Solar Powered Explorer Robotic System Using GSM Technology

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***Abstract*— In this paper, a solar powered wireless controlled robot is designed using microcontroller and GSM technology. The direction of the robot has been controlled remotely using dual tone multiple frequency (DTMF) decoder and GSM network system. The real-time video has been streamed to realize the physical aspects of the surroundings. Each DTMF tone from the user end is processed by the decoder to generate a unique binary code to the microcontroller, which operates the robot in any direction. Solar panel, PIR (Pyroelectric Infrared Sensor) sensor and LDR are used to detect any life even at low light condition to capture video providing uninterrupted power supply. These features incorporated in the robot can help to explore information from any remote and hazardous place.**

Keywords— DTMF, decoder, MCU, video streaming, solar power, human detection, password, retrace.

I. INTRODUCTION

It is said that our brain makes us different from rest of the world. The great result of application of human brain is robotics and it being used in each and every field of science and space and having gained accelerating importance in day to day life has thus resulted in more and more scope for study and therefore researchers are taking interest in the robotics which can help people in their daily life. One of the greatest advantages in this system is to control a robot using mobile phone from anywhere at any time[1]. A robot has the capability to do any task by its own, which is guided by computer, wireless devices like mobile phones or programming.

RF circuits are used to operate wireless-controlled robot but has several drawbacks, for example, frequency range, working range and control. [2][3]. The Mobile phone enables human to connect across the globe via Telecommunication network. The mobile phone is a qualified device to control the robot [4]. Using a mobile phone for robotic control can overcome above limitations [5]. Mobile phones can be used for controlling the robots using DTMF (Dual Tone Multiple Frequency) technology. Today mobile phones became very popular and essential entity for one and all. So, for any mobile based application, there is a great reception.

This paper suggests a methodology for controlling a robot by DTMF signals of the mobile phone. By simply pressing the keys in the mobile an user can control the robot by sending the DTMF tone[6][7]. Because of the effectiveness of mobile communication network users can take benefit of mobile phones to control the robot. It provides the advantages of robust control, working range as large as the coverage area of the telecom company, no interference with other controllers and up to twelve controls [8]. The solar panel with battery mounted on it provides uninterrupted power supply. So, this system will be a powerful and flexible tool that will offer this service at any time, and from anywhere with the constraints of the technologies being applied [4].

If two different tones were used to portray a single digit, then the false signal which may occur is signed out by using DTMF signal. A DTMF keypad generates a sinusoidal tone which is a mixture of the row and column frequencies which are low and high group frequencies respectively [9]. This prevents misinterpretation of the harmonics [4]. Also, the frequencies for DTMF are so chosen that none have a harmonic relationship with the others and that mixing the frequencies would not produce a sum or product frequencies that could mimic another valid tone [10]. The high-group frequencies (the column tones) are slightly louder than the low-group to compensate for the high-frequency roll off of voice audio systems [11]. The digital signal which is generated by the DTMF encoder is a direct algebraic summation, in real time, of the amplitudes of two sine or cosine waves which frequencies are distinct [4], that means, by pressing “1” will send a valid tone which is created by summing 697 Hz and 1209 Hz to the other end of the communication line [12].

This paper fully utilizes microcontroller features, embedded technology concepts and mobile communication system to reduce the time consumption, robust control and increase the quality of operating the devices.

DTMF Mobile ROBOT is a machine that can be controlled with a mobile [15]. In this project, the robot is controlled by a mobile phone which is normally registered in telecommunication service that makes a call to the mobile phone attached to the robot. There are three distinct phases that are involved in controlling a robot, via perception, processing, and action [14]. Generally, the preceptors are sensors mounted on the robot, processing is done by the onboard microcontroller or processor, and the task (action) is performed using motors or with some other actuators [11]. When the call is made to the robot the robot will interrogate a password from the user and proceed only when the correct password is entered. In the course of a call, if any button is pressed, a DTMF tone corresponding to the button pressed is heard at the other end of the call [15], [16]. The robot perceives this DTMF tone with the help of the phone stacked on the robot. The received tone is processed by the microcontroller with the help of DTMF decoder MT8870 IC. The decoder decodes the DTMF tone into its equivalent binary digit and this binary number is sent to the microcontroller, the microcontroller is pre-programmed to take decision for any given input [13]. According to the button pressed on the transmitting cell phone, the robot will

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move in any direction. This is also an intelligent system which includes the motion sensor and LDR for the security and exploration purposes of the area in which it is sent. The main aim of using these sensors is to monitor human existence, sufficient light detection to reduce energy consumption and proper video capturing in the desired area. A mobile camera is attached to the robot to realize the physical aspects of the real world and its surrounding through video calling over internet or GSM network or wifi (for short range) which also helps to control the robot. A solar panel has been attached to this system to supply the uninterrupted power supply while it would be used at outdoor for a long time. In case of observation during day time it will act as a parallel provider of power supply with respect to battery and battery can supply power when solar power is absent.

II. FRAMEWORK OF THE SYSTEM

A. System Flowchart

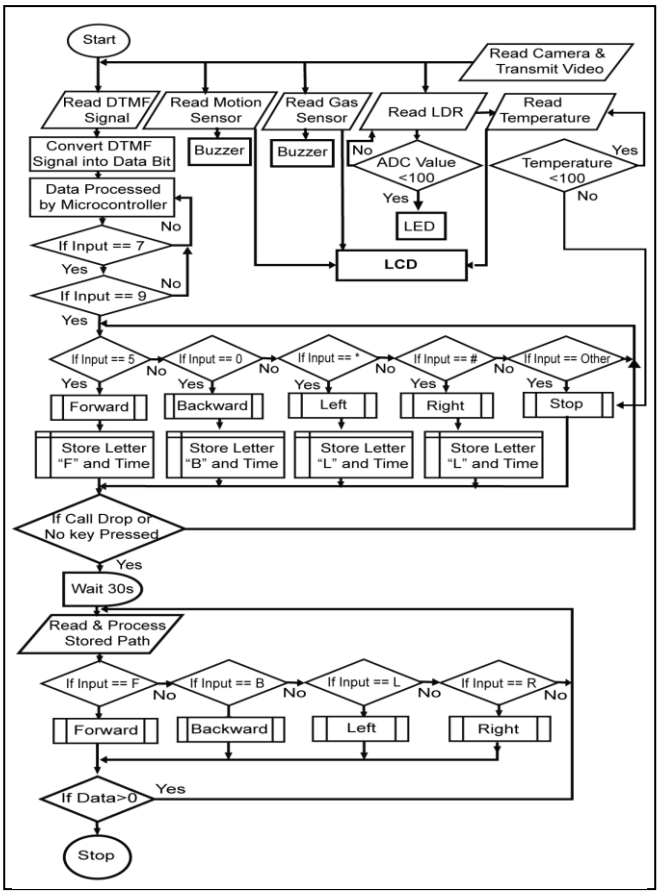

Fig. 1. Flowchart of the complete process

The processor dispatch all the commands to the embedded elements of it and it is the heart of the whole system. At the users end if any button is pressed, a tone resembling to the button is heard at the other end and the phone is stacked at the system by headphone jack. The robot perceives this DTMF tone and generate equivalent binary code with the help of DTMF decoder and then fed to MCU.

The preprogrammed MCU checks for correct password to give access to user about the movement of robot according to pressed key. PIR sensor activates buzzer and displays information when they find any moving objects. Flush light will be activated only at dark situation for proper video output and reducing power consumption. Thus, the sensors will be activated when it finds its desired things for which it has been used. The whole process is shown within a flowchart in Fig 1.

III. HARDWARE DESIGN AND DESCRIPTION

The robot shown in Fig. 2 contains mobile unit along with the DTMF decoder to contol the motion and camare powered by solar panel and the storage system.

Fig. 2. Explorer Robot

a) Mobile Units: This unit will receive the commands from the another mobile if we have to operate this robot from remote place, and if we want to operate robot remotely then we will press keys on this unit and the corresponding signals will be passed on the DTMF decoder. A mobile is used to send DTMF tones to the other mobile attached with the robotwhichis used as receiver.

b) DTMF Decoder Unit: The tones which are generated at the time of dialing on the keypad of the phone could be used to represent individual digits, and a pair of separate tone is used for each digit. This unit receives DTMF signal from the attached mobile phone and then fed 4-bit binary code to MCU.

c) Camera Unit: Here a camera phone is mounted on the top of the robot for providing live video streaming by skype video call using internet connectivity or GSM network. Video streaming also could be established using IPwebcam software over wifi.

d) Motion Sensor: Motion sensor is a 3 pin IC. 5 volt is applied here. It gives digital output through pin 2. So pin 2 is attached with a buzzer. When it detects motion buzzer will be activated.

e) Flash Light & LDR: LDR is used with flash light. When there is no light resistance of LDR will be increased and flush light (LED) will be activated.

f) Solar power and energy storage unit: In this project, a 10-watt solar panel and 800 mAh 9-volt lipo battery are used. Under average sun condition, the battery is practically gets fully charged within around 2 hours with solar charge controller. The dimension of solar panel is 340*280*22mm and weight is 1.5 Kg.

IV. SOFTWARE

Required software for this project are mentioned below in brief.

Atmel Studio (formerly AVR Studio) is a free Visual Studio-based established integrated development environment (IDE) for application development of 8-bit and 32-bit microcontrollers of the AVR family and 32-bit microcontrollers of the ARM family from Atmel. Atmel Studio contains a GNU C/C++ compiler and an emulator which allows debugging the program without loading it into the microcontroller.

The Proteus software is used to simulate, creating electronic schematics and electronic prints for manufacturing printed circuit boards.

There is a basic serial terminal integrated on the eXtreme Burner AVR can be launched with the help of USBasp firmware to use the terminal. With the help of this burner the compiled program is loaded into MCU.

Skype app provides online text message, voice calls and video chat services. It has a build in auto call receiver option to accept incoming calls automatically which is necessary for this project.

An IP camera is a networked digital video camera and it is known as "network camera". It is most often used for IP surveillance. It transmits data over a Fast Ethernet link. IP Webcam is an Android app by which a mobile phone can be used as network camera which will help stream videos remotely that are captured real-time and can be viewed by browser.

V. OPERATION OF THE SYSTEM

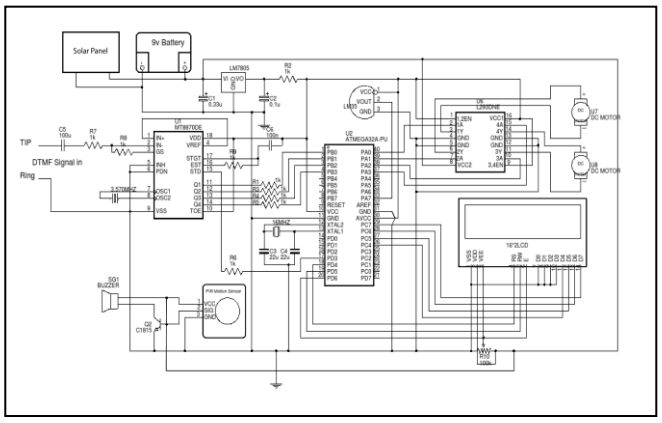

Fig. 3. Schematic diagram of the complete system

The receiver mobile is connected to DTMF decoder with a headphone jack. After getting the analog signal from mobile the decoder generate binary digit corresponding to it. The output of the decoder is fed to MCU's input port. MCU check the first conditional key press which is assigned for the password. If its password is matched then MCU takes the controlling signal otherwise it will continue checking for the password. At the same time, a video call will be established and automatically received and the robot transmits the video signal to the receiver. In the meantime, it reads motion sensor, LDR's value. If motion sensor detects any motion it activates the buzzer and shows it to the LCD. If LDR gives the ADC reading smaller than 80 it activates the flash light.

After passing password protection it goes for controlling key. If 5 is pressed it goes to forward direction and therefore 0 for backward, * for left, # for the right direction. A letter "F" is stored within an array for forward movement, "B" for backward, "L" for left and "R" for right movement for further use and this will be continued until it found no interrupt request for reading its stored value in the array. If the timer's time (30s) is expired before pressing another key then timer sends interrupt request to MCU to stop continuous operation and MCU starts its predefined task. The robot turns 360 degrees and MCU stops receiving signal from decoder until it finishes its predefined task. MCU checks stored array letter. If the checked letter is "F" robot moves to the forward direction, if letter is "b" it moves to backward direction, if letter is "L" it moves to right direction, if letter is "R" it moves to left direction, if letter is "B" it moves to back and "F" for the forward direction. It is continued until the stored data is null, i.e.: until it reaches starting position.

Some most important applications are briefly described below.

a) Animal diversity & Forest conservation: A lot of animals are on the brink of becoming elided. It can help us to observe and to take decision for preventing further destruction of the forest resources. It also helps us to conserve biodiversity.

b) Nuclear Power Plant: Mobile robots can be used to reach inaccessible areas. such as nuclear power plants. It can be used in nuclear power plants where the environment is highly radiative, especially at the time of disaster or threat of disaster.

c) Law Enforcement and spying: It can be used as a spy to collect information from a secrete area. Nowadays remote control robots are being used in law enforcement and military engagements.

d) Search and Rescue: These type of robots will likely play an extended role in rescue and exploration in the world. Many developed, as well as some developing nations, are thinking about the use of Unmanned Aerial Vehicles (UAVs) in case of natural disasters & emergencies. This could be a great asset for saving the lives of people along with soldiers in the war. Using this advanced methodsusing these advanced methods The loss of military personnel can be largely reduced.

VI. RESULT

The explorer robot which is designed in this project is a prototype model as shown in Fig. 2. It demonstrates the activities of a robot with the help of some sensors and two mobiles, used as the receiver and transmitter. After dialing a phone call and skype call both are received correctly and robot started to transmit video. By pressing the number on the dial pad of a cell phone, the robot could be moved in various directions. It is made possible with the help of DTMF receiver. The connection of receiver phone is established to the IC MT8870. The Atmega 32 microcontroller acts as processing unit. Mainly the microcontroller is interfaced with DTMF decoder, sensors, and the motor driver circuit for controlling, perceiving and driving the motors of the robot. The controlling mechanism of the robot was implemented successfully. The system

executed all commands, following tables describes results of system implementation.

TABLE I. " EXPERIMENTAL RESULTS AND COMMANDS OF IMPLEMENTED SYSTEM

Pressed Key	Command	Result
67	Password	Password Accepted
5	Forward	Moved to forward
0	Backward	Moved to backward
*	Left	Turned left
#	Right	Turned right
Any key	Stop	Robot stopped

When MCU detected that no key had been pressed for 30 seconds an interrupt request was made and the retrace mode had been activated. After retracing stored path it reached its destination from which point it started the run.

Here a PIR motion detection sensor is used to detect motion. If any motion is detected it is assumed that the logic state is 1 otherwise 0. The total summary of detection of motion is shown in a table below.

TABLE II. " OUTPUT OF MOTION DETECTOR

Motion	Logic State	Result
Not detected	0	Buzzer is Inactive
Detected	1	Buzzer is Active

The flush light is activated by LDR at low light to get proper video otherwise it remains quenched to reduce power consumption. Solar panel gives proper output and charger charges the battery properly.

All the equipment was worked correctly and gave correct information.

VII. CONCLUSION

This paper described the execution and design of an explorer robot using the DTMF encoding scheme as a method for controlling purpose. We can control the robot from any location of the world with the help of this technology. The mobile phone that makes a call to mobile phone attached to the robot functions as a remote. This control method uses commercial mobile communication networks as the system of data transmission. Hence this project does not require to the design any receiver and transmitter units. The system uses 3G mobile communication network for video and control but 2G can be used for controlling. To avoid unauthorized control password is required at first. In case of losing control for network failure the Robot will reaches to its starting point and thus it is protected from losing. The solar panel mounted on it provides uninterrupted power supply when the robot works at outside and besides it, power is stored into a battery for later use. It also could be tracked on map from anywhere as it will be logged in google. This explorer robot includes advantages such as robust control, cost-efficient, user-friendly, lower interference and a wide working range. The car requires six commands for controlling the movements. The remaining ten controls are available for other controlling modes depending on the area of application of the explorer robot. In these days, mobile service is being used by everyone. This system will be very useful in remote areas and the device control can be applied in many fields like agriculture, home, factories military use, spying, exploration, scientific use, research, law enforcement etc.

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