Design and Development of Unmanned Ground Vehicle (UGV)

Bansode Shreyas R.(BE-B-22), Jadhav Suyog R.(BE-B-37), Kadam Abhishek D.(BE-B-40), Gade Prashant R.(BE-B-30)

Department of Mechanical Engineering, SVERI's College of Engineering,
Final Year Engineering Student

ABSTRACT:

An unmanned ground vehicle (UGV) is any piece of mechanized equipment that moves across the surface of the ground and serves as a means of carrying or transporting something, but explicitly does NOT carry a human being. Unmanned Ground Vehicles (UGV) are frequently used to assist War fighter's in various missions and often endure personal high risk when attempting to deploy UGVs during missions. To reduce life-risk factors during military and rescue operations, unmanned vehicles minimize the presence of humans in hostile and insecure environments. According to the U.S military, during the period of 7 years (2005-2012) 792 lives were saved by employing robots in combat, thereby demonstrating the effectiveness of the new technology. With advancements in unmanned vehicle technology, new methods for controlling and guidance techniques have to be implemented for their effective use

Unmanned Ground Vehicle (UGV) comprise of different mechanisms viz. foldable stair mechanism, triggering mechanism etc. Foldable stair mechanism is used for moving motion up and down in order to achieve target very effectively. Triggering mechanism is that which controls rate of firing bullets with suitable cam and follower adjustment. Unmanned Ground vehicle (UGV) consists of a set of sensors to observe the environment, and will either autonomously make decisions about its behavior or pass the information to a human operator at a different location who will control the Unmanned Ground Vehicle (UGV) through remote operation. Remote operation is done by GSM modem. A GSM module is specialized type of instrument which accepts a SIM card, and operates over a subscription to a mobile operator, just like a mobile phone.

Unmanned Ground Vehicle (UGV) is designed to perform risky tasks of rescue, supply, surveillance and military operations (exploring unknown terrain including mine-filled areas) and would be cost-effective and efficient as well. UGVs doing tasks, Better, faster, safer, &more efficient. They are developed for peacekeeping operations, ground surveillance, gatekeeper/checkpoint operations, urban street presence, and to enhance police and military raids in urban settings. Future work includes development of an Unmanned Air Vehicle (UAV) or an autonomous drone that would be very cost effective for a number of applications where human reach is not possible due to a hostile and insecure environment.

INTRODUCTION

Unmanned vehicles can operate either on ground or in air. Further, these vehicles operate without a human driver and are either controlled autonomously or semi-autonomously. Consequently, the objective is to establish a path for the vehicle to traverse. A semi-autonomous multi-model approach has been proposed where the path is determined employing user defined waypoints. Due to significant user interaction, the accuracy in determining the path is not satisfactory - approximately 63%. In unmanned vehicles, fully autonomous control may provide better accuracy if appropriately modeled. The fully autonomous approach has been significantly explored in the past in order to reduce or minimize response delays and errors. Unmanned ground vehicle is presented using collaborative technologies for navigation and obstacle avoidance. The current model is more economically feasible and requires minimal human interaction.

There are two classes of unmanned ground vehicles:

Remote-Operated and Autonomous.

A remote-operated UGV is a vehicle that is controlled by a human operator via interface. All actions are determined by the operator based upon either direct visual observation or remote use of sensors such as digital video cameras. A basic example of the principles of remote operation would be a remote controlled toy car.

An autonomous UGV is essentially an autonomous robot that operates without the need for a human controller. The vehicle uses its sensors to develop some limited understanding of the environment, which is then used by control algorithms to determine the next action to take in the context of a human provided mission goal. This fully eliminates the need for any human to watch over the menial tasks that the UGV is completing.

Take for instance an incident in Göttingen in June 2010, where 3 highly trained Explosive Ordnance Disposal (EOD) experts were killed due to the delicate nature of the bomb. Thus, with the growing importance of UGVs in safeguarding precious human lives, this project will encompass the study of how effective UGVs are in carrying out search and destroy missions.

HISTORY

In 1930, the USSR developed Teletanks, a machine gun-armed tank. This was remotely controlled by radio from another tank. These were used in the Winter War (1939-1940) against Finland also at the start of the Eastern Front after Germany attacked the USSR in 1941. During World War II, the British developed a radio control version of their Matilda II infantry tank in 1941. Popularly known as “Black Prince”, it would have been used for drawing the fire of hide anti-tank guns, or for destruction missions. But because of the costs of converting the transmission system of the tank to Wilson type gearboxes, an order for 60 tanks was cancelled.

Since 1942, the Germans used the Goliath tracked mine for remote demolition work. The Goliath was a small traced vehicle capable of carrying 60 kg of explosive charge directed through a control cable. Their inspiration was subtle French tracked vehicle found after France was defeated in 1940. But integration of cost, low speed, dependency on a cable for control, also poor protection against weapons result as it was not considered a success.

The first major mobile robot development effort named Shakey was created during the 1960.The research study for the Defense Advanced Research Projects Agency for Artificial Intelligence (DARPA-AI) to test its submissiveness with commands. This was different from advanced robots that are autonomous or semi-autonomous. Shakey was a wheeled platform that had a TV camera, sensors, and a computer to help guide. The main purpose of this robot was the navigational tasks of picking up wooden blocks and placing them in certain areas based on commands.

In December 2001, a terrorist bomb plot planned by Jemaah Islamiyah (JI) was uncovered. The plot was to bomb foreign embassies and one of the Mass Rapid Transit (MRT) stations in Singapore. Thankfully, the plot was foiled before it could be carried out. However, this terrifying experience has led people to question if a bomb has indeed been placed in a train station, what would have done to resolve it?

The obvious choice used by Bomb Disposal teams nowadays is the use of Unmanned ground vehicles (UGVs) for these search and destroy missions. This is because this “hands-free” approach prevents the needless endangerment of human lives when working with such deadly ordnances.

EXAMPLES SARGE

SARGE is based on a 4-wheel drive all terrain vehicle. Currently, the objective is to provide each infantry battalion with up to eight SARGE units. The SARGE robot is primarily used for remote surveillance; sent ahead of the infantry to investigate potential ambushes.

THE WARRIOR

A new model of the PackBot was also produced, known as the Warrior. It is over five times the size of a PackBot, can travel at speeds of up to 15 mph, and is the first variation of a PackBot capable of carrying a weapon. Like the Packbot, they are instrumental in checking for explosives. They are capable of carrying 68 kilograms, and travelling at 8 MPH. The Warrior is priced at nearly 400,000 and more than 5000 units have already been delivered worldwide.

The Talon

The Talon is primarily used for bomb disposal, and was incorporated with the ability to be waterproof at 100 ft so that it can search the seas for explosives as well. The Talon was first used in 2000, and over 3,000 units have been distributed world-wide. By 2004, The Talon had been used in over 20,000 separate missions. These missions largely consisted of situations deemed to be too dangerous for humans. The Talon is one of the fastest Unmanned Ground Vehicles on the market, easily keeping pace with a running soldier. It can operate for 7 days off of one charge, and is even capable of climbing stairs. This robot was used at Ground Zero during the recovery mission. Like its peers, the Talon was designed to be incredibly durable. According to reports, one unit fell off of a bridge into a river and the soldiers simply turned on the control unit and drove it out of the river.

SWORDS ROBOT

Shortly after the release of the Warrior, the SWORDS robot was designed and deployed. It is a Talon robot with an attached weapon system. A SWORD is capable of mounting any weapon weighing less than 300 pounds. In a matter of seconds, the user can fit weapons such as a grenade launcher, rocket launcher, or 0.50 inch (12.7 mm) machine gun. Moreover, the SWORDS can use their weapons with extreme precision, hitting the bull’s eye of a target 70/70 times. These robots are capable of withstanding a lot of damage, including multiple 0.50 inch bullets, or a fall from a helicopter onto concrete. In addition, the SWORDS robot is even capable of making its way through virtually any terrain, including underwater. In 2004, only four SWORDS units were in existence although 18 were requested for service overseas. It was named as one of the world’s most amazing inventions by Time Magazine in 2004. The US Army deployed three to Iraq in 2007 but then cancelled support of the project.

DESIGN & DEVELOPMENT OF UGV

1. 300RPM 12V DC

Features

- 300RPM 12V DC motors with Gearbox
- 6mm shaft diameter with internal hole
- 125gm weight
- Same size motor available in various rpm

- 2kgcm torque
- No-load current = 60 mA(Max),
- Load current = 300 mA(Max)

2. 3.5 RPM 12V DC

Geared motors for robotics applications.

Feature

- 3.5 RPM 12V DC motors with Gearbox
- 6mm shaft diameter with internal hole
- 125gm weight
- Same size motor available in various rpm
- 5kgcm torque
- No-load current = 60 mA(Max), Load current = 300 mA(Max)

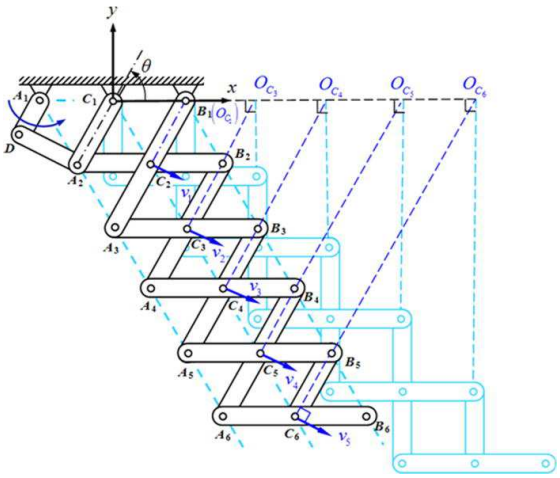
3. GE Small Double Tyre

Specification:

- 70mm diameter
- 4 cm width
- Hole diameter 6.1 mm
- Screw for fastening on motor shaft
- Made from virgin plastic

- High quality Plastic Wheel for DC motors with 6.1 mm diameter.

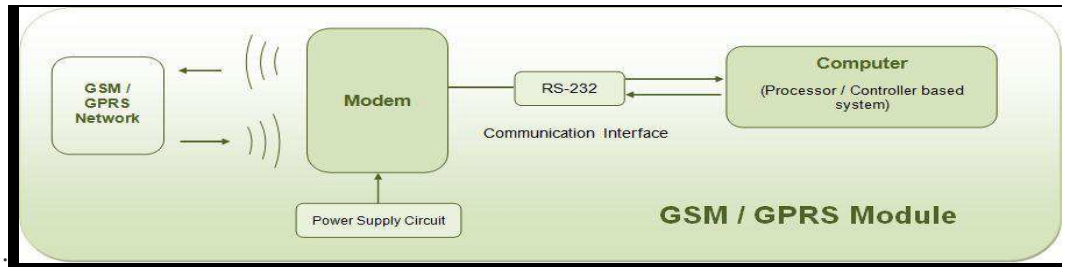
4. Foldable stair mechanism



Foldable stair is easily deployed for use and folded for storage. It consists of a number of identical deployable scissor-like elements which form the staircases when expanded. In addition to use, the folded stair can be used for up & down motion of weapons.

5. GSM module

GSM/GPRS module is used to establish communication between a computer and a GSM-GPRS system. When GSM module is connected to a computer, this allows the computer to use the GSM modem to communicate over the mobile network. While these GSM modems are most frequently used to provide mobile internet connectivity, many of them can also be used for sending and receiving SMS and MMS message. GSM modem assist to human for tracking the location of Unmanned Ground Vehicle (UGV).



6. CMOS Camera Module

Features

- High sensitivity for low-light operation;
- Low operating voltage for embedded application;
- Standard SCCB interface compatible with I2C interface;
- Raw RGB, RGB (GRB4:2:2, RGB565/555/444),YUV(4:2:2) and; YCbCr(4:2:2)output format;
- Support VGA, CIF and from CIF to 40 x 30 format;
- Vario Pixel method for sub-sampling; Auto Image Control: AEC, AGC, AWB, ABF, ABLC;
- Image Quality Control: Color saturation, hue, gamma, sharpness and anti-blooming;
- ISP includes noise reduction and defect correction; Support image scaling; Lens shading correction;
- Flicker 50/60Hz auto detection;
- Color saturation level auto adjust;
- Edge enhancement level auto adjust;
- De-noise level auto adjust.