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SMS Controlled Unmanned Ground Vehicle

Tanmoy Biswas[1*], Arup Kr. Goswami[2], Manas Pal[3], Saptarshi Naskar[4]

[1]Department of Computer Science, Syamaprasad College affiliated to University of Calcutta, West Bengal, India.
[2] A. K. Choudhury School of Information Technology, University of Calcutta, M.Tech in CEA, West Bengal, India.
[3]Department of Electronics, Netaji Mahavidyalaya, affiliated to University of Burdwan, West Bengal, India.
[4]Department of Computer Science, Sarsuna College, affiliated to University of Calcutta, Kolkata, West Bengal, India.

[*]*Corresponding Author: tanmoybiswas.ece@gmail.com, Mobile: +919062032387*

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***Abstract*—** An unmanned ground vehicle (UGV) is a vehicle that operates on the ground without an onboard human presence. UGVs can be used for many applications where it may be extremely dangerous, impossible, inconvenient, and unreachable by human operators. The UGV is equipped with a set of sensors to monitor the environment, and then it can take an autonomous decision or pass the sensory information to a human operator at a different location who will control the vehicle through wireless or wired communication channel. Study and implementation of various controlling techniques for Unmanned Ground Vehicle are our primary objective. Most of the techniques presently under use are extremely complex and costly as they require high bandwidth communication channel and complex hardware. We have used Short Messaging Service (SMS) to control the UGV, which eliminates the use of high bandwidth channels, costly mobile devices and internet or data connection network. The UGV will be continuously under the supervisory control of an operator till it is under the area covered by the GSM/GPRS mobile network. SMS would be sent through the mobile phone to the UGV housing a GSM module and an Arduino UNO. The SMS will be decoded and a set of signals corresponding to those SMS will be generated and sent to the controlling circuit of the vehicle. Entire experiment was carried out using Arduino UNO, GSM module SIM900A, Motor control driver unit based on L293D, geared DC motors, Aluminium based vehicle chassis, 9V DC batteries and a valid SIM card with enabled SMS facility.

***Keywords*—** SMS, GSM Module SIM 900A, Arduino Uno, Mobile phone, Near far communication (NFC).

I. INTRODUCTION

In recent years wireless (Mobile) technology has reached new heights and high speed data communication is a reality today. Mobile phones are not restricted to voice calling only, it is now equipped with wireless connectivity, and Bluetooth which are used for near field communication (NFC). USB connectivity is used for sharing stored files between the mobile phone and other computing devices. Inbuilt camera is used to transmit live images over social networking sites and is also used to capture stills and videos which can then be stored in the mobile phone internal storage. The inclusion of GPS in mobile phones also helps in navigation. But, apart from the usual way of using mobile phones, it can also be used to control different electronic equipments. Raul Ionel Gabriel Vasiu, Septimiu Mischie used GPRS based data acquisition and analysis system with mobile phone control system [1]. In recent years, several efficient methods are being introduced to control remotely located devices using smart mobile phones. Erdal Bekiroglua, Nihat Daldalb showed an efficient way of controlling an ultrasonic motor using a GSM mobile phone [2]. Study of Sensors is an important part in robotic science. Traditional methods to control any dynamic system require the knowledge and model of the system that has to be controlled. Automated guidance, navigation, and control of mobile platforms are key problem for any intelligent unmanned vehicle application. Hassan K. Sawalmeh, Haitham E. Bjanthala, Mustafa M. Al-Lahham, Belal H. Sababha used Microsoft 3D camera called Kinect and 3D tracking to control a robotic arm fitted on an unmanned ground vehicle without using conventional wireless RC joystick. A human arm movement is detected by the robot and the arm of the robot replicates the action performed by the operator [3]. A mobile robot has been an attractive subject in robotic research areas. This is mainly due to its ability to move around in difficult locations and terrains where human exploration is a big challenge or sometimes impossible. Autonomous navigation and control is again one of the major issues in the research areas of mobile robots. An accurate model is crucial for successful implementation of a robot controlling algorithm. Without algorithms and the software's for its implementation, a robot is a collection of mechanical parts, sensors and actuators with

no purpose to serve. Control programs tie these components together into an integrated system with high flexibility to perform different tasks. Several techniques have been investigated to control robots and unmanned ground vehicles. But the techniques often required complex hardware and high bandwidth communication channels. Our primary objective was to use an inexpensive device and a very simple method for controlling the UGV. Our paper presents a new and practical method to control UGV. The vehicle can be easily controlled if the mobile network is available in that area. The cost of our proposed technology is relatively low and is less complex. The section after introduction deals with a brief review of the earlier works carried out in similar fields. In the methodology section an outline of the work along with schematic diagrams, exploded views, block diagrams and implemented algorithm has been briefly explained. The concluding and result section highlights the output of the modules and practical utility of the proposed method.

II. RELATED WORK

Most of the research articles showed the various algorithms to control the AGV. But controlling AGV from remote locations using mobile networks is very limited. Several AI techniques were undertaken for controlling Autonomous ground vehicles. Keirsey, D., Mitchell, J., Bullock, B., Nussmeir, T., Tseng, D.Y applied different artificial intelligence techniques and algorithms for controlling AGV [4]. Tanmoy Biswas, Debasish Roy, Saptarshi Naskar showed that DTMF technique can also be used to control a Land Rover with cell phones [5]. The proposal of self organizing fuzzy logic algorithm (SOC) by B.A.M. Wakileh, K.F. Gill significantly improved the synchronous dynamic motions of robotic manipulators and hence the adaptive control approach is worthy of consideration for use in robotics [6]. Alexander A S Gunawan et al, designed a smart phone based control system for swarm mobile robots [7]. Two smart phones were used to create a link using NFC and then controlling signals were sent to the circuits in the mobile swarm robots. For motor control IOIO boards were used along with dual motor driver TB6612FNG. The communication between the two smart phones was done using IP address. The main disadvantage of such as system is the restriction offered by the mobile devices with regards to the NFC communication range. Ru Nie demonstrated the use of Bluetooth as a medium of controlling a mobile car [8]. Again the mobile car can be controlled only in the limited wireless range set by the Bluetooth device of mobile phone. We have offered a very simple and cost effective technique to the problem keeping in mind the restrictions offered by the various wireless devices used for controlling unmanned ground vehicle.

III. METHODOLOGY

Development of robotics depends on sensory hardware advancements & achievements in signal processing. Here we will discuss the basic design of our proposed work. We have used a GSM module SIM900A which is capable of receiving and sending calls and SMS. We have used the GSM module to access the mobile network. Arduino UNO is being used here with GSM module to accomplish the controlling strategy. Figure -1 shows the diagram of the communicating devices. We can control different types of vehicles with unique subscriber numbers using a simple mobile phone if the controlled devices are in the area covered by the GSM network.

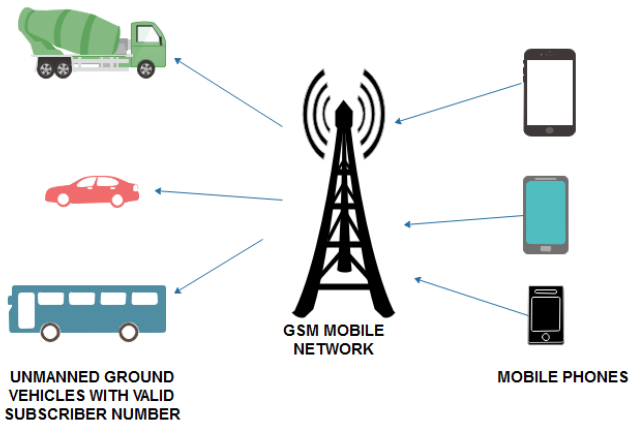

Figure-1, UGV and Mobile phone communication diagram.

Arduino UNO and the GSM module will communicate with each other using AT commands. Therefore, when an SMS is sent to the vehicle from a remote location using an ordinary mobile phone, the GSM module receives it and pass the information to Arduino UNO, which will decode the SMS. The UGV will be guided depending on the decoded SMS. The devices under consideration are to be programmed and connected properly. The Arduino UNO is a microcontroller board based on the Microchip ATmega328P. It was originally a research project initiated by by Massimo Banzi, David Cuartielles, Tom Igoe, Gianluca Martino, and David Mellis at the Interaction Design Institute of Ivrea in the early 2000s. The board is equipped with sets of digital and analog I/O pins that may be interfaced to various other expansion modules and custom made circuits. The module has 14 Digital pins, 6 Analog pins, 16 MHz quartz crystal, a USB connection, a power input terminal, an ICSP header, a reset button and it is programmable with the Arduino Integrated Development Environment (IDE) via a USB cable. The Arduino IDE is installed in the host computer and programming of the microcontroller can be achieved by transferring the codes through the USB cable. The USB cable itself can power the Arduino module, but it is always preferred to have a separate power source as current provided

by the host computer is very limited and if we connect expansion boards the current requirement will increase. We always try to derive the power from the external battery source, instead of relying on the current provided by the host computer. The board accepts voltages between 7 and 20 volts. It has similar features like Arduino Nano and Leonardo. "UNO" usually means one in Italian. It marks the release of the Arduino Software (IDE) version 1.0. The UNO board is among the first in series of USB Arduino modules. The ATmega328 on the Arduino UNO comes pre-programmed with a boot loader that allows uploading new code to it without the use of an external hardware programmer or burner. The layout of the Arduino UNO is shown in the figure 2.

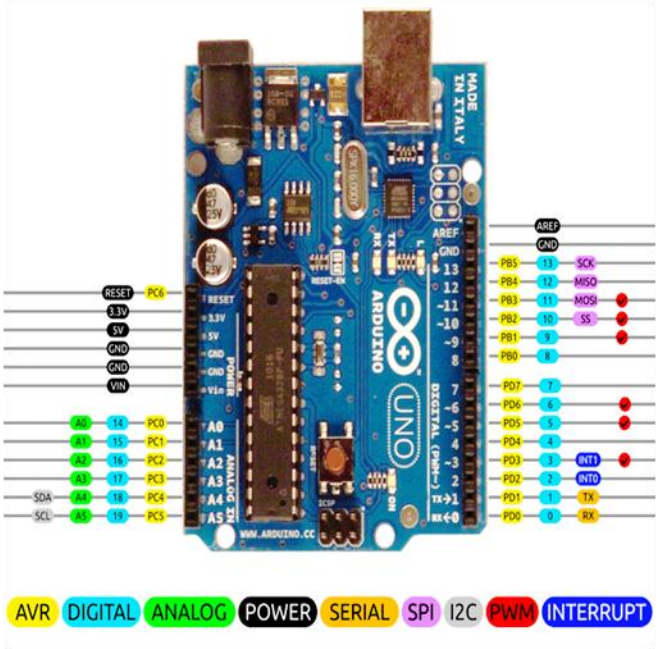

Figure 2, Layout of Arduino Uno using ATMEGA 328p.

The Arduino UNO has a number of facilities for communicating with a computer, another Arduino board, expansion boards or other microcontrollers. The ATmega328 provides universal asynchronous receiver-transmitter (UART), TTL serial communication, which is available on digital pins 0 (RX) and 1 (TX). An ATmega16U2 on the board channels this serial communication over USB and appears as a virtual communication (COM) port of the software on the host computer. The firmware of the system uses the standard USB COM drivers, and no external driver is needed. The Arduino Software (IDE) includes a serial monitor which allows simple textual data to be sent to and from the module/board. Light Emitting diodes (LED) flash when data is transmitted through the RX and TX pins. An inbuilt serial library allows serial communication on any of the UNO's digital pins. In our experiment the Arduino UNO was powered by a single DC 9 Volt battery. The power regulators are inbuilt and separate power output terminals are available which can be used to supply power to the other expansion modules installed on the UGV chassis. The master schematic diagram of Arduino UNO is shown in the figure 3.

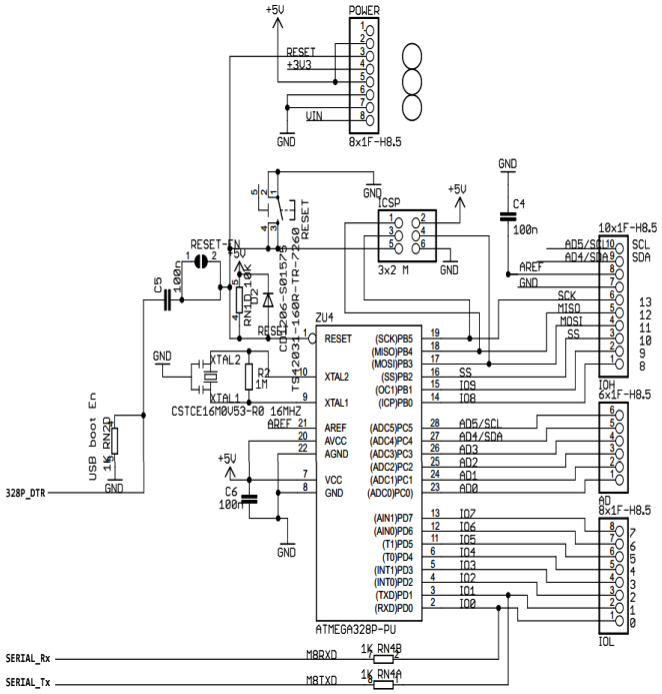

Figure 3, Master schematic of Arduino UNO.

The motor driver unit is constructed out of L293D.
The basic test circuit diagram of L293D motor driver, connected to the motors is shown in figure-4.

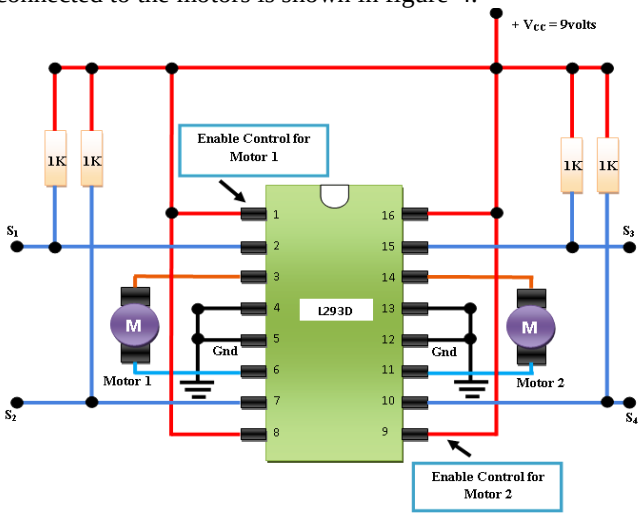

Figure 4, Motor driver circuit using L293D.

L293D Integrated Circuit (IC) is a quadruple high current half-H bridge driver. Basically used to drive inductive loads like stepper motors, DC motors and relays. It is capable of providing bi-directional current up to 1.0 amps. Supply voltage ranges from 4.5V to 36V. The outputs are totem-pole

type Darlington paired source and sink transistors. It can drive two DC motors independently. It receives TTL inputs for controlling the direction of rotation of the DC motors. Four input signals S_1, S_2, S_3, S_4 are shown in the basic test circuit of the motor driver circuit built around L293D in figure (4). Separate enable pins are provided for additional control of the motors. When the UGV is not in operation, the enable pins can be connected to low logic to disable L293D to reduce power consumption.

For connecting to the GSM network, we have used GSM/GPRS module SIM900A. It is compact and highly reliable wireless module and it can be fitted in any custom made equipment. It is a complete dual-band GSM/GPRS module. SIM900A delivers GSM/GPRS 900/1800MHz performance for voice, SMS, Data, and Fax in a small form factor and with low power consumption. It can be very easily interfaced with Arduino UNO and programmed using Arduino IDE. The schematic diagram of SIM900A has been shown in the figure 5. To establish communication with the GSM/GPRS module we need AT commands, abbreviation for Attention. AT commands are used to control MODEMs/GSM/GPRS modules. These commands are required for interaction with a computer. With the help of AT commands, the user can send or receive messages and make voice call. Apart from that AT commands with a GSM/GPRS MODEM or a mobile phone, can be used to access Information and configuration pertaining to mobile device/MODEM, SIM card, SMS, MMS, Fax services, data and voice link over mobile networks.

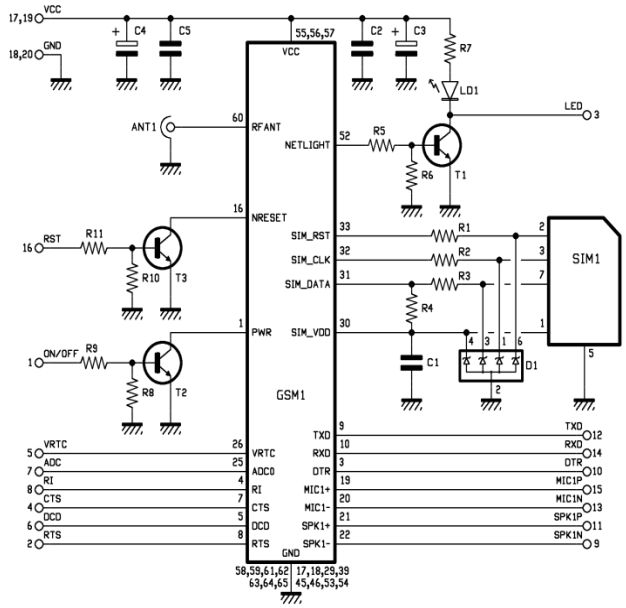

Figure 5, Schematic diagram of SIM900A.

The complete circuit and block diagram of the modules used in the UGV is shown in the figure 6.

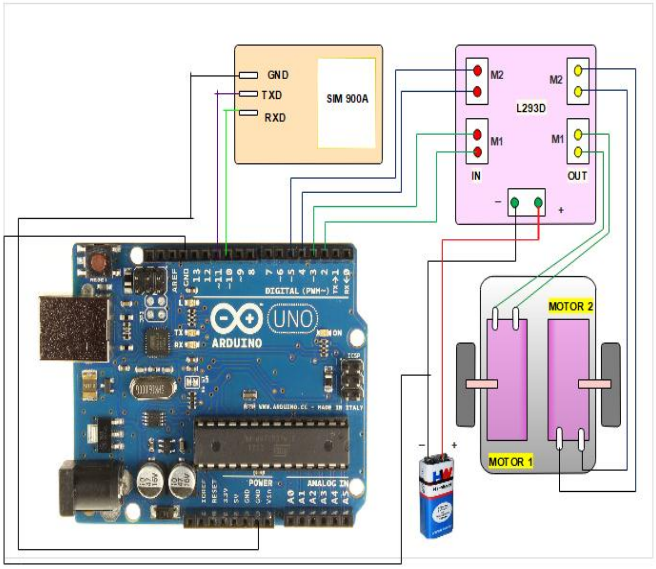

Figure 6, The complete block diagram of the system and control boards with power supply.

Basic algorithm of the procedure used for the entire experiment has been described in the following section.

The algorithm used in the proposed UGV.

Input: SMS received from remote location.
Output: Control the vehicle depending on received SMS.

Steps:

1. If SMS is received by GSM, then

1.1. Verify the received SMS,

1.1.a. If Country Code of sender is valid, then check sender cell number,

1.1.b. If cell number is valid, then check SMS,

1.1.c. If SMS string is valid, then execute the SMS command.

Else, give error indication.

(End If)

2. Clear SMS Buffer.

3. Repeat step 1-2.

4. Stop.

Flowchart of the entire process is shown in the figure 7.

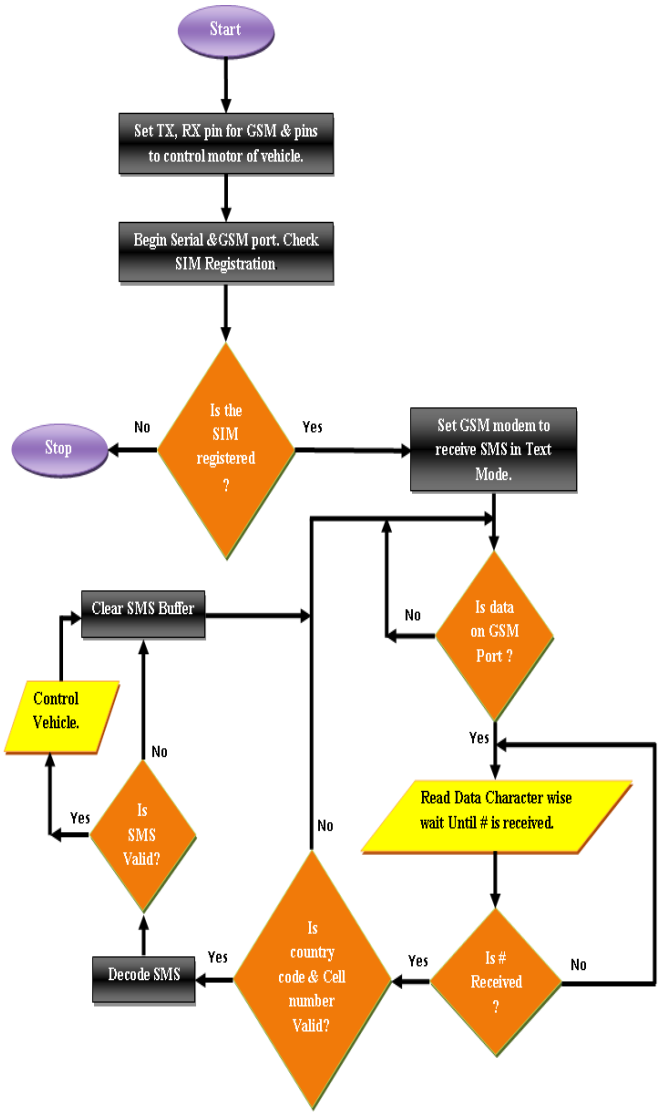

Figure 7, Flowchart showing the entire process.

The complete pseudo code related to the algorithm used to control the Unmanned Ground Vehicle (UGV) from any remote location via SMS is given in the following section.

Input: SMS Received from Remote Location.
Output: Control the Unmanned Ground Vehicle (UGV) depending on received SMS.

Steps:

1. Start.
2. Define Arduino Receiver & Transmitter pin to communicate with GSM – SIM900A.
3. Define Message = "" (in String format) & smsFlag = 1(in Integer format).

/*Run Once*/

4. Begin Serial port with baud rate 9600.
5. Begin GSM port with baud rate 9600.
6. Check SIM Registration,
   - 6.1. IF SIM is Registered, THEN
     - 6.1.1. Operate GSM modem in Text mode; set Message format to Text mode.
     - 6.1.2. Set Arduino pins for Motor Connection.
   - 6.2. ELSE
     - 6.2.1. RETURN

   (END IF)

/*Run Continuously*/

7. Check whether Data is present on GSM port or not.
   - 7.1. IF data is NOT present, THEN
     - 7.1.1. RETURN
   - 7.2. ELSE
     - 7.2.1. Read the data (present on GSM port) character wise.
     - 7.2.2. IF smsFlag =1
       - 7.2.2.1. IF '#' is received, THEN
         - 7.2.2.1.1. Call Function **ValidMsg**.
       - 7.2.2.2. ELSE
         - 7.2.2.2.1. Read data from GSM port character wise.

       (END IF)
     - 7.2.3. ELSE IF smsFlag = 0 AND Carriage Return is fed
       - 7.2.3.1. Call Function **ProcessGprsData** .
     - 7.2.4. ELSE
       - 7.2.4.1. Read data from GSM port character wise.

     (END IF)

   (END IF)
8. Stop.

/* Function **ValidMsg** is used to check whether received SMS is valid or not. */

Function **ValidMsg**

Input: Received SMS with all other strings are the input of the function.
Output: This function will take the decision whether received SMS is Valid or Not.

Steps:
1. Start.
2. Check whether Country code is valid or not in the received string. IF Valid (Valid if **+91**. Country: INDIA), THEN
   2.1. Check whether Cell number of Sender is Valid or not. IF Valid, THEN,
      2.1.1. Call Function **ProcessSms**.
   2.2. ELSE
      2.2.1. RETURN
      (END IF)
   (END IF)
3. Call Function **ClearGprsMsg**.
4. Stop.

/* Function **ClearGprsMsg** is used to clear SMS buffer. */

Function **ClearGprsMsg**

Input: SMS buffer with full of bytes, is the input of the function.
Output: Empty SMS buffer is the output.

Steps:
1. Start.
2. Clear the SMS buffer.
3. Stop.

/* Function **ProcessGprsData** is used to check whether the SMS starts with valid string or not. */

Function **ProcessGprsData**

Input: Received SMS string is the input of this function.
Output: Set the value of smsFlag to either 1 or 0.
Steps:
1. Start.
2. Check whether received string for AT commands is right or not. IF Right, THEN
   2.1. Call Function **ClearGprsMsg**.
3. ELSE IF **"+CMT"** is received
   3.1. Set smsFlag to 1.
   (END IF)
4. Stop.

/* Function **ProcessSms** is used to control the vehicle according to the received decoded Message */

Function **ProcessSms**

Input: Received SMS string is the input of this function.
Output: Control the vehicle according to the SMS command.

Steps:
1. Start.
2. Check whether Valid Command is Present in the SMS string or Not,
   2.1. IF Valid Command is found, THEN
      2.1.1. Control the vehicle accordingly.
   2.2. ELSE
      2.2.1. NO Effect.
   (END IF)
3. Stop.

IV. RESULTS AND DISCUSSION

We have successfully tested our proposed prototype of UGV. The image of the prototype of UGV is shown in figure 8.

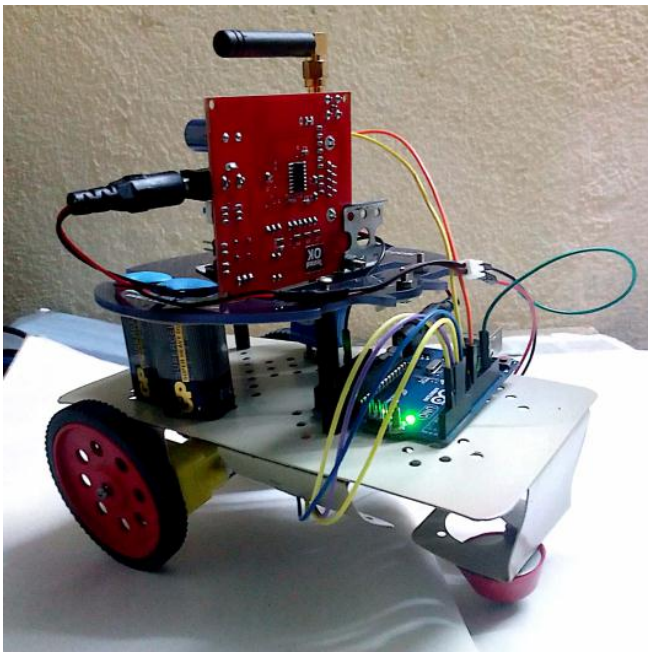

Figure 8, proposed prototype of UGV.

Arduino UNO sends some Digital signals via terminals 5, 4, 3, and 2 which are used to command the DC motors via motor driver L293D. The valid digital signals and corresponding actions of the DC motors are summarized in the table 1. The two DC motors M_1 and M_2 have inputs S_1, S_2, S_3 & S_4 respectively. Signals at S_1 and S_2 controls the rotation of the DC motor M_1. Similarly, signals at S_3 and S_4 controls the rotation of DC the motor M_2.

Table 1: Input and output of Motor driver Unit based on L293D.

Input and Output Digital Logic of Motor Driver Unit.						
Digital Inputs				DC Motor		Remarks
S_1	S_2	S_3	S_4	M_1	M_2	
0	0	0	0	OFF	OFF	Idle
0	1	0	0	ON	OFF	Motor1, rotation Anticlockwise
1	0	0	0	ON	OFF	Motor1, rotation Clockwise
0	0	0	1	OFF	ON	Motor2, rotation Anticlockwise
0	0	1	0	OFF	ON	Motor2, rotation Clockwise
1	1	1	1	-	-	Motor 1&2 are in Braked condition.

Table 2, summarizes the valid SMS commands which are sent from the mobile phone to the UGV.

Table 2: Valid SMS commands.

SMS	Purpose
Mb#	Move Backward
Mf#	Move Forward
Ml#	Move Left
Mr#	Move Right
St#	Stop

We can send command strings (SMS) of any length. There are different types of work that can be carried out by just providing or defining the SMS format in the controlling circuit of the UGV. Snapshot of sent SMS from mobile is shown in figure-9.

Figure-9, Screen shot of the SMS sent from the mobile.

The snapshot of the Arduino serial monitor showing the raw SMS string received by GSM/GPRS module is shown in figure 10.

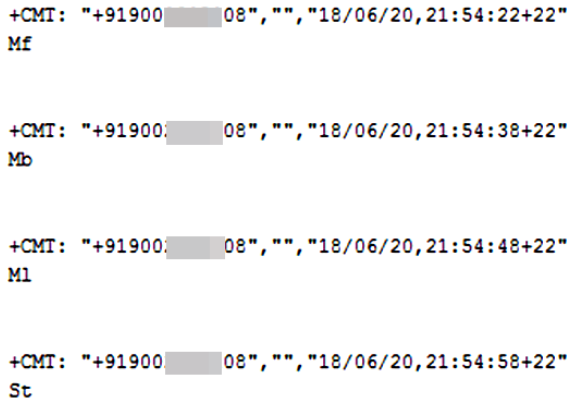

Figure 10, Screen shot of Arduino UNO serial monitor, raw SMS string, received by GSM/GPRS module.

Snapshot of the Arduino UNO serial monitor showing the SMS received by GSM/GPRS module SIM 900A is shown in Figure 11.

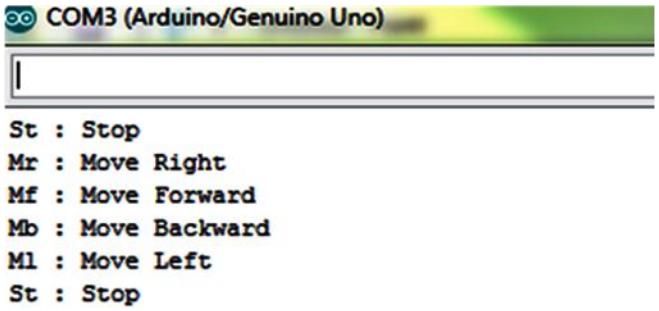

Figure 11, Screen shot of Arduino Uno serial monitor.

The main advantages of the proposed prototype of UGV are given below;

- Hardware complexity is relatively low.
- Cost is very low.
- It consumes less power & gives effective result.
- We don't need any data or internet connection or any other communication channel. We just need a GSM/GPRS mobile network connection with the enabled SMS facility.

V. CONCLUSION AND FUTURE SCOPE

We have studied the prototype under various conditions, including taking it out of the line of sight (LOS) of the mobile phone. The proposed system worked perfectly if the prototype of UGV and the mobile phone is in the area covered by the GSM mobile network. Even if the vehicle goes out of the coverage area the SMS which is in the buffer, gets into the

UGV once it enters into the area covered by the mobile network. There is no requirement of any internet or data connection network just a simple GSM/GPRS mobile network can serve the purpose. The only disadvantage is that the response of the UGV may get delayed due to the latency in the mobile network. The SMS will no longer be treated as a text only, in future it can be used as a series of codes that can be used to conclude or perform a given task by a robot or UGV. Programmed and control detonation of bombs can be carried out in restricted zones. This technique can also used for controlling the launch of rockets.

RECFERENCES

[1] Raul Ionel, Gabriel Vasiu, Septimiu Mischie, " GPRS based data acquisition and analysis system with mobile phone control", Measurement 45 (2012) 1462–1470, Elsevier.

[2] Erdal Bekiroglua, Nihat Daldalb, "Remote control of an ultrasonic motor by using a GSM mobile phone", Sensors and Actuators A 120 (2005) 536–542, Elsevier.

[3] Hassan K. Sawalmeh, Haitham E. Bjanthala, Mustafa M. Al-Lahham, Belal H. Sababha," A surveillance 3D-Hand-Tracking based Teleoperated UGV", 2015 6th International Conference on Information and Communication Systems (ICICS), IEEE.

[4] Keirsey D, Mitchell J, Bullock B, Nussmeir T, Tseng D.Y," Autonomous Vehicle Control Using Al Techniques", Vol. SE-11, No. 9, September 1985, IEEE transactions on software Engineering.

[5] Tanmoy Biswas, Debasish Roy, Saptarshi Naskar, "Cell Phone Operated Land Rover a Novel Approach", Volume 2,Issue 3, Nov. 2013, ISSN - 2320 - 5121, International Journal of Artificial Intelligence and Mechatronics.

[6] B.A.M. Wakileh, K.F. Gill, " Robot Control Using Self-Organizing Fuzzy Logic", 0166-3615/90, 1990 - Elsevier Science Publishers B.V.

[7] Alexander A S Gunawan*, Williama, Boby Hartanto, Aditya Mili, Widodo Budiharto, Afan G Salman, Natalia Chandra, "Development of Affordable and powerful swarm mobile robot based on smartphone android and IOIO board", Elsevier, Procedia Computer Science, 2nd International Conference on Computer Science and Computational Intelligence 2017.

[8] Ru Nie,"Design and realization of intelligent vehicle based on Android mobile phone Bluetooth control", Advanced Materials Research Vols 926-930 (2014) pp 2466-2469, Trans Tech Publications, Switzerland.

Authors Profile

Tanmoy Biswas is presently working as Assistant Professor in Department of Computer Science, Syamaprasad College affiliated to the University of Calcutta since 2008. He obtained post graduation in Electronic Science in the year 2002 from the University of Calcutta. After few months of industrial experience, he went on to complete Masters in Engineering (M.E) in Information Technology from University of Technology (UTECH) in the year 2006. His current interest is in Robots, Microprocessors, Microcontrollers, Embedded Systems, Digital Communication Systems, VLSI, and IoT. He is presently pursuing PhD in Electronic Science from Department of Electronic Science, University of Calcutta. He has a total 16 years of teaching experience. It includes 16 years in undergraduate and 4 years in post graduate teaching. He has a total of 4 years of research experience. Apart from regular teaching and research he is also engaged in different administrative assignments. He is presently the member of Under Graduate Board of Studies in Computer Science of Calcutta University. He is also a Government Nominee in the Governing Body of Panihati Mahavidyalaya, Sodepur.

Arup Kumar Goswami pursued Bachelor of Science from Syamaprasad College, affiliated to University of Calcutta in 2015 and completed Master of Science (M.Sc) in Computer Science from Sarsuna College, affiliated to University of Calcutta in 2017. He is currently pursuing M.Tech from A. K. Choudhury School of Information Technology, University of Calcutta. His main research work focuses on IoT and mobile robots. He has 6 months of teaching experience.

Manas Pal is presently working as Assistant Professor in Department of Electronics, Netaji Mahavidyalaya affiliated to University of Burdwan and he has been working since 2014. His current interest is in microprocessor and microcontroller systems, Digital, Analog Electronics and thin film devices. He is presently pursuing PhD in Electronic Science from University of Calcutta. He has 16 years of teaching experience and 4 years of research experience.

Saptarshi Naskar is presently working as Assistant Professor in Department of Computer Science, Sarsuna College, affiliated to University of Calcutta since 2008. His current interest is in Combinatorics. He is presently pursuing PhD in Computer Science from University of Calcutta. He has 10 years of teaching experience and more than 10 years of research experience. He has more than 35 research articles in various peer reviewed journals.

