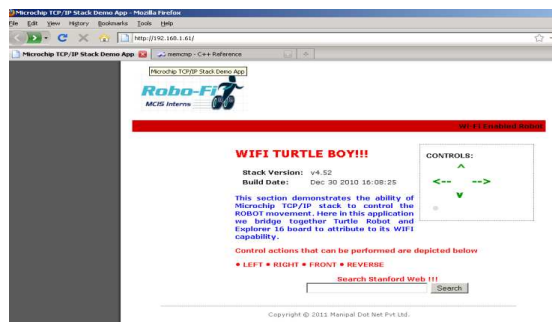

Figure 2: Custom made web page for Robot controls

Configuring GPIO Pins

Once this was accomplished we had to figure out the 4 GPIO Pins which are mapped with PIC24F series microcontroller and the former is available in the schematic of HNZG1 board. As a next step, we had to define and configure these GPIO pins from PIC as output pins and they must be asserted high to send +3.3v. Then, we had to map these GPIO pins to their respective movements (Left, Right, Forward and Backward) on webpage.

Important Programming Modules

In Hardware Profiles.h file of Microchip Stack, GPIO pins were just defined, details of TRIS register being output port was mentioned. On the contrary in CustomHTTP.C, GPIO pins were configured. This is accomplished in two pieces. First, the pins are configured as output ports by setting their direction (by assigning the corresponding TRIS register to 0). Next, GPIO pins are made to toggle between high and low as the respective click on the webpage is assumed. i.e. GPIO pins attribute to a Voltage of 3.3 volts when its high.
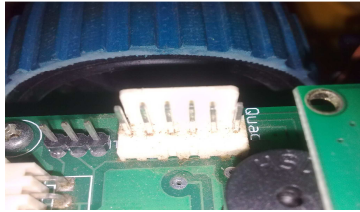
Figure 3: Quad Interface on the Turtle Robot

For the Robot to manoeuvre in different directions connection must be accomplished between one of the four pins for direction and the pin meant for the ground. If the circuit between the stipulated pins meant for the direction and the ground is complete, only then shall the Robot move. The voltages so attributed to these pins are approximately 3.9 volts.

III. HARDWARE PERSPECTIVE

The GPIO pins from the PIC of the HNZG1 board attribute to a voltage of 3.3V and on the contrary the Quad connector on the Turtle robot attributes to a voltage of 3.9V to 4.5 V (i.e., Turtle Robot is powered by a battery of 6v). Hence, there is an essentially a mismatch of voltages between the Turtle Robot and the HNZG1 board.

Power Supply to PIC and ZG-100

Power to PIC Controller and ZeroG-2100 module is given from the 6 volts battery of the Turtle Robot. As evident from the Schematic of the Fig 6, Power supply of up to 15V un-regulated can be given to the Pin 12 of the HNZG1 board. Hence a voltage of approximately 6 volts from the battery of Turtle Robot will not pose any problem. ZG_ENABLE pin must always be asserted high, only then shall ZeroG2100 module work, this is assumed by keeping pin 11 of HNZG1 board connected to 6 volt power input.
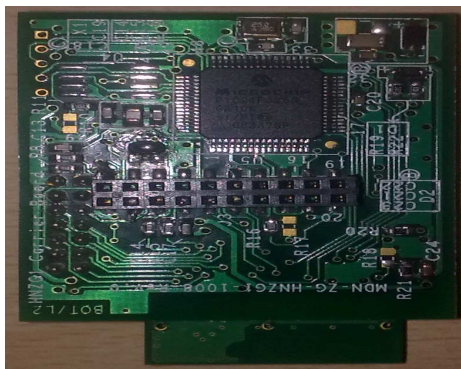

Figure 4: HNZG1 board with PIC24F256GA106 and ZeroG2100 Module

For the Robot to manoeuvre in different directions the respective direction control pins on the Quad connector must be grounded. As a solution to this we make use of the simple transistor switch. From fig 4, its quite clear that base of the transistor is to be connected to GPIO pins on the HNZG1 board via resistor Rb=220k.

Collector is connected to vdd via resistor Rc=10K(pull up resistor), also the output is tapped across the collector and given to the direction control pins of Turtle Robot and Emitter is grounded. When we click on the direction buttons of the Web page for appropriate movements (Right, Left, Backward and Forward), corresponding GPIO pins on the HNZG1 board gets activated and sends a voltage of 3.3 V. This 3.3 Volt is given to the base of the transistor and vdd of 5 volts is pulled down and output is 0 volts which is tapped across the collector, and given to one of the direction control pins of the Robot which are active low. Hence the robot moves in respective direction when the GPIO pins are high. When no direction buttons on Web page is clicked, no voltage comes out of GPIO pins, hence output is 5 volts tapped across collector, which is given to one of the direction control pins of the Robot. Hence, it's quite clear that the transistor is operated in Cut-off region and saturation regions respectively or it's used as a switch.

Note that transistor used in our project was MMBT3904.

To bridge between the Turtle Robot and the Wi-Fi module, the HNZG1 board of Manipal Dot Net, we built a custom made PCB comprising exclusively of Transistors. The Transistors are being operated in cut off region and Saturation region, hence replicating the behaviour of Digital switch which can be asserted either high or low depending on the Input signal.
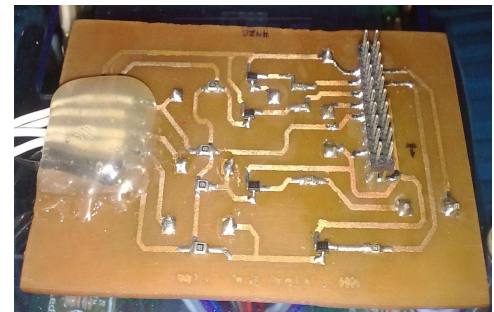
Figure 5: custom made PCB comprising of transistors to bridge between Robot and HNZG1 board

So as evident from the PCB one connector of the PCB is connected to the Quad connector of the Turtle Robot and other connector of the PCB is connected to HNZG1 module.

Hence, this is how we bridge between the Turtle Robot and the HNZG1 module using the transistor switching circuit. So, the final unified discrete coherent system is Wi-Fi enabled Robot, the control to which can be dictated using a custom made web page exclusively built by us and Robot can bank forth, backward, left and right.

Figure: 6 The complete Schematic of Wi-Fi Enabled Robot

IV. RESULT

We successfully completed the PCB design by soldering appropriate SMD components on this PCB. This PCB was perfectly placed on the top of this Robot thus minimizing the wires and additional overhead. Thus, asserting the capability of the Robot to be Wi-Fi enabled and being controlled through webpage. So we have bridged together Turtle Robot and HNZG1 board to build a single unified coherent system.

Fig 5: A Wi-Fi Enabled Robot

V. CONCLUSION

Hence, Wi-Fi enabled Robot is a completely new cliché unleashed. Robot is moved Forward, Reverse, and Left, Right with the appropriate controls dictated by the webpage. We find that this demonstration using PIC Controller and ZeroG-2100 module provides an innovative approach to the way we control most robots currently, which would intern prove to be very helpful in the days to come.

References

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