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Amphibian Robot

Nishant, Rudransh
College-BMIET/GGSIPU, School Sarvodaya Public School/Baghpat
New Delhi, India
Email: nsnt.rajput@gmail.com

Abstract: "Amphibian Robot"
To design & develop an amphibian exploring robot capable of operations in constrained mine environment puts a tremendous challenge to system develop from both scientific & engineering perspective. Very few attempts have made to fulfill these criteria of versatility in design, communication & control. The CSIR-MERI developed amphibian subterranean robotic explorer (SR) is capable of moving over fairly rough terrain. It can swim at 1 knot. A number of field trails have been carried out for performance testing of the system to ascertain it capability in underground flooded mine tunnel. This paper present the insight on the design of an amphibian robot for mine exploration. Safety & disaster mitigation with special features of low power consumption vis-a-vis high mission time..

Introduction: An amphibious robot as the name suggests is a robot that goes on land, on water and in water. Amphibious bot can be operated in various means. It can be operated manually as well as it can be an autonomous robot. The main objective of this project is to make an amphibian robot, which can travel on land, on water and inside water. The part where we need to build a robot that can transverse on land is quite easy. But as we need it to float on water, we design the bot in such a way that it is slightly positive buoyant. The metal detector works on the principle that when a current passes through the coil, it produces a magnetic field around it.

Objective: To design an amphibian robot for garbage and oil cleaning.

Swot: It is the study where we learn and tell the factual parts of any projects by it strength ,weakness, opportunities and threats.

Strengths: Strength is internal, positive attributes of an organization. These are things that are within your control. For control purposes, we need more mankind and by this project, we can provide more employment. The amount can be spent in an economically and efficient way.

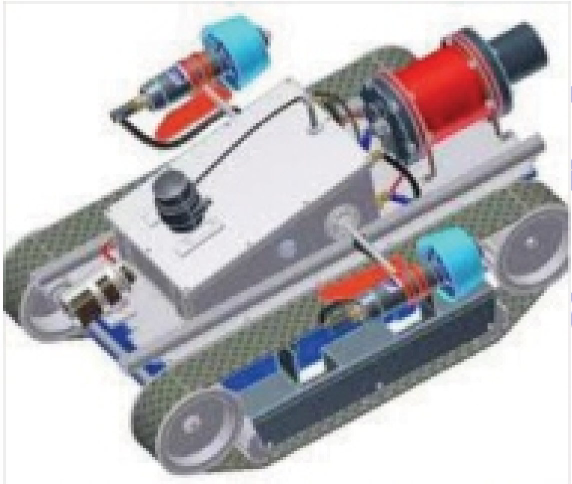
Weakness: Weakness is negative factors that detract from your strength. These are things that you might need to improve on to be competitive. Less working time of amphibian robot. Dependent on human reasoning.

Opportunities: Opportunities are external factors in your organization environment that are likely to contribute to your success. Advancement in the medical field as well as the technical field and in the caves which is the most hazardous in the recent times.

Threats: Threats are the external factors that you control over. you may want to consider putting in place contingency plans for dealing with them if they occur. Uncertainty in weather condition Overcrowded than expectations.

Body Joint: Connecting the two body segments presents many problems. Torque must be transmitted from the front motor to the rear wheel-legs. Power and communication lines must be passed between the two body segments. The body joint must be actuated with a motor and any linkage must be water and dirt tight. A pair of coaxial shafts are used: the outer one is rigidly attached to the front body segment, allowing a motor in the rear body segment to actuate the body joint; the inner shaft is the middle wheel-leg drive shaft, which also passes torque to the rear of the robot. The outer shaft is 6.35 cm in diameter, large enough run several electrical lines through. By keeping all connections axial in nature, a standard rotary shaft seal around the outer shaft can be used to keep water and dust out (Fig 4). A body joint on previous allowed the robot to climb larger objects by giving the front wheel-legs higher reach and by preventing high cantering. However, several designs have not survived field-testing.

Figure 1.0:



Equipment Layout: Arrangement of various equipment's and placements of sensors were determined based on their field of view and beam angle. The underwater camera used has a built-in light and having field of view 54º x30º. The sonar has a maximum scanning field of 360º and the acoustic modem with 17.8 kbps acoustic link has a range of 1.5km in narrow beam mode which is a 60º cone. Lower cavity of the hull is comparatively larger and houses most of the heavier equipment.

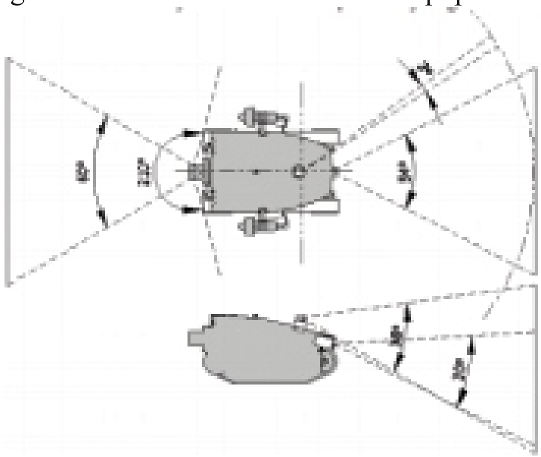


Fig 2.0, showing the layout of equipment to be fitted in the amphibian robot.

Force Management:

Rt = Rf + Rd

Where, R_f and R_d are friction drag and pressure drag respectively. Again.

$Rf = ½(\rho A w V^2 Cf)$

$Rd = ½(\rho A f V^2 Cd)$

Where,

V = Velocity of the explorer

ρ = Density of water

A_w = Wetted surface area

A_f = Frontal projection area

C_f = Skin friction resistance co-efficient

C_d = Viscous pressure drag co-efficient

Design Specification:

Basic Dimension	550*270*250mm
weight	41.5kg
Speed/depth	0.5m/s &10m
drive	Depends on motor
processor	PC-104
communication	Acoustic RF based
architecture	TCP/IP
Power supply	Li-On Battery

Features:

1. Lightweight design
2. Compact and modular
3. Reduction in the Unit power demand
4. Reduction in Aerodynamic Interferences between the Propellers
5. Better Stability by keeping the Center Of Mass on the Center of the Longitudinal Axis
6. Single Robot is Cost-effective than Multiple Dedicated Robots

Terrestrial locomotion:

The movement on land is simply based on the working of tanks. It moves on a conveyer belt wound around two wheels (one on either side). These wheels are attached to the shafts of high torque motors (this is to ensure that the motors are able to carry the vehicle in adverse terrestrial conditions). Above all the motion is cleared to transit the motion on the land for the surface, whether it is slides. Hilly and random plane. Based on the body structure, motion characteristics of amphibians, two generations of multimode biomimetic amphibious robots, named "Amphi Robot", have been developed. For terrestrial movements, a geometry based steering method called body-deformation steering has been proposed and optimized, taking advantage of the wheel-like mechanisms attached to the robot. At the same time, a chainlike CPG network responsible for coordinated swimming between multi-joint tail and artificial pectoral fins has been built. The aquatic control parameters mainly involve the length of undulation part, oscillating frequency and amplitude cooperatively regulated by the threshold values of the saturation function for each propelling unit. The real-time online calculation of controlling parameters has been also implemented. Preliminary testing results, both on land and in water, have demonstrated the effectiveness of the proposed control scheme. However, the amphibious locomotion performance of the Amphi Robot is still far behind that of animals in terms of speed and agility, especially in complex unstructured environments. More cooperative efforts from materials, actuators, sensors, control as well as learning aspects will be needed to improve the robot locomotor skills in unstructured and even unknown surroundings. The ongoing and future work will focus on the analysis and optimization of locomotion control for autonomous movements as well as flexible water-land transitions. Hydrodynamic experiments-based hybrid mechanical/electrical optimization, of course, is a plus for real-world applications.

Locomotion on the water surface: Using kinematic and mechanical experiments, we have shown how fisher spiders, Dolomites triton (Araneae, Pisauridae), can generate horizontal propulsive forces using their legs. This horizontal thrust is provided primarily by the drag of the leg and its associated dimple as both move across the water surface. Less important sources of resistance are surface tension and bow waves. The relative contributions of drag, surface tension and bow waves were examined in several different ways. In one experiment, we measured the forces acting on a leg segment as water flowed past it in non-turbulent flow; the bow wave was not present at leg relative velocities below 0.2ms-1 and thus cannot play a role in thrust production at low leg speeds. In a second experiment, we varied the surface tension by altering the concentration of ethanol from 0% to 9% in the experimental water tank. At a constant dimple depth, force varied little with changes in surface tension, a result consistent with the hypothesis that drag is the primary source of resistance. In addition, however, as surface tension decreased from 0.072 to 0.064Nm-1, the power exponent of the relationship between force and velocity (as measured by the exponent of the power function relating the two variables) increased; at lower surface tensions, down to 0.054Nm-1, the power exponent of the relationship between force and velocity decreased. These results suggest an influence of surface tension (albeit still secondary to drag) in generating horizontal resistance to leg movement. We also measured flow disturbance in the water downstream from a leg segment and confirmed that, even at velocities well below 0.2ms-1, the leg-cum-dimple transferred momentum to the water, which is a clear indication that drag is a contributor to the resistance encountered by a spider's leg. Finally, modelling the leg-cum-dimple as a circular cylinder generates values of drag that account for 7598% of the measured leg force when the dimple is 0 or 1mm deep. These results not only elucidate the primary mechanism of propulsion for D. triton and other similar-sized arthropods, such as adult water striders (Gerridae), but also suggest that the formerly enigmatic locomotion of very small water-walking organisms (e.g. first-instar water striders) can be understood in the same way.

Underwater Movement Mechanism:

Cost Efficiency: -

ARTICLES	QUANTITY	PRICE
Fabrication		9000
Motors of graphite served	2	3000
Thrusters	2	1500
Li-on Battery		300
PC-104+Based system computer		5500
sensors		800 Total= 16000 Approx.

Key Benefits: Pollution free, Opportunities, Environmental beneficial, Decrease in health issues, Better livelihood, Cost effective, Time saving, Swachh Bharat.

Conclusion:

We report the preliminary design of a robust amphibious biologically inspired robotic platform, Whegs™, IV. These design innovations will allow Whegs™ IV to navigate on rough terrain and under water, and to accomplish tasks with little or no low-level control. This will greatly simplify the autonomous control problem and give the vehicle unprecedented mobility and versatility. Because of Amphibious Whegs™ ability to swim, it could be deployed far out to sea, swim toward shore and then walk along the ocean floor through the surf zone and onto the beach. It could search for objects on land or on the ocean floor and swim over obstacles that pose any risk of trapping it, making it ideal for mine sweeping, surveying and civilian applications.

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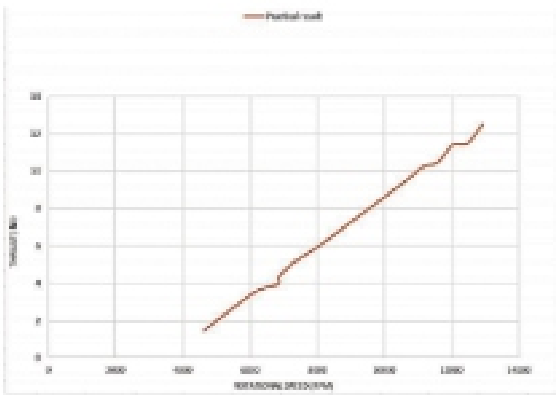
Graph Thrust V/S Speed:



Future Scope: In our future work, we would like to develop methods to further improve our approach (e.g., adaptive horizon). We would also like to extend our approach to a decentralized Amphibian robot guidance problem to rescue multiple targets. In this decentralized case, we will induce coordination among the Amphibian robots to rescue multiple targets by appropriately optimizing the communication (at the network level) between the bot along with the kinematic controls for the bot.

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