Design and Implementation of a Robotic Vehicle With Real-Time Video Feedback Control Via Internet

S.M. Tasmeeh Ahsan, Md. Zahid Hassan, Md. Tareq Imam
Department of Electrical and Electronic Engineering
American International University-Bangladesh (AIUB)
Dhaka, Bangladesh
atasmeeh@yahoo.com, mdzahidhassanaiub@gmail.com, jibon4u@yahoo.com

Kazi Faysal Md. Anwar Sadat, Md. Rifat Hazari, Mrs. Laila Nawsheen Manzoor
Department of Electrical and Electronic Engineering
American International University-Bangladesh (AIUB)
Dhaka, Bangladesh
Apu1990.kazi@gmail.com, rifat.hazari@gmail.com, lailanawsheen@gmail.com

Abstract—**This paper illustrates on an approach to control a robotic vehicle using internet as communication medium between user and robotic vehicle. Conventionally wireless robots have the drawbacks of limited working range, limited frequency range and limited control. But internet can overcome these limitations with the help of DTMF decoder IC and a preprogrammed micro-controller IC that control the movement of the robotic vehicle according to output sent from DTMF decoder. The outstanding feature of this implemented robotic vehicle is use of tilt sensor that keeps controlling of the robotic vehicle unaffected upon tilting more than 90 degree.**

Keywords—Autonomous vehicle; DTMF decoder; Skype; Robotics.

I. INTRODUCTION

Robot is an object which is mechanical or virtual, basically electro-mechanical machine and controlled by computer program or electronic circuits. Although this definition does not exactly fit to robot about thousand years ago. Because about thousands of years ago robot were not controlled by computer program or electronic circuit. It was mainly controlled by switch on/off or by the assistance of human. Initially robot existed in myths. But when industrial revolution took place robot came out of myths and made their place in real world. At that time robot were built using principle of mechanics and it improved with time when electronic age developed. Using both electronics and mechanics concept robot was much improved in its inner and outer architecture and the application of robot were thought in broader fields. Initially robot was built for mainly industrial application like picking up things and placing it to somewhere or packaging a product.

So far the robots that have been made in earlier times and recent times have complex circuit and costly. Also sometimes not reliable. But this project use internet as the medium to create communication between user and robotic vehicle for which it is very much reliable. And due to video feedback process the robotic vehicle need not to be in the user's vision of range. Tilt sensing feature allows the controlling of robotic vehicle to remain unaffected. Microprocessor chip Atmega 48 is used which is currently one of the fastest processor compare to other microprocessor chips. For this reason the response of robotic vehicle is very fast. MT8870 a modern and efficient DTMF decoder is used which have feature in it so that minimum noise passes making the whole system efficient. The circuit is less complex and overall it is cost efficient. With time the important thing to lookout is higher efficiency and a smart technology which this project enhances completely [1].

II. PROPOSED CIRCUIT DESIGN OF ROBOTIC VEHICLE

The complete software design of the robot is done by Microsoft Visio.

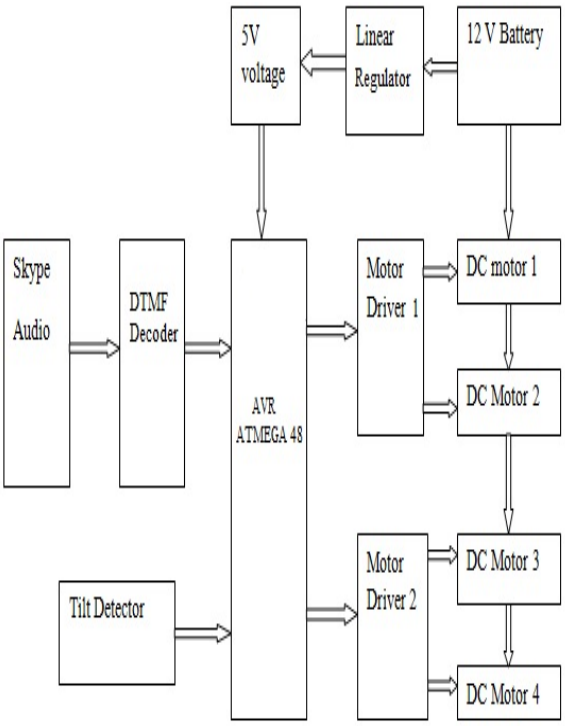

Fig. 1. Block diagram of skype control robot

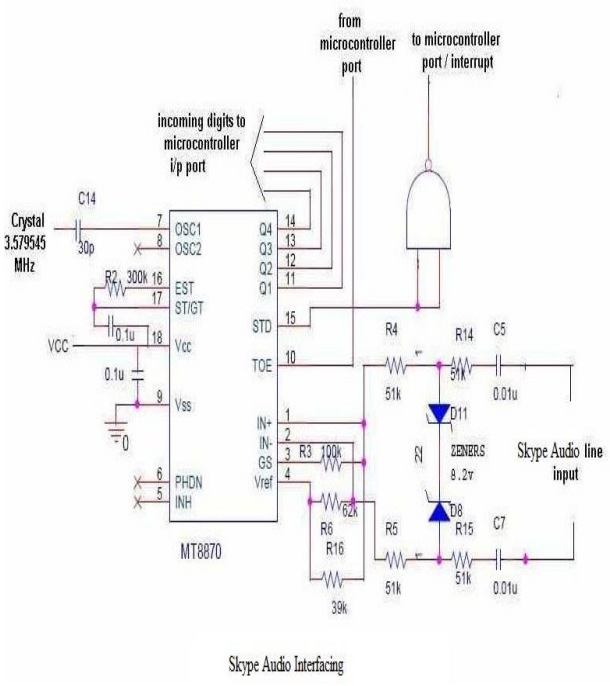

Fig. 2. Circuit diagram of MT 8870 DTMF decoder

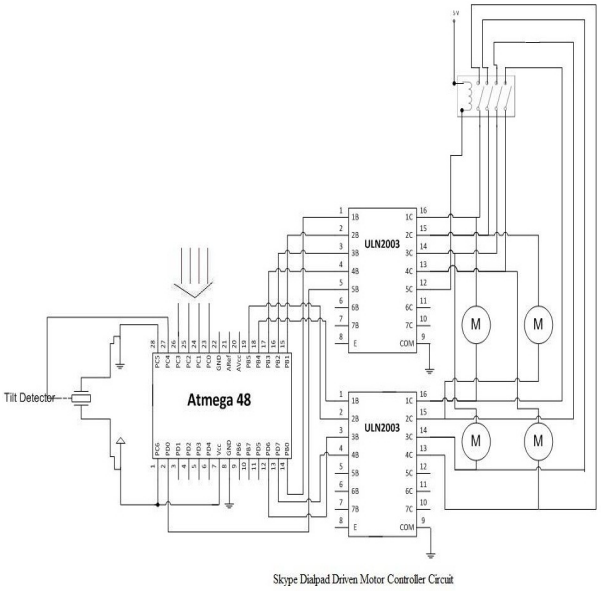

Fig. 3. Complete circuit diagram of robot with differnet components

Commanding the robotic vehicle is achieved by internet enabled device which can be Tab, laptop, smartphone or any other device that have Skype software installed. These internet enabled device is the remote control that commands the robotic vehicle of necessary action to be performed by generating DTMF tone when number keypad 2,4,6,8 and 5 is pressed which is received by sensor which is the smart phone connected to the robotic vehicle. These DTMF tone are decoded by DTMF decoder IC MT8870 into binary digits as shown in figure 2. Then these binary digits are processed by micro-controller IC Atmega 48. The micro-controller IC Atmega 48 takes decision based on different binary number and makes the motor driver IC ULN 2003 to rotate the DC motor in either clockwise or anti-clockwise direction, depending on which direction the robotic vehicle is command by user to move. Figure 3 shows the connection of processor Micro-controller IC Atmega 48 with motor driver IC ULN 2003 along with four contact relay and tilt sensor which is operational whenever the robotic vehicle tilts more than 90 degree.

III. MAIN PARTS OF THE ROBOTIC VEHICLE

The parts used in the proposed robotic vehicle are battery, linear regulator (IC 7805), tilt sensor, DTMF decoder (MT8870), Atmega 48, ULN 2003, DC motor, and four contact relay.

A. Battery

The 12V lead battery used in the robotic vehicle for which all the IC's are getting the power and turned on.

Fig. 4. Lead acid battery

The battery also provides power to the rest of the eqipments of the robot.

B. Linear regulator

IC 7805 is used as linear regulator. The battery total supplies 12 V, but the linear regulator only allows 5V from the battery because excess voltage can heat up the IC's and may damage the equipment due to excessive current flowing. It is connected with the battery as shown 12 [2].

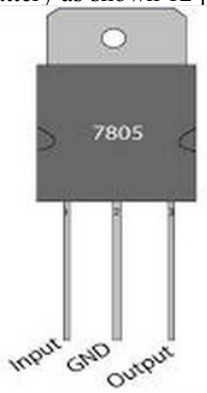

Fig. 5. Linear regulator [2]

C. Tilt sensor

It is used whenever the robot is tilted and it prevents the robotic vehicle's controlling to be unaffected upon tilting. The coding consists of a part where tilt sensor is mentioned in which , upon tilting it sends a message to Atmega 48 that allows four contact relay to get energized and the connection of DC motor are reversed allowing the user not to bring any change in controlling method. The controlling of robotic vehicle that is pressing 2,8,4,6 and 5 make the robotic vehicle move forward, backward, left, right and stop respectively. The tilt sensor is connected with Atmega48 as shown in figure 3 [3].

Fig. 6. Tilt sensor

D. DTMF decoder (MT8870)

Decodes the dual tone multiple frequency of 2,4,6,8 and 5 into its corresponding binary number that is 0010, 0100, 0110, 1000 and 0101 respectively and send this output to input of Atmega 48. The MT8870 is connected to Atmega 48 as shown in figure 12. It is seen that there is a thin metal sheet above MT8870. This absorbs the heat buildup in the chip to prevent it from damage [4].

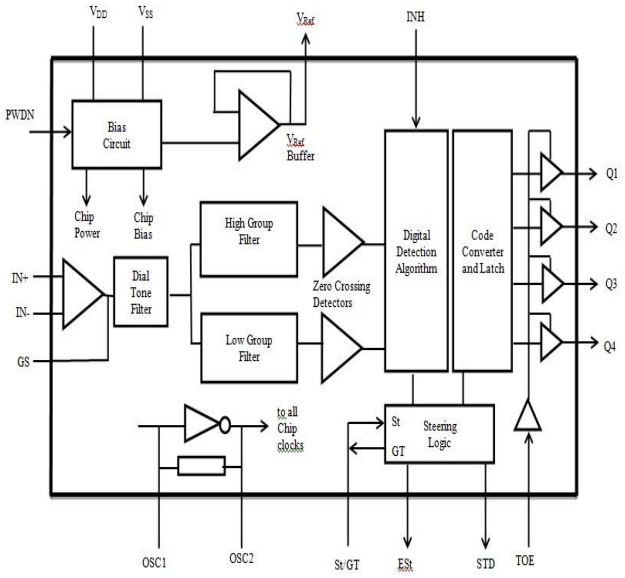

Fig. 7. DTMF decoder [4]

E. Atmega 48

The micro-controller chip Atmega 48 receives output of MT8870 as input and provides its output as input of ULN 2003. It is one of the fastest micro-controller chips at present. It is the core part of the robotic vehicle because the program is burned in it according to which the robotic vehicle responds. The MT8870 connected with Atmega 48 which is connected with ULN 2003 and also it is connected with tilt sensor as shown in Figure 3 and 12. The metal sheet which cover the Atmega 48 as shown in figure 12 also used for same purpose as used in MT8870 that is to protect it from overheating.

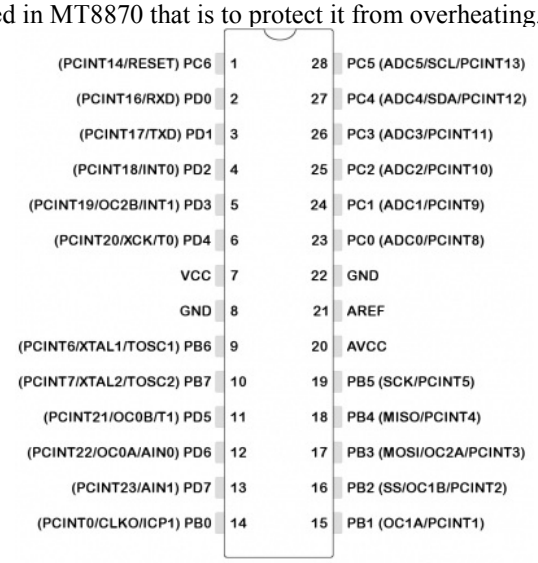

Fig. 8. Microcontroller chip (Atmega 48) [5]

F. ULN 2003

It is the motor driver IC. It receives input from Atmega 48 and drives the motor according to program burned in IC Atmega 48. Figure 3 show how output from Atmega 48 is connected to ULN 2003's input and how the two ULN 2003 connected to four DC motor. Each ULN 2003 is connected to two DC motor. The ULN 2003 is also connected with relay so that in case of tilting of the robotic vehicle, the relay organizes the connection of motor in such a way that the controlling of robot is unaffected. Here the thin sheet of metal covering the two ULN 2003 prevents the ULN 2003 from overheating [6].

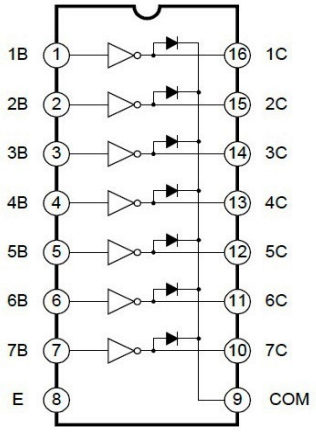

Fig. 9. ULN 2003 [6]

G. DC Motor

The DC motor being driven by ULN 2003 according to program burned in Atmega 48. The DC motor is bi-directional. It moves in both clock wise and counter clockwise direction, enabling the robotic vehicle to move forward, backward, left, right and stop. The four motors are connected to two ULN 2003 IC where two motors are connected to one ULN 2003 and also with four contact relay as shown in figure 12 [7].

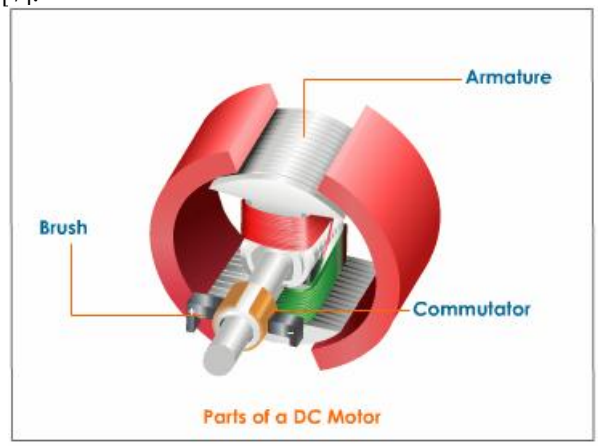

Fig. 10. DC Motor [8]

H. Four contact relay

Its main purpose is to energize switch so that the connection of motor is changed whenever the robotic vehicle tilts and the change is done so that controlling remains unaffected. The relay is connected to ULN 2003 and DC motor as shown in figure 12.

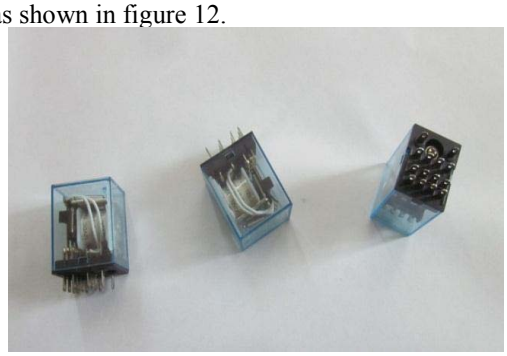

Fig. 11. Four contact relay

IV. HARDWARE IMPLEMENTATION

The figure 12 shows the complete hardware implementation of the smart phone controlled robotic vehicle. The battery is source to supply energy to IC's and other components, two battery providing 12V each giving 12 V in total as they are connected in parallel but is only allowed to provide 5 V because the linear regulator used connected with battery as shown in figure 12 restricts the supplied voltage. When a skype call is made between user's laptop/PC to smart phone of robotic vehicle, the video call is received by automatic reception or received by someone. Once the video call is received, then by pressing skype software's dial pad 2, 4, 6, 8, 5 operating DTMF are generated. Skype audio line inputs are received in a noise filtering part which is connected to basic DTMF receiver MT8870. This MT8870 decodes the received DTMF tone.

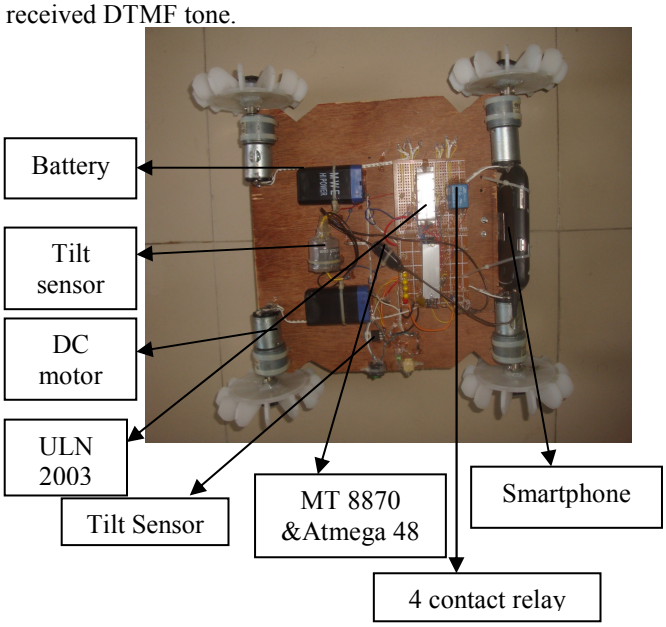

Fig. 12. Hardware implementation of the robotic vehicle

A fixed 3.579545 MHz crystal oscillator is connected to clock input of the decoder MT8870. It completes internal oscillation. DTMF tones are decoded into four (04) bit binary digits, which go through the 11, 12, 13, 14 port of MT8870 to the Microcontroller Atmega 48 as shown in figure 12.

Port 17 (StD) represents logic high when a received tone pair has been registered and the output latch updated, returns to logic low when the voltage on St/GT falls below VTSt. Port 18 (ESt) presents a logic high once the digital algorithm detects a valid tone pair (signal condition). Any momentary loss of signal condition causes ESt to return to a logic low. And an interrupt is generated to the microcontroller Atmega 48 by the port 17 (StD) between the NAND gate. Microcontroller receives the four bit binary codes by the port 23, 24, 25, 26 (PC0, PC1, PC2, PC3). Two Voltage amplifier and relay driver device UNL2003 are connected to Atmega 48 as shown in figure 12. The output of Atmega 48 is connected to ULN 2003 and ULN 2003 is connected to four contact relay and DC motor. One ULN 2003 is connected to two DC motor as shown in figure-12. Besides this a tilt sensor is connected to Atmega 48 with the port of PC4, PC5, PC6 connection as shown in figure-12. A tilt sensor can measure the tilting in often two axes of a reference plane in two axes +90 to -90. Microcontroller receives the corresponding binary codes and gives logic high to ULN2003. ULN2003 amplify voltage which is given to motor. Then motor starts to move on. Operational command is when user is pressing 2 in Skype dial pad (corresponding binary code 0010 received by Atmega 48) the four motor start to move in same direction that is clockwise moving the robotic vehicle in forward direction. Similarly, when user is pressing 6 (binary code 0101) two motor moves clockwise and other two moves counter clockwise and robotic vehicle move right. When user is pressing 4 (binary code 0100) the two motor which

previously moved counter clock wise on pressing 6 now moves clockwise and the other two motor move clock wise making the robotic vehicle to move left. When user is pressing 8 (binary code 1000) four motor starts to move counter clockwise moving the robotic vehicle backward. For the breaking condition when it is pressing 5 (binary code 0101) four motor stops thus stopping the robotic vehicle.

A load calculation is done in time of construction of robotic vehicle. So the specialty is that the motor moves left or right in a standing position. The special feature of the robotic vehicle is when the robotic vehicle stumbles in a rough surface in time of moving, the Tilt sensor senses it and gives logic zero through the port PD0 of Atmega 48. It goes through an ULN 2003 which is connected to one side of the relay with also one side of the motors, as shown in Fig 12. Where another UNL 2003 connected with opposite side of motor, is connected to opposite side of the relay. A logic zero from tilt sensor via Atmega48 connects the relay coil and makes the path short. Then the coil of the relay starts to charge on and the four switch of the relay is made short. Then the motor operation is changed and reversed. The motors start to operate all command in a reverse mode. It occurred when the robotic vehicle falls from a rough surface. This is how all the IC and components work in conjunction according to command from user.

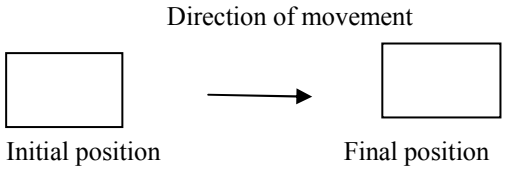

Fig. 13. Block diagram of robotic vehicle moving forward

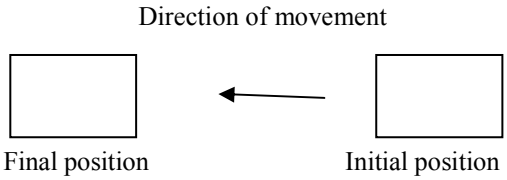

Fig. 14. Block diagram of robotic vehicle moving backward

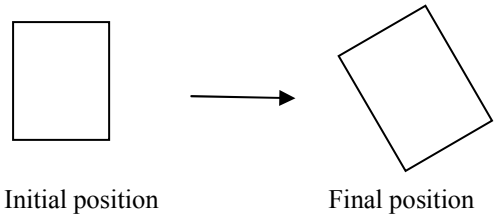

Fig. 15. Block diagram of robotic vehicle moving left

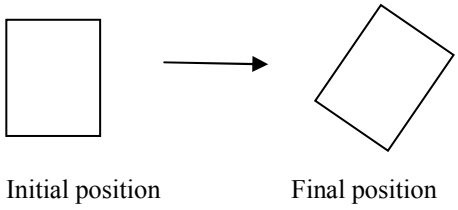

Fig. 16. Block diagram of robotic vehicle moving right

V. CONTROL ALGORITHM

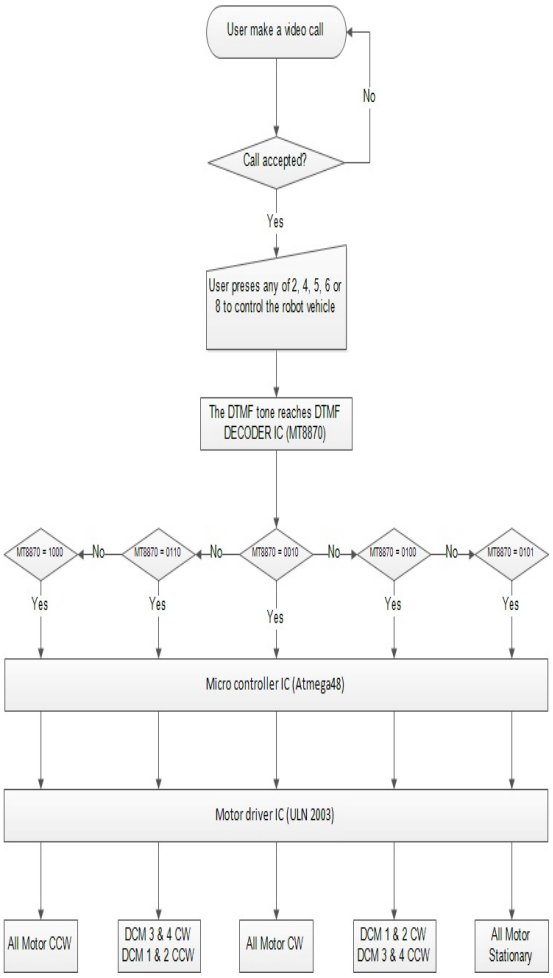

Fig. 17. Flow chart of the entire design

The steps taken to control the robotic vehicle are:

- A video call from the user's internet enabled device has been made to the smart phone stuck on the robotic vehicle.
- After the call acceptence in the robotic vehicle's smart phone, the user press the button. The buttons are 2, 4, 5, 6 and 8.
- Then the DTMF decoder decodes the signal to the binary digit.
- Based on the DTMF output pulses the micro-controller takes the decision and send instruction to the ULN 2003 motor driver.
- Then ULN 2003 control the direction of rotation of the DC motor.

The relationship between the DTMF decoder and the decision taken by the micro-controller is shown in figure 17.

VI. DISCUSSION

The proposed robotic vehicle gives user the freedom to control it across worldwide by utilizing the modern invention of 21st century like Skype, Smart phone and other internet enabled devices. As it is dependent upon DTMF tone, so absence of it will not allow the robotic vehicle to operate which is a limitation of this robotic vehicle. If a substitute can be used as back up other than DTMF tone like microwave, ultrasound or any other type of wave to create the communication medium between user and the robotic vehicle, then this limitation can be overcome.

VII. CONCLUSION

When internet is used as communication medium between user and robotic vehicle, it is possible to control the robotic vehicle even when it is not in user's vision of range. And the user can be any part of the world controlling the robotic vehicle carefully getting live video as feedback and tilt sensor make it possible to maintain controlling even if the robotic vehicle somehow rotate by 360 degree. The concept behind controlling the robotic vehicle through internet will remain same that is the use of a DTMF decoder, Micro-controller and a motor driver IC. But depending on the modification of robotic vehicle different IC can be used which also serve similar purpose like MT8870, Atmega 48 , ULN 2003 and a change in coding and structure. With addition of new IC like updated version of MT8870, Atmega48 and ULN 2003, the robotic vehicle can be more efficient. The robotic vehicle can be upgraded by using unused pin of Atmega 48 to make it possible for applying it in many purposes which this robotic vehicle does not exhibit.

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