1 of 1

2

Conf-940859--11

SAND-9...

A Highly Agile Ground Assessment Robot (HAGAR) for Military Battlefield and Support Missions

P. Klarer

Advanced Vehicle Development Department
Robotic Vehicle Range
Sandia National Laboratories
Albuquerque, New Mexico

Abstract

A mobile robotic vehicle with potential for use in military field applications is described. Based on a Sandia design intended for use in exploration of the Lunar surface, the Highly Agile Ground Assessment Robot (HAGAR) is a four wheeled all-wheel-drive dual-body vehicle. A uniquely simple method of chassis articulation is employed which allows all four wheels to remain in contact with the ground, even while operating in very rough terrain and climbing over obstacles as large as a wheel diameter. Skid steering and modular construction are used to produce a simple, rugged, lightweight, highly agile mobility chassis with a reduction in the number of parts required when compared to conventional vehicle designs for military battlefield and support missions. The design configuration, mobility parameters, potential mission configurations, and performance of existing and proposed HAGAR prototypes are discussed.

Introduction

Reconnaissance, surveillance, intelligence gathering, and treaty monitoring\verification are activities that require the acquisition of high quality, accurate data in a timely fashion. Presently the use of high technology, typically in the form of orbital platforms, high altitude aircraft, or air deployable non-mobile ground sensors are the preferred methods. There are limits to the quality of data that may be gathered from standoff distances and fixed ground locations, therefore the requirement at some point for mobile 'eyes on the ground' currently calls for the emplacement of specially trained personnel. In friendly territory this does not present a significant problem, however in hostile territory the danger to human assets can be significant, as can the ramifications if those assets are compromised.

The concept behind this paper is based on the premise that people should be used for such dangerous missions only as a last resort, and that mobile robotics technology can be employed to augment data gathering operations, and to mitigate the danger and potential national security ramifications of mission compromise[1]. Mobile robotics technology has

This work was supported by the United States Department of Energy under Contract DE-AC04-94AL85000.

several potential advantages over humans for data gathering missions in hostile territory. They include disposability, deniability, and long term mission capabilities that are difficult and expensive to match with people. By employing existing technologies, several small inexpensive air-deployable mobile robotic sensor platforms may be covertly delivered inside hostile territory to aid special operations personnel with intelligence gathering, surveillance, reconnaissance, and prestrike military missions.

HAGAR Design Configuration

The High Agility Ground Assessment Robot (HAGAR) design is a direct outgrowth of the Robotic All Terrain Lunar Exploration Rover (RATLER), a vehicle originally designed for exploration of the Lunar surface[2]. Although there are significant differences between RATLER and HAGAR, there are enough similarities to warrant a brief discussion of their requirements. Both systems must be lightweight, highly mobile, relatively small, and robust. In addition, they both must have a certain level of onboard autonomy. In both cases, this requirement derives from a desire to minimize the number and level of interactions with the robot by a remote human operator. Both systems must be capable of transporting and supporting a mission payload, including the acquisition of sensor data and relay of that data back to a human operator. The differences between RATLER and HAGAR mission and performance requirements include unit cost, on-station operating time, environmental conditions, and maximum traverse speed performance. Although development of the HAGAR system is not currently funded, several RATLER prototypes and a HAGAR-like version of RATLER have been built and are currently operational. Figure 1 shows the RATLER prototypes with the HAGAR prototype painted in desert camouflage.

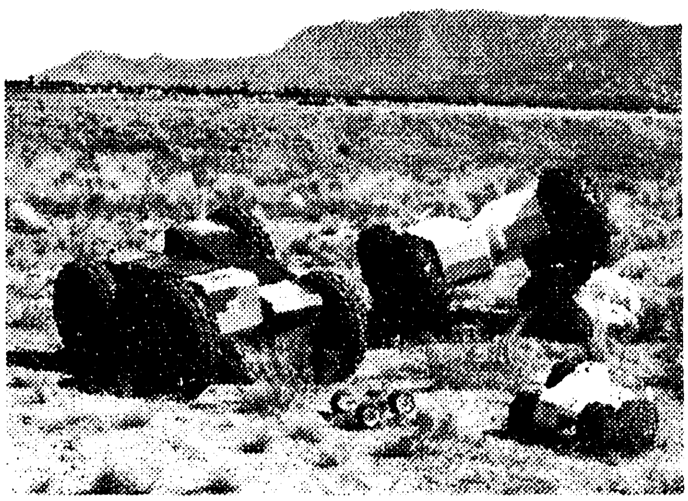

Figure 1. RATLER and HAGAR Prototypes

Like the RATLER, the HAGAR vehicle is expected to display superior mobility in rough terrain and be mechanically simple and lightweight. In addition, HAGAR is expected to be relatively inexpensive to mass produce. It is constructed of a high strength, low weight carbon\epoxy composite material, which has very low observable signatures in the RF and thermal spectrums, and is electrically powered to minimize its acoustic signature. Although an actual HAGAR has not yet been constructed, several RATLER vehicles have been. The major difference between the existing RATLER prototypes and a HAGAR prototype is in maximum speed capability. The RATLER is not required to move very fast, only up to 1 meter per second. On the battlefield or in a covert mission, a HAGAR vehicle may have to cover ground very quickly, and it is estimated that a dash speed of at least 10 to 15 meters per second may be required. Table 1 lists the expected performance requirements and physical configuration for a HAGAR vehicle, and is based on experience with the RATLER II system and discussions with potential military users of a HAGAR robotic vehicle. Figure 2 shows the mechanical configuration of the RATLER II prototype, on which the HAGAR design concept is based.

Table 1. HAGAR Specifications

Parameter	Value	Units
Wheel Radius	27.9	cm
Wheel Width	25.4	cm
Wheelbase	73.6	cm
Stance (to center of contact patch)	95.3	cm
Total Vehicle Mass (TVM, no payload)	70	kg
Total Stored Volume (TSV)	0.6	$meters^3$
Maximum Single Dimension of TSV	174	cm
Maximum Speed	13.4	meters/second
Slope Stability	>45	degrees
Slope Climbing	~30	degrees
Obstacle Climbing	~75	cm
Maximum Payload Mass (additional to TVM)	18	kg
Maximum Payload Power (planned)	100	watts (electric)
Maximum Payload Internal Volume	9600	cm^3

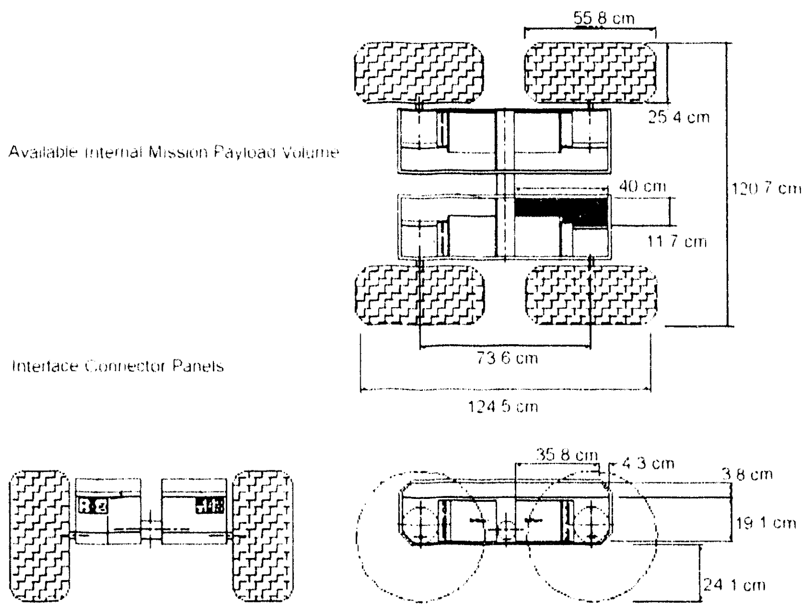

Figure 2. RATLER II\ HAGAR Configuration

Control Driving Station

The RATLER system Control Driving Station (CDS) shown in Figure 3 was originally intended to support field test operations using the prototype vehicles, and would be used for remote operations of the HAGAR vehicle. The CDS is approximately 60 centimeters wide, 46 centimeters tall, 76 centimeters long, and weighs ~18 kilograms. Designed to accommodate field operations and rapid setup, the CDS accepts power from either a 28 VDC or 110VAC external source, and includes separate RF modules for data and video links. The CDS incorporates two joysticks, a color liquid crystal display (LCD) video screen, an electro-luminescent (EL) data display w/ touchscreen interface, a 32 bit computer architecture with two processors, and a menu driven real-time multitasking software system.

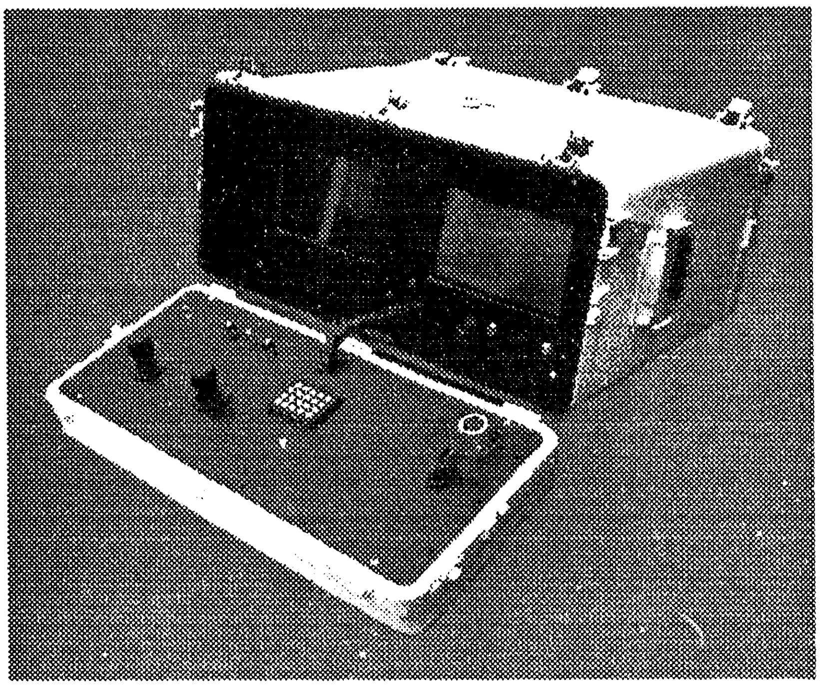

Figure 3. Control Driving Station

Possible HAGAR Mission Scenarios

Reconnaissance, surveillance, intelligence gathering, and covert military operations inside hostile territory are some of the unconventional activities performed by military personnel. This section attempts to address the applicability of a small, covert mobile robotic device employed either as an air deployable (parachute drop) system or as an amphibious platform deployed offshore. The design goal for a HAGAR development program would be to add a capability that serves to protect and assist the primary assets of the mission, i.e. the mission team's highly trained and very valuable personnel. The robot could be very valuable by providing a means to create diversions without putting friendly personnel at risk, to covertly acquire data in highly dangerous situations prior to initial action, to probe unknown situations or locations in advance of the team, and to provide a measure of 'force multiplication' by acting as part of an armed assault force. Various sensor packages can be tailored for mission-specific requirements, including such existing technologies as low-light cameras, IR imagers, acoustic sensing, NBC detectors, and RF monitoring\intercept equipment. Other potential payloads could include RF jamming gear, various decoy systems, laser target designators, or even high explosive charges. The potential missions for a small, highly agile, covert mobile robot are seemingly endless, particularly when a fleet of robots, each configured for a particular phase of an operation or set of operational missions, could be deployed simultaneously from either a single aircraft or marine vessel

Air Deployment

When housed in an air-deployable clamshell canister fitted with airbags and a high speed drogue parachute, the HAGAR can be deployed from aircraft using either a high speed, low-altitude lay-down delivery technique or a high altitude - low open (HALO) technique. A radar proximity fuse would deploy the chute and the airbags just prior to impact, to minimize the system's observability during deployment. After impact, the airbags and chute are jettisoned, and the clamshell shaped canister opens to deploy the robot and a high gain phased array satellite communications antenna. Projected missions after deployment include reconnaissance, intelligence gathering, target designation, post-attack damage assessment, and preparation\clearing of potential drop zones. Additional applications include using HAGAR in a direct support role for assault forces, special operations forces, and regular ground forces in conventional battlefield operations as a squad-level equipment transport "mule", or as a deployable mobile decoy device.

Marine Deployment

When properly configured for operations in shallow water and surf, the HAGAR platform could be deployed from a small boat or submersible just offshore, and proceed either along the bottom or at shallow depth through surf to arrive on a hostile beach. The design modifications to allow operations in a wet environment and to shallow pressure depths appear to be relatively straightforward, involving the addition of shaft pressure seals, a specialized wheel design, and underwater communications gear. Such a platform could be very useful in assaulting a heavily defended beach, in that it could be used as a 'sacrificial' attack mechanism when fitted with an Explosively Formed Projectile (EFP) warhead similar to that used on the FIREANT[3] system, and would be suitable for use in obstacle clearing or against hardened targets that otherwise might result in heavy casualties if attacked by conventional military forces. The robot would very likely be electrically powered, and would be operated from a small, portable control station via a secure fiber optic link. In addition to the optical link, electrical power for the robot may also be transmitted along the tether, which significantly improves the robot's ability to carry payloads and operate for long periods.

Conclusion

It appears that the use of mobile robotics technology for military purposes is a logical extension of existing "smart" weapons technology, in that modern guided missiles and glide bombs are in fact robotic devices with sensing and onboard guidance control systems. The HAGAR concept is based on a highly agile mobile chassis design originally intended for nonmilitary applications, and which is currently under development at Sandia National Laboratories. All of the technologies envisioned for use in the proposed system already exist in one form or another. It only remains to properly integrate the required elements to demonstrate the HAGAR system's capability. It should be recognized however, that there is an element of risk in the pursuit of this proposed system. Potential "show stoppers" include, but are not necessarily limited to: communications, power versus range\operating lifetime on station, and total cost (including sensors) in mass production.

Acknowledgments

The author wishes to thank the following colleagues for their ideas and input to the material in this paper. Bryan Pletta, James Purvis, and Stephen Roehrig have brought their own creative powers to bear on the HAGAR system concept, and have provided many useful ideas and approaches to overcoming technical problems with the system concept. Although much remains to be done, their help has been critical to the work successfully accomplished to date in both the RATLER vehicle development and the HAGAR concept design.

References

1. SHAKER M. and WISE A.;"War without Men, Robots On The Future Battlefield"; Pergamon-Brassey's International Defense Publishers Inc., 1988; ISBN 0-08-034216-7

2. KLARER, P. and PURVIS, J., "A Highly Agile Mobility Chassis Design for a Robotic All Terrain Lunar Exploration Rover," American Nuclear Society's Fifth Topical Meeting on Robotics and Remote Systems, Knoxville, TN, (1993).

3. Sandia National Laboratories Internal Video-documentation: FIREANT Demonstration, 1986

DATE FILMED

7/7/94

END