Detection of Obstacles using Gesture Controlled Ground Vehicle (GCGV)

Aarti Goel, Vishal Sharma, Rohit Rastogi

Abstract: ***A Gesture Controlled Ground Vehicle (GCGV) Is A Semi-Autonomous Car Which Creates An Interface Between The Vehicle Location And The Operator (Who Operates It). An Operator From A Remote Location Can Get The Visual Information About The Surroundings To Control The GCGV By Gestures Which Creates A Virtual Environment For An Operator As He Is Driving The Vehicle. Additionally, An Obstacle Avoiding Sensor Is Also Attached To GCGV Which Helps In Detecting Obstacles By Sending Signals To The Operator. In This Paper, We Are Going To Propose How GCGV Can Be Manufactured And Used As The Best Substitute For Human Beings. The Proposed Vehicle Can Be Used In Various Areas Such As Military, Industries, Travel And Tourism, Agriculture, Transportation, Mining Etc.***

Keywords: GCGV, Night Vision Sensor, Semi-Autonomous Car, Infrared Light Emitter.

I. INTRODUCTION

Robotics is a significant change that brought revolution in technology [13]. This fast developing world needs technology that can ease human efforts. Therefore, we need interaction between machine and human beings. In order to increase these interactions, new technologies namely Machine learning, Internet of Things, Artificial Intelligence, Neural network, Genetic algorithm are emerging and helps us in improving our living standard.

Gesture Controlled Ground Vehicle (GCGV) is an unmanned vehicle that operates while in contact with the ground and without onboard human presence. Basically, ground vehicles can be differentiated into two types: (i) Remote controlled (ii) Self-controlled (Autonomous). Remote controlled vehicles may seem very primitive in this advanced world but these can be replaced by Gesture Controlled Ground Vehicles (GCGV).

Around 1600 military soldiers lose their lives every year due to geographical and climatic conditions of INDIA. In the last four years, our defense services had lost over 6500 brave soldiers. This is really a big concern for the nation. Therefore, our proposed vehicle can be used for border patrol at the extremely cold place like Siachin, exploring an unknown route using navigation, determining underground-mines using sensors, exploration drones, bomb discarding, nuclear attacks etc.

Revised Manuscript Received on December 22, 2018.

Aarti Goel, Department of CSE, ABES Engineering College, Ghaziabad, U.P, India

Vishal Sharma, Department of CSE, ABES Engineering College, Ghaziabad, U.P, India

Rohit Rastogi, Department of CSE, ABES Engineering College, Ghaziabad, U.P, India

Furthermore, this GCGV can be located at suspected locations for collecting information from the remote location. SARGE, a four-wheel vehicle is used for remote surveillance, sent ahead of infantry to investigate potential ambushes [8].X-2, a medium size UGV is used for mine detection, patrolling across the border, searching and rescue [8]. WARRIOR, a large size UGV can carry a weight of 68 kg while travelling at 8 kmph is used for checking of explosives [8].

Another application of Gesture controlled bots can be found in the domestic area which can perform different household activities and as a result of which human time and money can be saved. In large scale industries, robots are used to automate applications, reduce wastages and produce the best quality products with high precision in mass [1].

The concept of mobile UGV was first raised at Stanford Research Institute in the mid 20th century. Later on, various institutes like MIT and Carnegie Mellon University also worked on this concept. In recent years, Intelligent Vehicle Highway System (IVHS) is the biggest development in this area [2]. This technology leads to automated vehicle control and thus improving the safety and efficiency of on-road transportation.

II. RELATED WORK

In 1921, Karel Capek, a Czech writer first used the term robot which simply means a digital and programmable machine. Then in 1942, Runaround, a story of robots written by Asimov states three laws of robotics i.e.

(i) A robot should not harm the human.

(ii) A robot must follow the orders given by humans without conflicting first law.

(iii) A robot should protect its existence without conflicting first and second laws.

Table. 1 Year of Innovations

S.No.	Year	Innovations
1.	Mid 19th century	Emerged as dawn for robotic revolution. The invention of *Unimate*, first digitally operated robot (which can be programmed as well) by George Devol in 1954 established a pillar for the robotic industries.[3]

Published By:
Blue Eyes Intelligence Engineering & Sciences Publication

2.	1956	World's first Robot Company was established.
3.	1959	MIT demonstrated Computer assisted manufacturing.
4.	1963	*Rancho Arm*, the first artificial robot controlled by computer was developed for physically disabled people [4].
5.	1969	An electrical supplied robot controlled arm named *Stanford Arm* was developed and controlled by computer [9][10].
6.	1970	The first mobile robot Shakey was introduced and was controlled by artificial intelligence.
7.	1974	Using touch and pressure sensors another robotic arm named *Silver Arm* was developed [4].
8.	1979	After solving the problem of self-navigation and obstacle, a human assistance robot was developed [11].
9.	End of 20^{th} century	Results in the development of mobile robots which are proposed to be used for the purpose of medical, industries, military or space.[12]
10.	21^{st} century	Research works are being carried out in order to provide artificial intelligence and decision making capability in robots. The main objective of these researches is to provide emotions, feelings, self-judgemental capabilities etc.[11]

In the last five years, there has been a drastic change in the development of GCGV. Now, the main challenges in designing of GCGV are size, durability and clear visual recognition. These challenges need to be eradicated in order to design an effective GCGV [14].

III. PROPOSED METHOD

In this paper, we are going to propose how .GCGV can be designed in small size, light weight using onboard sensors, and the navigation control system. The size of this vehicle is kept small so as to make it handy and operated even through narrow routes. The four wheels of this vehicle are covered by a rotating chain which helps it in moving easily even on rough terrains. In order to provide vision to the operator in darkness, we have attached an onboard night vision sensor.

A. Mechanical Design of the Vehicle

Basically, the design of GCGV depends on its application. In our current work, we have used thick iron chain rotating over the two wheels of either side of the vehicle which helps in the movement of the vehicle over rough terrains or slippery surfaces. Two D.C. motors (12 V, 2A) have been used to rotate two pairs of wheels either in an anticlockwise or clockwise direction as per the instructions. To make it lighter, strips of aluminium has been used for car structure. It also provides mechanical strength to the vehicle.

For the ease of rotation, two motors are connected to two diagonally opposite wheels while two other wheels remain free. Thus, a torque is applied which can rotate about an axis, hence making a smoother turn in a lesser space. It can rotate up to 360 degrees without any displacement (almost) about its centre of gravity.

B. Navigation Control System

To design GCGV, the most challenging task is to inbuilt navigation control system [3]. In our current work, we have attached a wireless Camera at the top of the vehicle which sends video feedback with the help of transmitter to the operator. The operator then analyzes the feedback visible on the screen and sends the corresponding navigation signal to the vehicle (Fig 1). We have also attached onboard obstacle avoiding sensor to send an alert in terms of feedback to the operator when obstacle reaches to the vehicle (approx. 2 feet). For video feedback in darkness, onboard night vision sensor has been used. These installed sensors make navigation system more effective [5][6][7].

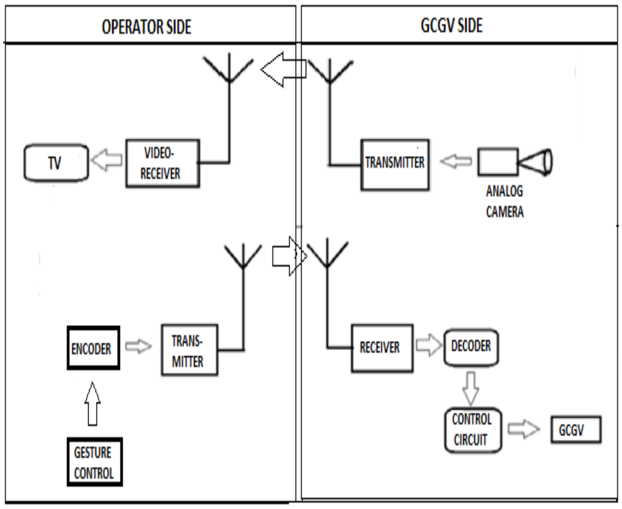

Fig. 1 Proposed Navigation control system at both end

C. Control Mechanism at Operator End

GCGV sends analog video signal in encoded form to operator's location via the transmitter. This signal is received by video receiver which is then displayed on a BW 6'' TV (operator's screen). The operator after getting the visual information sends navigational instructions through gestures to GCGV. The operator's hand movement generates signals which are sent to encoder whose circuit is based on Dual Tone Multiple Frequency (DTMF) technique (Fig 2). The encoder sends that encoded signals to the RF transmitter which are then received by RF receiver installed at GCGV and the GCGV moves accordingly [4]. During the night, the operator activates the night vision sensor which uses Infrared light for navigation and reduces the risk of getting marked as in case of ordinary light [15].

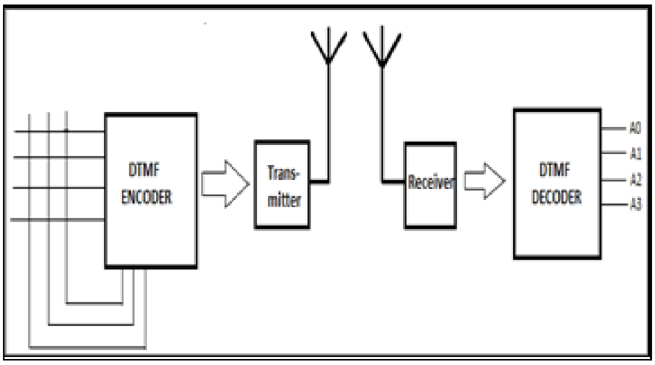

Fig. 2 Operations of DTMF Encoder and Decoder

D. Control Mechanism of GCGV

An analog camera is installed in the front of the GCGV which seems like an eye of the vehicle and works as a sight for the operator. We have used an accelerometer for sensing the motion of the operator's hand. RF receiver is installed at GCGV for receiving the instructions from the operator in encoded form. After the instruction is being received by RF receiver (attached to the car), it gets decoded. This decoded signal is then sent to the motor driver. The motor driver accordingly rotates the motor which in result moves the GCGV (Fig 1). A 12 V, 7 AH rechargeable Lead storage battery has been used with a running capacity of 4 hrs (approx). We have also used 12 IR emitting diodes light for night vision.

E. Obstacle Detecting Sensor

It consists of an Infrared movement detector having IR transmitter and receiver which emits IR rays. In case of an obstacle (within 2 feet), the transmitted IR rays reflect back from object to the IR receiver which in return glows the red LED placed below the camera. The operator on detecting the red light on his screen changes the direction of GCGV accordingly (Fig 3).

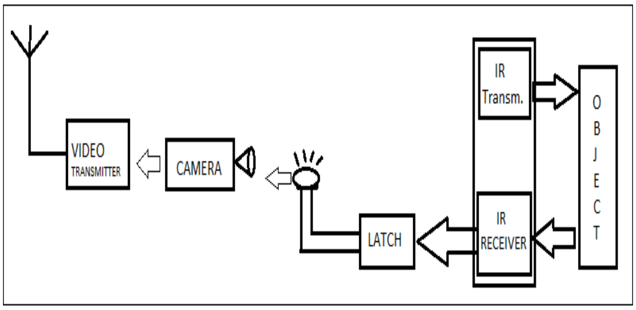

Fig. 3 Proposed IR movement detector

IV. RESULTS AND OBSERVATIONS

The Working of the Above Stated Gcgv Results In the Following Observations:-

Working Range

The working range of our GCGV is within 100m (328.08 ft.). After 100m (max limit.) the connection between transmitter and receiver breaks. As observed, the GCGV works properly within the range of 95.23m (312.43 ft.) and after this range its accuracy gradually decreases till maximum limit.

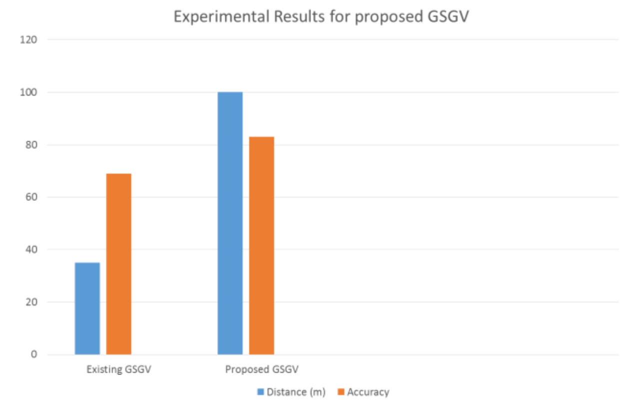

Fig.3 Result for Existing and Proposed GSGV

As stated, the length of GCGV is 24cm. While making a 360 degree turn on a plain surface, the GCGV swaps an area of 530.92 cm2 by covering a circle of diameter 26cm. This shows that turn is almost without any mark displacement about its centre of gravity (almost).

Table. 2 GCGV Response Table

I. HAND'S MOVEMENT	II. ANGLE SWAPPED	III. GCGV RESPONSE
IV. ALONG (+VE) X AXIS I.E. RIGHT	V. 0-30^{o}	VI. MOVE RIGHT
VII. ALONG (-VE) X AXIS I.E. LEFT	VIII. 0-30^{o}	IX. MOVE LEFT
X. ALONG (+VE) Z AXIS I.E. LEANING FORWARD	XI. 0-30^{o}	XII. MOVE FORWARD
XIII. ALONG (-VE) Z AXIS I.E. LEANING BACKWARD	XIV. 0-30^{o}	XV. MOVE BACKWARD

V. NOVELTY IN THE PAPER

Remote controlled vehicles may seem very primitive in this advanced world. Moving the car with the help of buttons does not provide real experience of driving.

But, Driving the GCGV with the help of gestures will give the operator real experience of driving the car. It will make him to feel as he is actually driving the car.

The main attraction of this GCGV is its gesture control mechanism, capability of navigating over rough terrains, obstacle detecting mechanism and vision in darkness.

VI. FUTURE WORK

The future work will focus on autonomous GCGV in which gesture control will be used to launch, shoot or propel the bullets from the weapon attached to the GCGV.

Thereafter, this work can also be extended by making

Published By:
Blue Eyes Intelligence Engineering & Sciences Publication

GCGV as Gesture Controlled Aerial Vehicles (GCAV), Gesture Controlled Surface Vehicles (GCSV), Gesture Controlled Underwater Vehicles (GCUVs) capable of being operated in air, water surface and below the water surface respectively. Similarly, Gesture Controlled Harvesters can be used in agriculture as a grass cutter, pitch leveler, weeds cutter, pesticides sprinklers, and crop cutters etc. which decreases human effort. Furthermore, GCGV can also be used for transportation of materials under the surveillance of the operator and can be beneficial in navigating mine tunnels.

VII. CONCLUSION

In this paper, we have presented and successfully developed a prototype of a Gesture Controlled Ground Vehicle (GCGV). The GCGV will be able to move over both rough and plain surface without an onboard presence of human. In upcoming years, GCGV will bring revolution in human life and reduce life-threatening circumstances.

REFERENCES

1. J. Yang, W. Bang, E. Choi, S. Cho, J. Oh, J. Cho, S. Kim, E. Ki and D. Kim, 2006, “A 3D Hand drawn Gesture Input Device using Fuzzy ARTMAP-based Recognizer”, In Journal of Systemic, Cybernetics and Informatics, Vol. 4 Issue 3, pp. 1-7.
2. Douglas W. Gage, “A Brief History of Unmanned Ground Vehicle (UGV) Development Efforts”, Special Issue on Unmanned Ground Vehicles, Unmanned Systems Magazine, Vol. 13, number 3, Summer 1995.
3. W. Hu, T. Tan, L. Wang, S. Maybank, “A survey on visual surveillance of object motion and behaviors”, *IEEE Trans. Syst. Man Cybern. C Appl. Rev.*, vol. 34, no. 3, pp. 334-352, Aug. 2004.
4. K. Brahmani, K. S. Roy, Mahaboob Ali, April 2013, “Arm 7 Based Robotic Arm Control by Electronic Gesture Recognition Unit Using Mems”, International Journal of Engineering Trendsand Technology, Vol. 4 Issue 4.
5. L.H.Matthies and P.Grandjean, “Stochastic performance modeling and evaluation of obstacle detectability with imaging range sensors”. *IEEE Transactions on Robotics and Automation*, 10 (6): 783 - 791, December 1994.
6. Bruce A. Draper, G. Kutlu, Edward M. Riseman, Allen R. Hanson, "ISR3: Communication and Data Storage for an Unmanned Ground Vehicla", proceedings of ICPR, 1994.
7. Dajun Zhou, Minghui Shi, Fei Chao, Chih-MinLin, Longzhi Yang, Changjing Shang, Changle Zhou, “Use of human gestures for controlling a mobile robot via adaptive CMAC network and fuzzy logic controller”, Neurocomputing,Volume 282, 22 March 2018
8. https://en.wikipedia.org/wiki/Unmanned_ground_vehicle
9. Mohd Ashiq, KamarilYusoffReza, EzuanSaminBabul, Salam KaderIbrahim, “Wireless Mobile Robotic Arm”.
10. Gregor Klančar, Andrej Zdešar, Sašo Blažič, Igor Škrjanc,“Introduction to Mobile Robotics” ,Wheeled Mobile Robotics, 2017
11. AshitavaGhosal : “Resolution of redundancy in robots and in a human arm” , Mechanism and Machine Theory, Volume 125, July 2018
12. Yury S.Bekhtin, Pavel V.Babayan, Valery V.Strotov, “Onboard FPGA-based fast estimation of point object coordinates for linear IR-sensor” , Microprocessors and Microsystems,Volume 51, June 2017.
13. Konstantinos Sirlantzis, Layla, Bashir Larsen Lakshmi, Krisha Kanumuru, Paul Oprea, “Robotics”**,** Handbook of Electronic Assistive Technology,2019.
14. Shwet and Sharma, S.K. and Rastogi, R.,2015,A revolutionary technology to help the differently abled person International Conference on Computing for Sustainable Global Development, INDIACom 2015.
15. Rungta, S. and Srivastava, S. and Yadav, U.S. and Rastogi, R., 2014 A Comparative Analysis of New Approach with an Existing Algorithm to Detect Cycles in a Directed Graph, Advances in Intelligent Systems and Computing,2014.

*Published By:
Blue Eyes Intelligence Engineering
& Sciences Publication*