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Tele Reconnaissance and Surveillance Rover

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Abstract

This paper describes the proposed Tele Reconnaissance And Surveillance [TRAS] ROVER which enables the person/personnel to monitor and acquire data of the environment. Here monitoring is done using 3G module that streams the live video of the environment to the users mobile phone using 3G technology, the geographical position of the field using GPS, it is also enabled with sound and obstacle sensor and the person /personnel can control the TRAS rover using GSM controller. To implement these features we make use of 3G-324 protocol technology, GPS (Global Positioning System) tracker, microphones and IR sensors which will be controlled using Microcontroller through a programming language. All the above information is accessed by person/personnel using a mobile phone through which he/she can view the location. Authentication of the person/personnel is performed in the micro controller using GSM (Global System for Mobile communication) data.

Keywords— Video streaming, 3G-324 protocol, GPS tracker, microphone, IR sensors, GSM controller and microcontroller

I. INTRODUCTION

Remote surveillance systems are the most demanded systems to secure the belongings and premises of individuals and entities alike. It basically enables the user to check for activities on the remote site by having closed-circuit TV (CCTV) camera(s) to be attached to the conventional security room

where display monitors are usually monitored. The proposed system, attempts to extend the user to reach the monitoring system from anywhere. The proposed model is designed in a laboratory environment.

In the literature survey, [1] the authors proposed a system regarding the video surveillance. They described a multi-level mobile video surveillance notification system that provides access to the monitoring system from anywhere there is a mobile handset with wireless connectivity. The system automatically identifies motion abnormalities and the output is recorded in a lightweight animated GIF file. The output file can be sent to the user using MMS or stored on the server and accessed via a URL that is exchanged to the user via SMS. The system is fully configurable from the user handset application, making it suitable for various surveillance environments. But it is lagging in following aspects such as, it does not have continuous video monitoring, lack of memory to store and send the data and it uses GIF. Format animated frames, so it has very less accuracy of surveillance. In [2] they reveal that, in order to improve the effect of video monitoring and decrease the rate of false alarm, an intelligent video monitoring system is designed based on 3G telecommunication technology and face recognition. This intelligent video monitoring system has multifold functions: long-distance video monitoring, automatic multistage alarming and long-distance backup. Some disadvantages which I noted in this paper are they use 3G only to transmit the alarm signals and the face image is sent through internet/3G, no live video streaming in distance monitoring. In [3] they say that the requirements of some intelligent vehicle monitoring system need the software integration of Global Position System (GPS), Geographic Information System (GIS) and Global System for Mobile communications (GSM) in the whole. The advantages of this model is that it helps us to know the exact position of vehicle whenever we want, and we can also monitor the places traversed by the respective vehicle. It is a very important in case of autonomous surveillance robot. In [4] they have designed a GSM remote controller where the instructions are sent using SMS, where there arises the problem of delay. Here we make use of DTMF tone as the control signal for GSM remote control, which rectifies the delay as in [4]. In [5] the robot is equipped with two microphones for sound detection which is an essential module for an autonomous robot. Here it is

not possible for 360 degree surveillance and also we cannot separate the required sound from the environment. In the TRAS rover we have used a 3D array of microphones for 360 degree surveillance which are connected to a low pass filter.

The Section II of the paper deals with the components that make up the sensor mote, Section III discusses the architecture that has been proposed, Section IV describes the Data aggregation techniques employed, and Section V discusses how the fault tolerant characteristics achieved in the proposed architecture in detail. The results are discussed in Section VI of the paper.

II. T.R.A.S ROVER ARCHITECTURE

The proposed TRAS rover, shown in figure 1 is comprised of four major building blocks of Live Video Streaming using 3G-324 protocol, GPS tracking through periodic SMS, Sound and Obstacle sensing and User control using DTMF GSM controller.

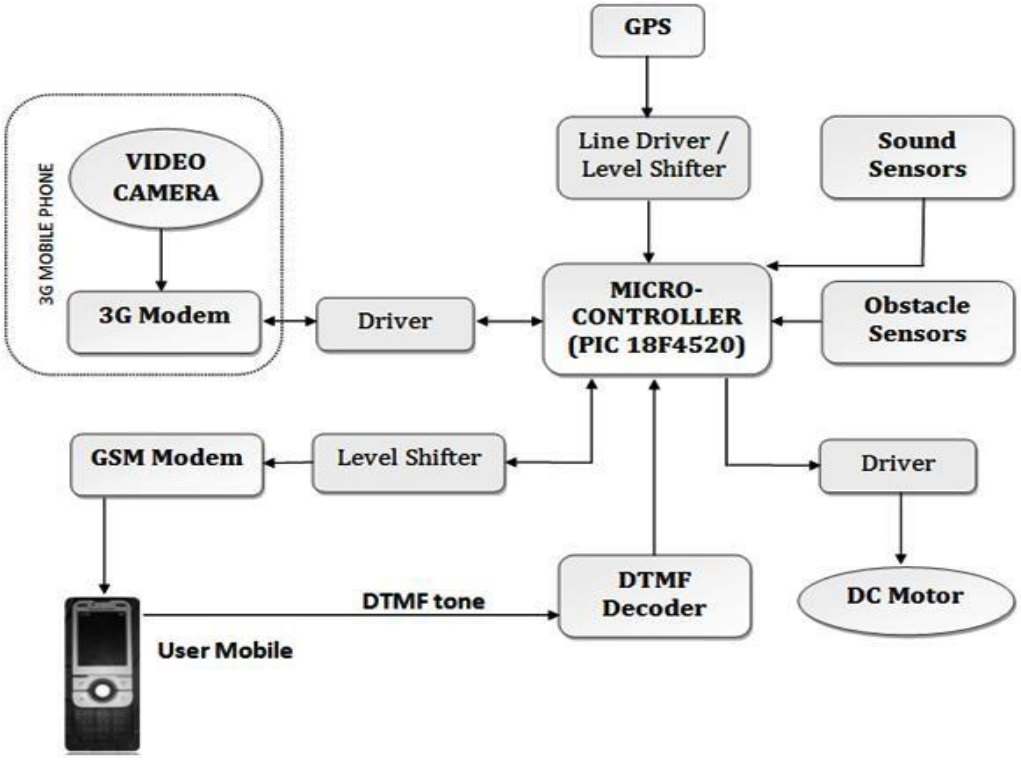

Fig 1 Block Diagram of TRAS rover

A. Live Video Streaming using 3G-324 protocol

Here instead of using a video interfacing with a 3G modem, we are making use of a 3G mobile phone because of non-availability of the modem in India. The video surveillance is made by enabling a video call from the authenticated person/personnel to the monitoring system module. The video call will be enabled only if it is from the authenticated person/personnel. This authentication is performed by checking the incoming video call to the module. We make use of the microcontroller which is programmed to check the SIM number of the incoming call with that of the authenticated SIM number.

B. GPS tracking using periodic SMS

Here a GPS tracker is interfaced with the microcontroller. When the GPS tracker, is detected by four of the GPS satellite signals the tracker will start sending the GPS signals in NMEA (National Marine Electronics Association), which will have lots of junk data, but for us latitude and longitude data alone is sufficient. In order to extract the required data from the received NMEA GPS data, it is feed into the microcontroller which is programmed to extract the latitude and longitude alone from it. This extracted GPS data is given as the input to the 2G modem for every 40 seconds which transmits the data as SMS to the authenticated person's/personnel's mobile.

C. Sound and Obstacle tracking

Target localization is one of the most important aspects for the surveillance rover navigation. To resolve the above problem of target localization, the proposed model uses the "Sound source" to locate the target. It uses sound sensors (Microphone) to locate the direction from where the sound comes, because sound is Omni-directional and can be detected even in dark scenario. The TRAS rover has three microphones which are placed in a 3D triangular position to detect sound from 360 degree. Based on the detection of the sound from the sensors the rover will be guided towards the sound source.

Being operated in autonomous mode too, it also uses Obstacle avoidance sensor (IR sensor) to avoid the obstacles in the path. Rover is attached with two IR sensors in front face of the rover. If any obstacle is sensed by the sensor the rover will move away from the obstacle and continue its assigned operation.

D. User Control using DTMF-GSM controller

DTMF is a generic communication term for touch tone (a Registered Trademark of AT&T). The tones produced when dialling on the keypad on the phone could be used to represent the digits, and a separate tone is used for each digit. However, there is always a chance that a random sound will be on the same frequency which will trip up the system. It was suggested that if two tones were used to represent a digit, the likelihood of a false signal occurring is ruled out. This is the basis of using dual tone in DTMF communication. Separate functions are assigned to each key on the key pad of the user mobile. Using this, the user can switch the rover from autonomous mode to user mode or vice-versa.

III. MODULES DEVELOPED FOR TRAS ROVER

A. Developed GSM module

The GSM module used to control the video monitoring and extraction of the GPS data for periodic SMS is shown in figure2.

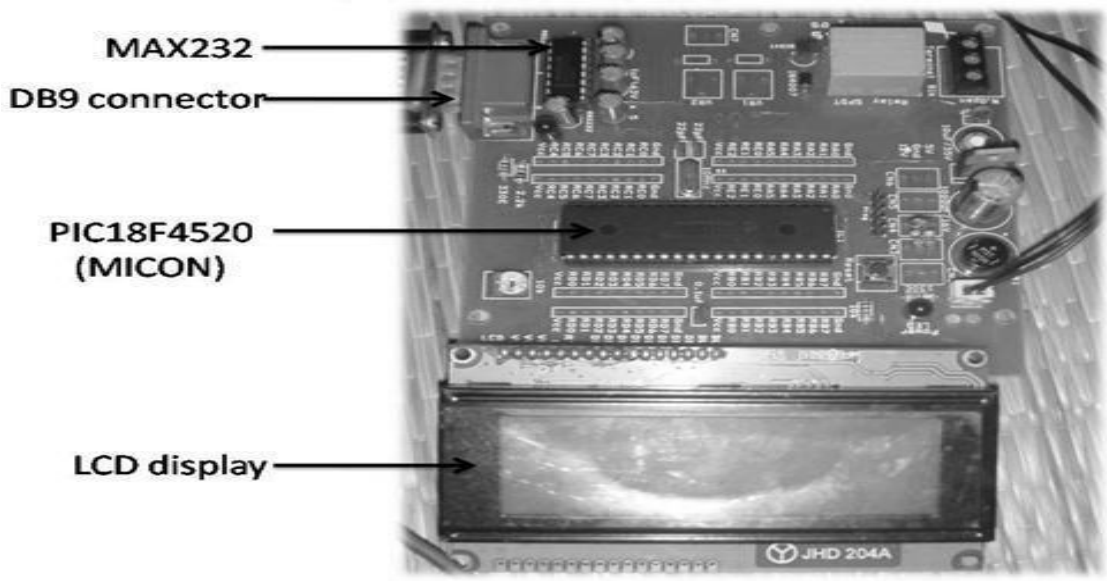

Fig2. GSM controlling module

B. Module for 3G Live Video Streaming

The module consists of 3G mobile phone connected to a laptop in order to enable a serial communication between mobile phone and microcontroller through a data cable. The microcontroller is programmed using assembly language to perform the function of authentication of the user and enabling the video calling procedure in the module. The developed module is shown in the figure 3.

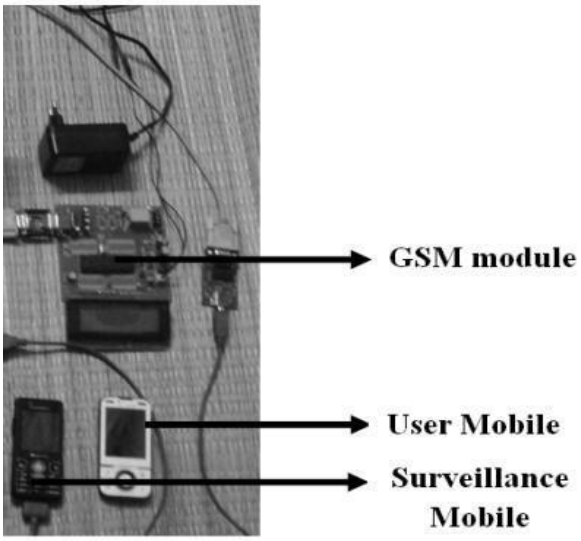

Fig.3 Video monitoring system

C. Developed GPS tracking through periodic SMS

The system employs a GPS module to know the exact position of the robot in the globe. As the robot is also controlled by a mobile phone at the user end, it uses GSM modem to send the GPS data in the format of Short Message Service (SMS). The GPS module will send data continuously to the microcontroller in NMEA format, and then the microcontroller is programmed in assembly language to extract the required data such as latitude and longitude from entire GPS data and send it to GSM modem which will send SMS in a periodic manner. The developed module is shown in figure 4.

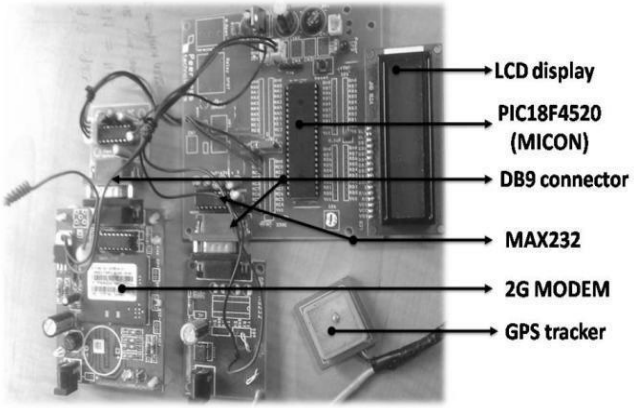

Fig. 4 GPS tracker with periodic SMS

D. Developed Module for sound and obstacle sensing

The Rover will be switched into autonomous mode, when the user is in need of any target localization. Once the rover is switched to autonomous mode by the user it starts sensing the target with respect to sound, with the help of the three microphones placed on the front, right and left sides of the

rover. And during this process it is assisted with IR sensors to avoid obstacles. These sensing activities will be monitored using live video streaming by the user. All these sensors are controlled using a PIC microcontroller which is shown below in figure 5.

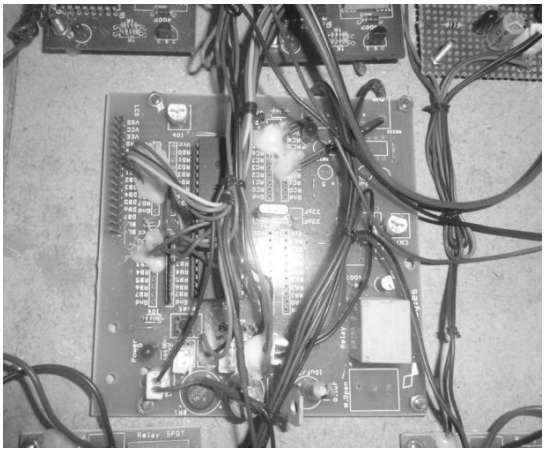

Fig. 5 PIC microcontroller circuit for autonomous mode

Once the sound arises in the environment, the sound will be detected in all three microphones. But among the three microphones, the microphone which is closer to the sound source will detect it first. To check which of the microphones detects the sound first, all the three microphones are connected to the three interrupt pins of the microcontroller respectively. The electric signal from the entire microphones will be reaching the microcontroller, but the signal which reaches first will be only taken in as the input signal by the microcontroller. Thus the microcontroller is programmed to detect the direction from which the sound is raised and it will guide the rover to move in the respective direction of the sound. The microphone connected filter circuit is shown in figure 6.

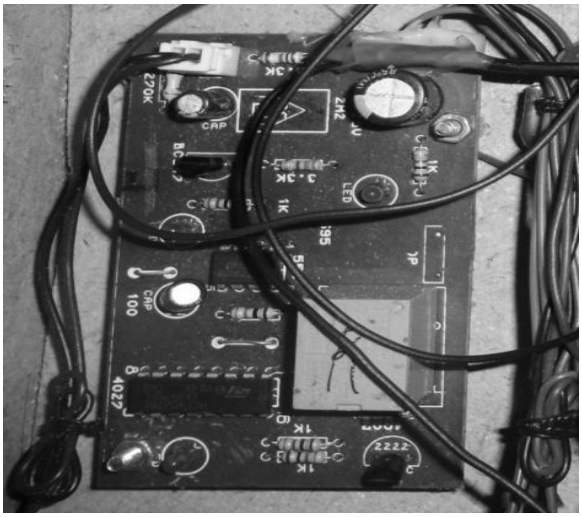

Fig. 6 Microphone connected filter circuit

The rover is equipped with two Infra Red (IR) sensors to detect the obstacle on the path of navigation. The sensors are placed in such a way that it can sense obstacle to the right, left and front sides of the rover. The sensors detect any obstacle by means of sending change in voltage level to the microcontroller through the phototransistor installed in the rover, which will receive the reflected IR light from the obstacle ahead of the sensors. The microcontroller is

programmed in such a way that it avoids the obstacle on its way and moves in the navigation path. The sensor circuit for obstacle sensing is shown in the figure 7.

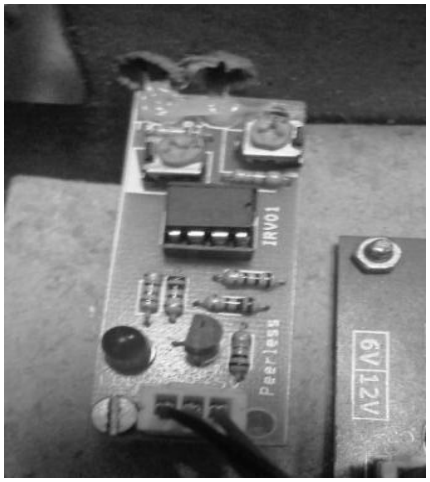

Fig 7 Obstacle Sensor (IR Sensor)

E. Manual Override

In user control mode or manual override mode the rover will be controlled using DTMF controller which is nothing but the user mobile phone. We choose DTMF because it is prominent among all GSM controllers. Once the user presses the key which he wants the rover to do, the tone is sent from user mobile phone to the rover. In rover the tone is received and sent to the DTMF decoder which performs the decoding of the received tone and find the respective key pressed by the user. This recognized key signal is sent to the microcontroller which is programmed to do the respective function assigned to the key pressed by the user.

IV. PERFORMANCE EVALUATION AND DISCUSSION

A. Live Video Streaming using 3G

The developed monitoring system performs the function of authentication of the user which makes the person to take the control of the robot. The following figure 8.1, figure8.2 and figure 8.3 shows the call acceptance, call rejection and a snapshot of the video monitoring.

Fig 8.1 LCD display - Call Acceptance

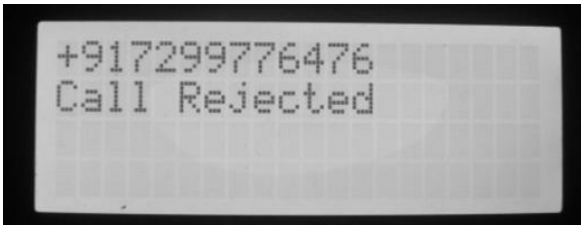

Fig 8.2 LCD display - Call Rejection

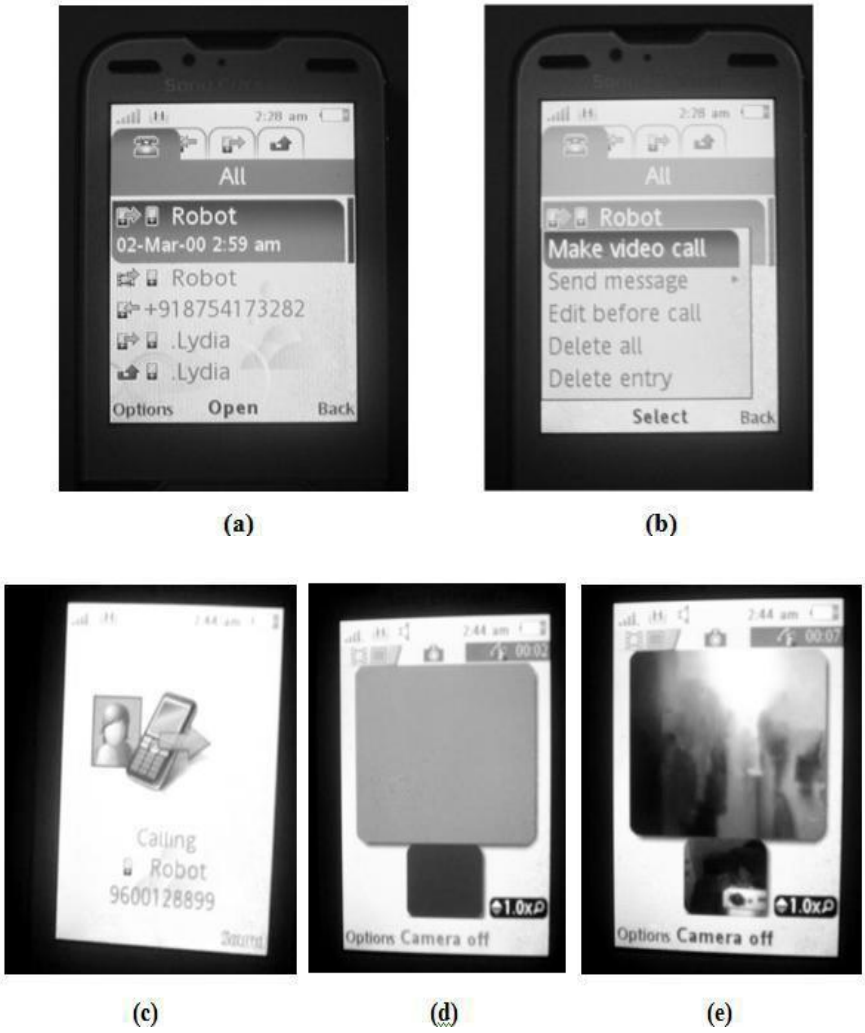

Fig 8.3 Execution of video monitoring

B. GPS data through periodic SMS

The system makes use of a GPS tracking module to detect the GPS signals from the satellites once it detects, it starts sending the GPS data in NMEA format i.e it has all the data having latitude, longitude, date, time, satellite identity numbers, orbital length etc., but to track the robot it needs only latitude and longitude data alone. So the entire GPS data is feed into the microcontroller which extracts the required data from the entire GPS data. After extraction of the required data it is sent to GSM modem which will convert the TTL logic to text format and send it as Short Service Message for every minute. The required GPS data detected by the module and its SMS is shown in figure 9.1 and figure 9.2 respectively.

Fig 9.1 Extracted GPS data

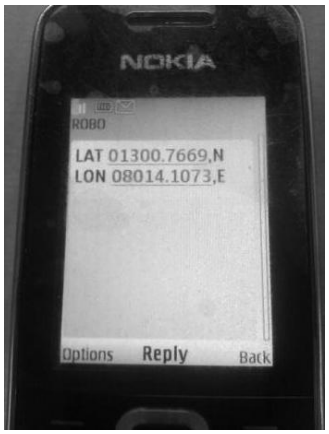

Fig 9.2 Extracted GPS data as SMS

C. Sound tracking

In autonomous mode, if any sound or audio pulse arises in any direction with respect to the microphone direction it will be sensed by the microphones and the detected sound signal will be sent as an electric pulse to the interrupt pin of the PIC microcontroller through the sensor circuit board in which the microphone is placed. Then the microcontroller will perform will check which microphone has detected the sound pulse first and accordingly sends instruction to the DC motor to make the rover to move in the respective direction of the sound arrival. The detection of sound direction and the response by the rover are shown as snapshots in figure 10 below.

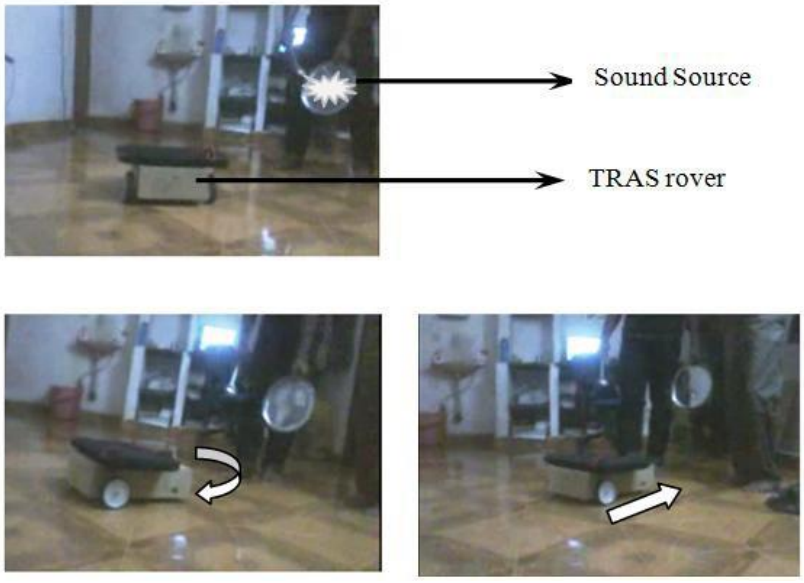

Fig 10 Sound sensing by TRAS rover

D.Obstacle tracking

Obstacle on the path of navigation will be detected by the change in the voltage level of the input voltage from the phototransistor given to the microcontroller. The obstacle avoidance by TRAS rover is shown as snapshots in figure 11 below.

E. Manual Override

Among the GSM remote controller we choose DTMF controller as it is prominent among all GSM controllers. These decoder outputs are given as input to the microcontroller as inputs which will perform the further operation.

Here we are making use of only seven keys for controlling the rover namely 2, 4, 5, 6, 8, 0 and # their respective functions are shown in table 1.1 below.

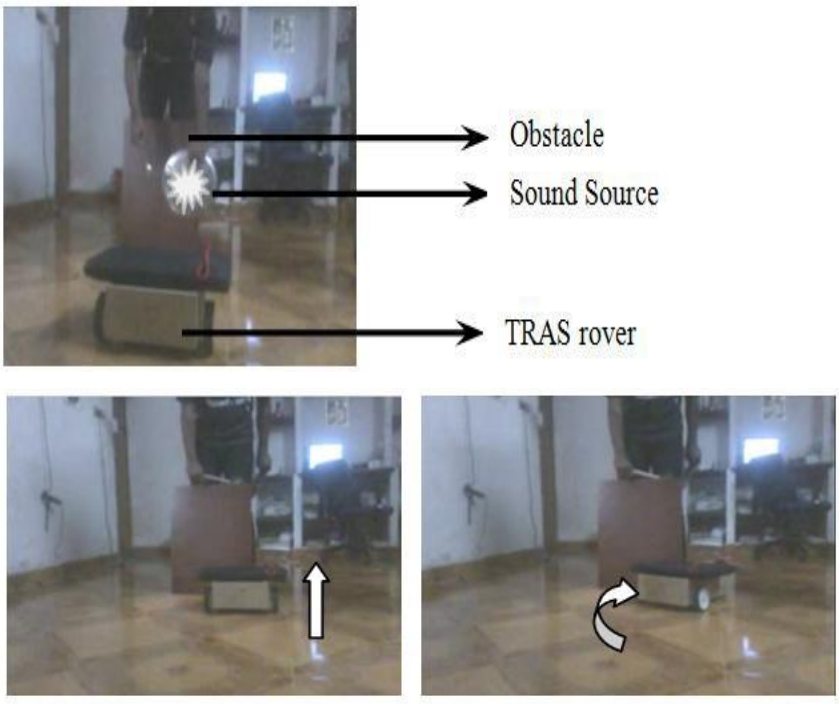

Fig 11 Obstacle sensing by TRAS rover

Table 1.1 Unique functions for each keys

Actions Performed Based on the Key Pressed			
Number Pressed By User	**Output Of DTMF Decoder (CM8810P1)**	**Input to the MICON (PIC 18F4520)**	**Functions Performed**
2	0010	1101	Forward Motion
4	0100	1011	Right Turn
6	0110	1001	Left Turn
8	1000	0111	Backward Motion
5	0101	1010	Stop
#	1100	0011	To User Control
0	0000	1111	Autonomous Mode
Other keys	-	-	No Function

V. CONCLUSION

The work done so far depicts the benefits of integrating a 3G module in a surveillance rover, thereby enabling live video streaming of data. This proves to be highly advantageous when the surveillance details are needed without delay. In order to improve the merits of the surveillance robot, it has other necessary functionalities such as, sound sensing, obstacle sensing and avoidance and GSM remote control using DTMF tone from mobile phone in the subsequent phase. Tracking of the surveillance robot is made simple by integrating GPS tracker in it. The mobile phone used for video surveillance also maintains a track of its whereabouts. This is achieved through the aid of the messages sent by the GSM modem.

FUTURE WORK

The prototype model of TRAS rover is built in a laboratory view, so there is an existence of a GSM operator between the user and rover. A satellite modem and satellite mobile phone is to be employed instead of

GSM modem and GSM mobile phone to have a secure data transmission. Hence in future the TRAS rover will be designed using satellite modem and satellite mobile phones.

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