Virtual Reality based Unmanned Ground Vehicle

Alistair Lasrado[1], Prajwal Shervegar[2], Vaishnavi[3], Anusha[4]
[#] Department of Electrical and Electronics Engineering, Canara Engineering College,
Benjanapadauv, Bantwal Taluk, Mangaluru - 574219, Karnataka, India
(Affiliated to Visvesvaraya Technological University, Belagavi)

Mr. Divyesh Divakar
[*]Under Guidance of
Asst..Professor,
Department of Electrical and Electronics Engineering
Canara Engineering College, Benjanapadauv, Bantwal Taluk, Mangaluru – 574219,
Karnataka, India

***Abstract*— Virtual Reality Based Unmanned Ground Vehicles (VR-UGVs) have advantages over people in a number of different applications, ranging from sentry duty, scouting hazardous areas, convoying goods and supplies over long distances, and exploring caves and tunnels. The VR headset has a gyroscope sensor attached which reads the angle of head movement, which in turn gets sent to microcontroller in the UGV which processes the data and gives readings to the servo motor which rotates the camera to collect the video information to VR. This enables the UGV controller to control UGV with virtual reality experience. 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.**

Keywords—VR headset, Virtual Reality Based Unmanned Vehicle, head movement, virtual reality experience, video information.

I. INTRODUCTION

The purpose of this paper is to provide a brief survey of a number of different threads of development that have brought the VRUGV field to its current state, together with references to allow the interested reader to probe more deeply.

In the broadest "dictionary" sense, a virtual reality based unmanned ground vehicle (VR-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. A discussion of such a broad universe of possible VR-UGV systems needs some organizing principle, and in fact a taxonomy of VR-UGV systems could be based upon any of a number of characteristics of each system, including:

• the purpose of the development effort (often, but not always, the performance of some application-specific mission);

• the specific reasons for choosing a VR-UGV solution for the application (e.g., hazardous environment, strength or endurance requirements, size limitation);

• the "long pole" technological challenges, in terms of functionality, performance, or cost, posed by the application;

• the system's intended operating area (e.g., indoor environments, anywhere indoors, outdoors on roads, general cross-country terrain, the deep seafloor, etc.);

• the vehicle's mode of locomotion (e.g., wheels, tracks, or legs);

• how the vehicle's path is determined (i.e., control and navigation techniques employed).

To reasonably limit its scope, this survey will focus principally on the large number of systems where the

"long pole" technological challenge is or has been in the area of navigation and control.

II. MOTIVATION

The surveillance solutions available in the market are:

- Expensive.
- Time consuming in setup.
- Need technical knowledge of operation.

III. OBJECTIVE

VR based surveillance vehicle processes the data and gives readings to the servo motor, which rotates the camera to collect the video information to VR receiver. This helps the controller to control UGV at ease.

IV. WORKING

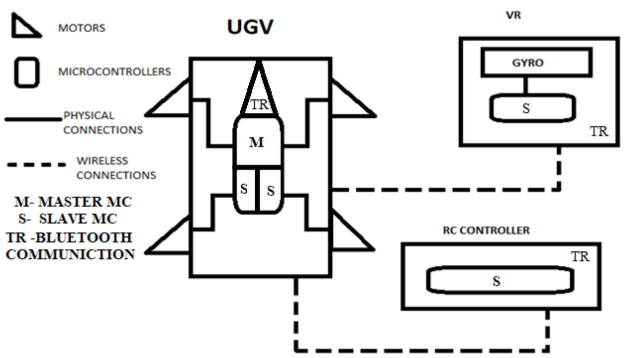
The operations of the Unmanned Ground Vehicle (UGV) can be categorized into three set of operations: Maneuverability, Head Movement, Data Gathering

Maneuverability: This is the basic movement of the robot so as to reach a destination. This is essential for enhanced data gather. Under this operation of the system four motors are integrated into the system via an h-bridge to the microcontroller. The microcontrollers are integrated in the system as a master-slave communication function. Where two microcontrollers have to control two motors on each side and the ‘master’ microcontrollers control the motors via ‘slave’ microcontrollers. The command signals are sent via Bluetooth and hence the system has motion.

Head Movement: Here the ‘Head’ is referred to the robot ‘Head’ which has a plate mounted over a servo motor and the required input sensor (in this case camera) is placed on the plate. The movement of the plate occurs in the real time due to the readings sent to the servo motor controller by the gyroscopic sensor mounted on the virtual reality headset [These readings are angle of tilt of the head in horizontal axis].

Data Gathering: Here the data read by the 'Head' is sent to the smart phone placed on the VR-headset. The data is real time as the mode of communication is Wireless-Fidelity (Wi-Fi). Thus creating an illusion of physical presence at the place even though the operator is far away. This basically can be termed as 'Virtual presence'.

V. BLOCK DIAGRAM



VI. HARDWARE USED

a) MICROCONTROLLER

Microcontroller used in UGV is Arduino. Arduino is a single-board microcontroller to make using electronics in multidisciplinary projects more accessible. The hardware consists of a simple open source hardware board designed around an 8-bit Atmel AVR microcontroller, or a 32-bit Atmel ARM. The software consists of a standard programming language compiler and a boot loader that executes on the microcontroller.

It is programmed using an integrated development environment (IDE) for Arduino, which is a software application that provides comprehensive facilities to computer programmer for software development. An IDE normally consist of source code editor, build automation, tools and debugger.

Due to versatility of software in support in supporting multiple Arduino board and also providing multiple libraries to help interface with countless premade modules, Arduino IDE is best suited for the task to program the microcontroller when compared to AVR studio. The simplicity makes it easy to debug.

HARDWARE SPECIFICATIONS:

- Microcontroller: ATmega328
- Operating Voltage: 5V
- Input Voltage (recommended):7-12V
- Input Voltage (limits): 6-20V
- Digital I/O Pins: 14 (of which 6 provide PWM output)
- Analog Input Pins: 6
- DC Current per I/O Pin: 40 mA
- DC Current for 3.3V Pin: 50 mA
- Flash Memory: 32 KB (ATmega328)
- SRAM: 2 KB (ATmega328)
- EEPROM: 1 KB (ATmega328)
- Clock Speed: 16 MHz

b) DC MOTOR

Motor used in UGV for movement of vehicle is *gear motor* and for the movement of camera is *servo motor*.

a. SERVO MOTOR

SPECIFICATIONS:

MODULATION	DIGITAL
TORQUE	13 Kg/cm
ROTATON ANGLE	180 DEGREE
VOLTAGE	3V ~ 7.2V
WEIGHT	56g
DIMENSIONS	5.4cm X 4.4cmX2.0cm

b. GEAR MOTOR

FEATURES:

- Long-life: Intermittent operation over 1 million cycles with optimized brush design.
- Continuous operating life of 3000 hours.
- High output: High heat dissipation and heat resistance achieves higher output.
- High strength: High radial load capacity due to robust construction, large diameter output shaft and ball bearings.
- Low noise and increased insulation due to new resin brush holders.
- Large selection of gear heads and reduction ratios are available to meet all need.
- Easy to maintain.

SPECIFICATIONS:

RPM	200RPM @12V
VOLTAGE	4V to 12V
STALL TORQUE	18.33 kg-cm @12V
GEAR	Metal(spur)
SHAFT SIZE	8mm diameter
SHAFT LENGTH	25 to 30mm

c) LI-PO BATTERY

SPECIFICATIONS:

RATED VOLTAGE	11.1V
RATED CURRENT	2200mAh 30C/25C
EXACT WEIGHT	150 – 160 GRAMS
L X H X W	100 X 20 X30 APPROX

d) PROTECTION BOARD

DESCRIPTION:

- 11.1V (18650 or 3.7 lithium battery rated voltage).
- Size Approx. 5x1.6x0.1 cm /1.97x0.63x0.04 inch.
- Overcharge detection voltage: 4.25 to 4.36±0.05V.
- Over-discharge detection voltage: 2.3 to 3.0V±0.05V.
- Maximum working current: 3A to 5A.
- Transient current 4A-6A.
- Short circuit protection.
- Overcharge protection.
- Over-discharge protection.
- Overcurrent protection.
- Compact size and lightweight.
- Operating temperature: 40~50ºC.

e) H-BRIDGE

SPECIFICATIONS:

- Double H-bridge Drive Chip: *L298N*
- Logical voltage: *5V Drive voltage: 5V-35V*
- Logical current: *0-36mA Drive current: 2A (MAX single bridge)*
- Max power: *25W*
- Dimensions: *43 x 43 x 26mm*
- Weight: *26g*

*Built-in 5v power supply, when the driving voltage is 7v-35v.

f) COMMUNICATION

There are two modes of communications used in UGV:

- Bluetooth→ HC-05
- Wi Fi

Bluetooth communication is used for short range control of UGV as well as control camera motion.

Wi Fi communication is used to get video feed from the camera.

HARDWARE SPECIFICATIONS OF HC-05:

- TYPICAL -80dBm sensitivity.
- Up to +4dBm RF transmit power.
- Low power 1.8V operation, 1.8 to 3.6V I/O.
- PIO control.
- UART interface with programmable baud rate.
- With integrated antenna.
- With edge connector.

g) FUTURE APPLICATIONS

- The nuclear industry, doing work in areas with radiation levels dangerous to human workers. The centre for Engineering Systems Advanced Research (CESAR) at Oak Ridge National Laboratory (ORNL) is a major hub for DOE funded work, including the HERMIES series of mobile robots.
- Military heavy equipment for moving dirt under enemy fire, such as repairing craters in a runway or breaching a minefield or other barrier. The Air Force has the lead in this area with projects such as Rapid Runway Repair.
- Strong manipulators for moving and loading heavy items such as ammunition. Army Human Engineering Lab (HEL) efforts have included the Soldier-Robot Interface Program (SRIP) and the Field Material Handling Robot Technology (FMR-T) project.
- Explosive ordnance disposal (EOD) -manipulators capable of dealing with packages containing suspected bombs, unexploded ordnance, etc. The Navy's EODTECHDIV has the joint services lead in this area; one project has been the Robotic Ordnance Neutralizing Device (ROND).
- Rescue and fire-fighting mission can be easily handled by UGV.
- Unmanned Ground Vehicle as a weapon system or weapon.
- Virtual presence in dangerous environment.
- Data acquisition and analysis.
- Photography and entertainment.
- Military application such as DRDO (Defence Research and Development Organisation).

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VIII. CONCLUSION

By adopting a well developed architecture and adapting software and hardware created for Virtual Reality Unmanned Ground vehicles, a significant reduction in construction and integration resources can be realized.

Robotic development and integration time can be dramatically reduced by adapting robust technologies created for different families of vehicles. Typically, the expected vehicle response to a given stimulus is independent of the medium in which the vehicle is operating. Since VR-UGVs operate in an essentially two dimensional worlds (they cannot submerge or fly) the control system rules are nearly identical, only the magnitude and direction of the response to a given situation can vary significantly. Realizing this characteristic early in the design of new vehicle types may lead to adaptation of existing vehicle systems which will reduce vehicle development time.

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