The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 10 Issue 1, 2022
pp: 48 - 55

A Review on Unmanned Ground Vehicle for Surveillance and Security

Dr. Avinash M. Pawar*
Bharati Vidayapeeth's College of Engineering for Women, Pune (MS), India.
avinash.m.pawar@bharatividyapeeth.edu

Sheetal S. Patil
Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune, 411043, India
sspatil@bvucoep.edu.in

Dr. Kalyan D Bamane
D Y PATIL COLLEGE OF ENGG AKURDI PUNE, India
kdbamane@dypcoeakurdi.ac.in

Dr. J.J. Kadam
Bharati Vidyapeeth College of Engineering, Navi Mumbai, Mumbai, Maharashtra, India
jjkadam702@gmail.com

Amol P. Yadav
Bharati Vidayapeeth's College of Engineering for Women, Pune (MS), India.
amol.yadav@bharatividyapeeth.edu

Dr. Pramod V. Londhe
Bharati Vidyapeeth (Deemed to be University) College of Engineering, Pune, 411043, India
sspatil@bvucoep.edu.in

Dr. Sachin G. Ghalme
Sandip Institute of Technology and Research Centre, Nashik (MS), India.
sachin.ghalme@sitrc.org

Dr. Mahesh S. Harne
Amrutvahini College of Engineering, Sangamner, (MS), India.
mahesh.harne@gmail.com

*Corresponding Author Email: avinash.m.pawar@bharatividyapeeth.edu

Abstract-

Some of the foremost distinguished issues facing the globe nowadays square measure acts of terrorism and Insurgency. Governments and scientists across the world square measure operating day and night so as to bring these issues into restraint. Billions of greenbacks square measure spent by nations for the analysis of latest defence systems that are capable of safeguarding voters from terrorist threats. Nowadays with major advancements within the field of auto automation, several dangerous and crucial counter terrorist operations square measure being handled by subtle machines that aren't solely economical however are liable for saving many human lives. Our project "Unmanned Ground Vehicle" is constructed to commence tasks like border police investigation and in energetic combat each as an individual unit for metal detection which can be used for metal detection moreover (automatic) moreover as in coordination with human troopers (manual) wirelessly. It is an image illustrating the ever-expanding want for stylish technology and exactness driven vehicles to the current day desires for a primary line of defence. A person from a distant place will manage the motion of the mechanism wirelessly and in things wherever manual management isn't practical, the automobile has the ability to drive itself to the pre-set destination. This mechanism would be put in with associate degree automatic bomb detection (metal detection sensor) and a distant operator would be obtaining a live video feed from the camera to assist.

Keywords- *Metal Detection Sensor, Autonomous ground vehicle, Remote operated, GPS, Live feed, Surveillance*

1. INTRODUCTION

Unmanned mobile robots are an area unit actively being created for both military and civilian use to accomplish uninteresting, dirty, and dangerous events. They tested to be operational in

The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 10 Issue 1, 2022
pp: 48 - 55

an exceedingly sizable number of environments wherever the employment of humanoid labour is just very valuable, the task is risky, or it's impractical for human capability. There are 2 general categories of unmanned mobile vehicles: Teleoperated, just like the one delineated within the gift work, and Autonomous. A teleoperated, or unmanned radio-controlled vehicle (UGV), may be a vehicle that's controlled by an individual's operator at a far-off location via a communications link. Totally autonomous UGVs have seen in-depth development driven by the Defence Advanced Research Projects Agency Grand Challenge competition. Although a number of these solutions are at an awfully advanced stage, they're still undergoing tests and their readying is however to be seen. On the contrary, remotely controlled UGVs have already created it for the reading section. This sort of vehicle is additionally seeing a proliferation of developed solutions particularly within the light-weight to medium weight sizes. Several problems associated with this class are addressed within the literature. These problems may be classified within the following sides: communication aspect, management side, obstacle turning away side, base station problems and vision systems development, dependability and system strength problems are attention-grabbing aspects to contemplate. Although a number of the works relate to the autonomous branch of the UGVs (or UAVs), its nature applies absolutely to remotely controlled UGVs analysis and development of UGV is usually targeted on specific applications and area units thus designed consequently. The flexibility to be custom or reconfigured and performance in associate unstructured, outside setting may be a desired feature of robotic platforms. Among the recently planned specialised applications are unit the military vehicles for military science intelligence and explosive disposal missions. The US Department of Defence is attending to replace a 3rd of its armed vehicles and instrumentality with robots by 2015. Such systems are expected to reduce the operation value and battle damage. In reference, a survey of military use of UGVs has been bestowed. Many UGVs have created it to the sector, just like the PackBot and also the claw family which provide an oversized portfolio of various UGVs. A number of them, just like the claw brand, have been deployed in Al-Iraq. The split saw constitutes a typical remotely controlled UGV. It's quick, reliable and may carry troopers and safely facilitate their withdrawal from combat zones. This study defines the look, construction, testing and enactment of a UGV for security applications victimising the newest wireless pc communications and thoroughly designed mechanical and electronic systems for effective management and manoeuvring. The system is provided with 2 pan/tilt cameras, rifle/gun management, steering/speed/brake management, and plenty of fail-safe options. The model was totally and critically evaluated, and suggestions for consequent generation.

2. HISTORY

In October 1921 first two-wheeled unmanned vehicle was manufactured. It was controlled wirelessly through the radio. In 1930’s Russia made “Tele tanks” which were armed vehicles controlled by radio from other tanks and they were used in the winter war. The British produced a radio control variant of its Matilda II infantry tank during 1941, which was used in World War II. Its common name is "Black Prince," and it was utilized for demolition missions or for deflecting anti-tank gun fire. The first major development was in 1960 by DARPA which

included TV sensors, cameras and computer programmes to monitor its direction of motion. [1]

- 1915 – Development of "Torpille Terrestre" (Land Torpedo) was done by French Army engineers and it was accumulated using explosives.
- 1930 – The Soviets started mistreatment; the primary UGVs supported the T-26 and T-18 tanks, called Tele tanks.
- 1940s – The tele tanks employed using the Red Army during the Winter War beside the Finland Republic.
- 1960 – UGV Shakey employed for a DARPA-funded AI programme by Stanford analysis Institute.
- 1970s – SRI International's Shakey grow into the primary AI controlled mobile mechanism.
- 1973s – UK's MORFAX made the "Wheelbarrows" EOD UGV and used widely in European countries.
- 1980 – Carnegie-Mellon University created a one legged root for analysis functions within the space of mechanism levelling.
- 1987 to 1989 – Once analysed, Grumman and Martin Marietta created Teleoperated Mobile Anti-Armour Platform (TMAP) UGV for the combat operations.
- 1999s – Sony announced the primary robotic dog i.e. Aibo,.
- 2000s – Honda conferred the ASIMO two legged mechanism, one among the foremost painting android robots, which had been superannuated in 2011 however the non-heritable power facilitated towards construction of new-fangled ones for extremely dedicated tasks.
- 2011s – Devastation of the Fukushima Daiichi nuclear power facility brought on by the earthquake and shifting ridge. UGVs used to inspecting the dangerous ruins
- 2012 – The establishment of Russia's own bureau was sponsored.
- 2012 to 2015 – Between 2012 and 2015, the Bureau AI Challenge was held in an effort to develop ground robots that could do difficult tasks in hazardous locations.
- 2016 – The most recent iteration of Boston Dynamics' running & jumping rescue system is called Atlas.
- 2017s – The Offensive Swarm Enabled Tactics (OFFSET) programme, launched by the Bureau, intends to design, develop, and test a swarm systems architecture that enables the simultaneous operation of many unmanned devices.
- 2017s – DsTL, in cooperation with business and domain, initiated the "Last Mile" project to style UGVs that may give logistic support to combat units.
- 2017s – The metal that escaped after one of the Fukushima nuclear reactors was destroyed is found by a protected UGV created by Toshiba.
- 2018s – The Uran-9 combat UGV was put through its paces by the Russian Army in an Asian country.

The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 10 Issue 1, 2022
pp: 48 - 55

- 2019s – Associate in Nursing Estonian Army unit platoon installed in the Mali Republic with Milrem's Themis UGV to check it in the combat.
- 2020s – The US Army decides to move through with the OMFV event (Optionally-Manned Fighting Vehicle).
- 2020s – Milrem presented X combat UGV. [1]

a. DARPA Autonomous Land vehicle (ALV)-

The ARPA, supported the development thread of "Mobile robots as an application domain for the AI and high-performance computing technique" which was activated in 1960's with Shakey re-emerged in 1980's such as DARPA ALV (Autonomous Land Vehicle). The ALV was created using a typical manufacturing process for eight-wheel, all-terrain vehicles with hydrostatic drive that can travel up to 45 kph on smooth roads and up to 18 kph on rough terrain. This vehicle was installed with a diesel APU which was providing 12kw power. Initially it had a colour video camera and laser scanner. There were lots of advancements that happened in ALV, but the striking development happened in 1987 regarding, applying vision-guided off-road transit in which vehicles avoided rocks, ditches, trees and other small obstacles.

b. Security Robots

ROBART I was created in 1981 at Naval Postgraduate School and was the first autonomous security robot in the world. This robot had collision avoidance sensors but due lack of research they didn't know where to use it exactly means indoors or outdoors. But after reapplying the methods it was able to enroute by itself and periodically can come back to the charging station. Following on, ROBART II was the second generation which was operated indoors inducing multiprocessor architecture and different sensors suited in order to achieve better navigation and security capabilities.

c. SARGE-

The Yamaha Breeze four-wheeled all-terrain vehicles serves as the foundation for the reconnaissance and surveillance Ground Equipment (SARGE) vehicle. It was industrialised meant for the US army as a prototype for military operations with advanced technology embedded in it. SARGE was consisting of day-night imaging, thermal imaging, has zooming camera that can zoom on a person who is walking at a distance of 1km.SARGE had comprised of a very strong computing system having solo board class 386SX CPU and with upgradable multiprocessor configuration for forthcoming advancements. The primary use of SARGE was to surveillance remotely and send ahead of the military to investigate the positions of the enemy.

3. LITERATURE REVIEW

The primary goal of the vehicle, according to Mohd. Khalfan and Amir Al. Habsi's research, is a self-lifting mechanism which raises itself if the vehicle has experienced a "Topple," which is activated by a user some distance away from the vehicle. This UGV can ensure that surveillance is carried out effectively while also reducing the need for human labour. There are various sensors used that includes ultrasonic sensor which has capacity of 600mm range to detect the

object which is controlled by Arduino unoThe operator controls the worm gear through RF, which is utilised to elevate the vehicle anytime it tips. Limitations included low ground clearance which made it difficult to climb higher terrains. Motor driving sometimes distorts the camera's vision, so it also needs to improve. [2]

Marco.C., De Simone, Domenica Guida in their paper mentioned that , the chassis of the vehicle is made of Methyl Methacrylate on which the group of wheel motors are mounted and Arduino Mega 2560 microcontroller is used. Ultrasonic sensors and accelerometers are used for detecting the obstacle in path. There are different kinds of algorithms used to obtain the dynamic model of vehicle, while open and closed-loop were implemented over micro-controller. Obtained results showed the efficiency of the suggested technique for identifying and managing the mechanical system. Limitation of this vehicle is seen that only the average rate of the axis is measurable for identification purposes. A state observer is needed to estimate the system. Also, it is ineffective in imposing the trajectory of the target. [3]

Abdelhafid Bouhraoud, Necar Merah, Manson AlDajani, Mostafa El Shafei in their paper on commercial Quad motorbike consisting of 1-cylinder gasoline engine having power of 5 HP has been reconsidered and converted into fully automated vehicle that can be operated remotely. For security purposes a gun is used which is provided with an automated triggering system. Due to high-speed requirements accelerometer and brake actuating systems are used. This system lags in power consumption and battery life which has to be taken into account. Also, the triggering subsystem also has to be improved. Otherwise, this vehicle gives excellent demonstration of design, manufacturing and control capabilities. [4]

Seemala Vijaykumar, Sumit Kumar on their paper mentioned SDR (Software Defined Radio) is used which is a lot advantageous over traditional methods. SDR gives the unique flexibility to the whole system. It can be programmed for frequency hopping. It is also comprised of Electronic Counter Counter Measures (ECCM) which can work in enemy territory carelessly of electronic signal jammers. Due to use of SDR user can easily shift from one frequency to another. Remote mine detection can be incorporated using SDR based UGV. Also, Remote firing from a gun mounted on UGV can be incorporated. [5]

In their research, Sijo Thomas and Dr. Aruna Devi suggested a device that uses a 4-finger mechanism that is simple, portable, and light-weight. Its haptic glove system offers comfort and accuracy for control method and is not restricted to variations in finger size. Diffusion and Bomb detection technology is built into this system. The fingers are employed as the location for flex sensors. They are resistors whose value varies with the degree of flexing. As the proposed system is very useful and user-friendly, still work in the haptics and actuators can be done effectively. [6]

Saurav Chakraborty, Subhadip Basu in their work mentioned system is intended to operate in rough terrains and narrow escape routes where space for directional movements is minimum. It is with a chained wheel mechanism where 2 wheels are connected by a thick iron chain. All 4 wheels are connected to the chassis by individual steel shafts and steel ball bearings. It is consisting of an Infrared camera and infrared sensor which can detect obstacles within 2 feet.

The Ciência & Engenharia - Science & Engineering Journal
ISSN: 0103-944X
Volume 10 Issue 1, 2022
pp: 48 - 55

After that sensor blinks red after detecting. Difficulties were faced during the ground clearance. This can be improved by increasing the diameter of wheels. Interference was caused due to motor windings often distorts the camera vision. [7]

Jianqiang Li, in his study, it is studied that UGV and UAV are worked as cooperative systems. By using UAV ground images are obtained from areal vision then image processing helps in constructing a ground map. It is suggested that a hybrid path planning algorithm be used to enhance path planning. The UAV has a control module, camera module, and communication module and they work in a synchronized manner. As creating maps is the basis for developing paths, for UAV environmental conditions are stationary and for UGV conditions are changing dynamically. The obstacle identification is the important part so it is come close to by the polygon model for environmental modelling and the vehicle is observed as a particle. A hybrid-path planning algorithm is suggested for this system. The outcomes are continuously improved using a genetic algorithm for local rolling optimization and global path planning. More work is required in applying Harri-Corner detection method as it still faces difficulty in gating accurate corner images. Effects such as unreliable wireless communication also needs to be considered. [8]

Sainadh Jasthi, Ponnammal P, Aditya Shashank Neti, Akhil Cherukuri in their paper mentioned about an unmanned ground vehicle with self-control has been discussed. These self-controlled are able to counter emergency problem that now-a-days soldiers are facing. As self-controlled robots are handy in working with position tracking of terrorist parallelly with soldiers. This vehicle works autonomously with given GPS co-ordinates and also gains the climatic conditions. So, it has been successfully built a prototype of self-controlled vehicle having GPS antenna, magnetic compass, and path planning and obstacle detection algorithm. As they are planning to control the vehicle by using arm controlled or gesture-controlled mode. Also, they can consider of using camera live feed for it. [9]

Panagiotis Papadakis in their article about terrain transversally analysis has been discussed. It is used for navigating ground vehicle where environments are varying with different complexities. There are multiple types of analysis explained named as: Exteroceptive transferability analysis, Appearance transferability analysis, Proprioceptive transferability analysis, and Geometry based transferability analysis. While analysing transferability different sensors taken into use. Based on these sensors 3D scene created having different obstacles. This vehicle lacks in some environmental conditions. Research would be also made on making completely autonomous vehicle. [10]

P. Kim, J. Park, Y.K. Cho et.al performed work on as-is Geometric Data Collection and 3D Visualization through the Collaboration between UAV and UGV and discuss about UAV and UGV are used in collaboration for collecting superior geometric records important for construction activities. This introduces a new framework 3D data in dynamic jumbled environments by UGV and UAV. Firstly, UAV is deployed to collect images of site and creating 3D terrain including obstacle information. Using all this information mesh grid is created and this all information is shared with UGV for optimal path planning. As a result, this

collaboration decreases human effort and provide different interventions. [11]

Yang Cong, Xiaomao Li, Ji Liu, Yandong Tang et. al. in their work reported that the UGV is guided to climb the stairs at varying angles using a vision-based algorithm. The position of the UGV on the steps and the angle of the stairs are crucial considerations for executing this on UGV. In order to accomplish this, a Gabor filter is used to limit reflection. For steering the vehicle RANSAC algorithm is used. Due to use of Gabor filter small lines are removed so the stairs can be perfectly detected. By looking at the objective, work on camera vision is needed, as UGV gets in trouble at high light condition and can work easily in low light condition. [12]

4. CONCLUSION

- There are several of UGVs are already in the market but still their objectives are different from each other.
- There is a lot of research needed in with different approaches such as in tactical situations, autonomous control and behaviour, safely operating around humans, reliability, and functionality human-machine interface.
- UGV, UAV are the future of remote or autonomous vehicle in various scenarios and helping processes.

REFERENCES

[1]. Wikipedia, "Wikipedia," [Online]. Available: https://en.wikipedia.org/wiki/Unmanned_ground_vehicle?msclkid=c410cc4dc52711eca36e05b6247f890c.

[2]. M. Khalfan, A.-H. and M. Kalimuthu, "Design and fabrication of unmanned ground surveillance vehicle," Design and fabrication of unmanned ground surveillance vehicle, vol. 11, no. 3, p. 3, 2017.

[3]. M. C, D. S. and D. Guida, "IDENTIFICATION AND CONTROL OF A UNMANNED GROUND VEHICLE BY USING ARDUINO," IDENTIFICATION AND CONTROL OF A UNMANNED GROUND VEHICLE BY USING ARDUINO, vol. 80, no. 1, p. 14, 2018.

[4]. N. M. M. A. a. M. E. Abdelhafid Bouhraoua, "Design and Implementation of an Unmanned Ground Vehicle for Security Applications," in Proceeding of the 7th International Symposium on Mechatronics and its Applications (ISMA10), Sharjah, UAE, 2010.

[5]. S. Vijaykumar and S. Kumar, "SDR Based UGV for Covert Surveillance," International Journal of Scientific & Engineering Research, vol. 5, no. 12, 2014.

[6]. D. Sio Thomas, "Design and implementation of unmanned ground vehicle (UGV) for surveillance and bomb detection using haptic arm technology," IEEE, 2017.

[7]. S. B. Saurav Chakraborty, "Design of a Smart UGV for Hazardous Environments," in In proceedings of 2nd National Conference on Recent Trends in Information Systems (ReTIS-08), pp. 222-225, Feb 7-9, 2008, Kolkata, Kolkata, 2008.

[8]. G. D. C. L. Q. L. Q. Y. a. Z. M. J. Li, "A Hybrid Path Planning Method in Unmanned Air/Ground Vehicle (UAV/UGV) Cooperative Systems," IEEE Transactions on Vehicular Technology, vol. 65, no. 12, pp. 9585-9596, 2016.

[9]. P. A. A. Sainadh Jashti, "Reliability and Failure in UGV," International Journal of Pure and Applied Mathematics, 2018.

[10]. P. Papadakis, “Terrain traversability analysis methods for unmanned,” Engineering Applications of Artificial Intelligence, vol. 26, no. 4, pp. 1373-1385, 2013.

[11]. J. P. Y. C. Pileun Kim, “As-is Geometric Data Collection and 3D Visualization through the Collaboration between UAV and UGV,” in Proceedings of the 36th ISARC, Banff, Canada, Banff,Canada, 2019.

[12]. X. L. J. L. ,. T. Y. Cong, “A Stairway Detection Algorithm based on Vision for UGV Stair Climbing,” 2008 IEEE International Conference on Networking, Sensing and Control, pp. 1806-1811, 2008.

[13]. J. Pike, “SARGE Surveillance And Reconnaissance Ground Equipment,” 7 July 2011. [Online]. Available: https://www.globalsecurity.org/military/systems/ground/sarge.htm. [Accessed 18 April 2022].