Manufacuring of Articuated Insect Robot

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Abstract

The aim of this project is to manufacture robot of six legs having single motor and battery at each leg and which can able to walk on land and swim under the water. For this manufacturing process we consider material with maximum light in weight. As well we are using different sensors and ardiuno to control the robot
Insect behavior has been a rich source of inspiration for the field of robotics as the perception and navigation problems encountered by autonomous robots are faced also by insects. The Insect robot that was built as a test bed for new biologically-inspired, vision-based algorithms and systems. The Insect robot is a ground-based robot but it is capable of simulating conditions of free flight. It is a robust test bed for flight navigation algorithms that offers advantages over other platforms such as helicopters blimps and other air vehicles. We present the navigational behaviors currently implemented on this robot. Major sub systems include the well-known bee-inspired, corridor-centering behavior, a flow-based docking algorithm and feature detection algorithms.

Keywords: *"Bionic Underwater Micro-robot, Micro ICPF actuators, Micro-mechanism, Multifunctional locomotion, Autonomous Underwater Vehicles, Cathode bending*

I.INTRODUCTION

Insect behavior has been a rich source of inspiration for the field of robotics as the perception and navigation problems encountered by autonomous robots are faced also by insects. The Insect robot that w as built as a test bed for new biologically-inspired, vision-based algorithms and systems. The Insect robot is a ground-based robot but it is capable of simulating conditions of free flight. It is a robust test bed for flight navigation algorithms that offers advantages over other platforms such as helicopters blimps and other air vehicles. We present the navigational behaviors currently implemented on this robot. Major sub systems include the well-known bee-inspired, corridor-centering behavior, a flow-based docking algorithm and feature detection algorithms.

The main advantage of legged robots is their ability to access places impossible for wheeled robots. By copying to the physical structure of legged animals, it may be possible to improve the performance of mobile robots. To provide more stable and faster walking, scientists and engineers can implement the relevant biological concepts in their design. Our design is inspired by the creature rather than an attempt to copy it, since that is not always possible or desirable with current technology. Although the locomotion of animals, including many insects, is superior to current robots, we use a different design for our legged robot than that found in nature

Keywords: "Bionic Underwater Micro-robot, Micro ICPF actuators, Micro-mechanism, Multifunctional locomotion, Autonomous Underwater Vehicles, Cathode bending

II.LITERATUREREVIEW

2. 1 M.F.SILVA AND J.A.TENREIRO MACHADO

During the last two decades the research and development of legged locomotion robots has grown steadily. Legged systems present major advantages when compared with "traditional" vehicles, because they allow locomotion in inaccessible terrain to vehicles with wheels and tracks. However, the robustness of legged robots, and specially its energy consumption, among other aspects, still lag being mechanisms that use wheels and tracks. Therefore, in the present state of development, there are several aspects that need to be improved and optimized. Keeping these ideas in mind, this paper

presents the review of the literature of different methods adopted for the optimization of the structure and locomotion gaits of walking robots. Among the distinct possible strategies often used for these tasks are referred approaches such as the mimic of biological animals, the use of evolutionary schemes to find the optimal parameters and structures, the adoption of sound mechanical design rules, and the optimization of power-based indexes.
Keywords: Walking Robots, Artificial Legged Locomotion, Locomotion Gaits, Optimization, Genetic Algorithms.

2.2 Uluc. Saranli , Martin Buehler ,Daniel E. Koditschek

In this paper, the authors describe the design and control of RHex, a power autonomous, untethered, compliant-legged hexapod robot. RHex has only six actuators one motor located at each hip achieving mechanical simplicity that promotes reliable and robust operation in real-world tasks. Empirically stable and highly maneuverable locomotion arises from a very simple clock-driven, open loop tripod gait. The legs rotate full circle, thereby preventing the common problem of toe stubbing in the protraction (swing) phase. An extensive suite of experimental results documents the robot's significant "intrinsic mobility" the traversal of rugged, broken, and obstacle-ridden ground without any terrain sensing or actively controlled adaptation. RHex achieves fast and robust forward locomotion traveling at speeds up to one body length per second and traversing height variations well exceeding its body clearance.

***Keywords:* -** legged locomotion, hexapod robot, clock Driven, mobility, autonomy, biomimesis

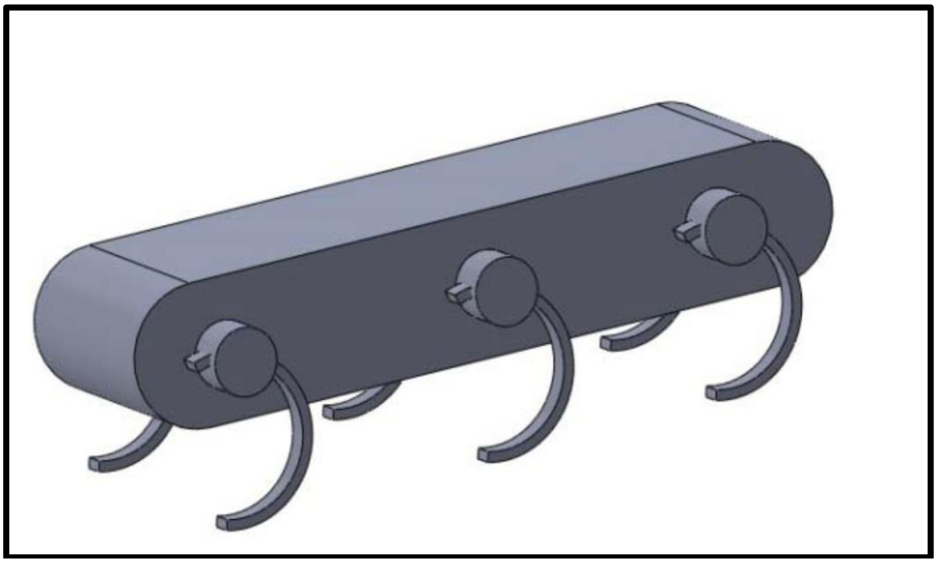
2.3 Heraclio Pimentel Jr.

For at least a decade, curiosity and innovation have driven humans to combine the natural with the technical to create Hybrid Insect Micro-Electro-Mechanical Systems ("HI-MEMS" 1 or "cyborg insect drones"). Originally fueled by the Defense Advanced Research Projects Agency ("DARPA"), humans are exploiting insects' natural abilities to achieve feats that are not currently available with purely mechanical technology such as drones. The potential uses of this HI-MEMS technology include: mapping difficult to explore environments, search and rescue operations, environmental rehabilitation and monitoring, and even counter-terrorism. With these beneficial uses also come certain obvious risks such as surveillance concerns. Further, as the technology advances, the "dual-use" applications of HI-MEMS create the potential for nefarious actors to invade personal privacy and endanger national security. This article will provide an introduction to cyborg insect drone research and discuss some of the benefits and risks presented by HI-MEMS.

III..DESIGN OF THE ROBOT

3.1 Basic concept:

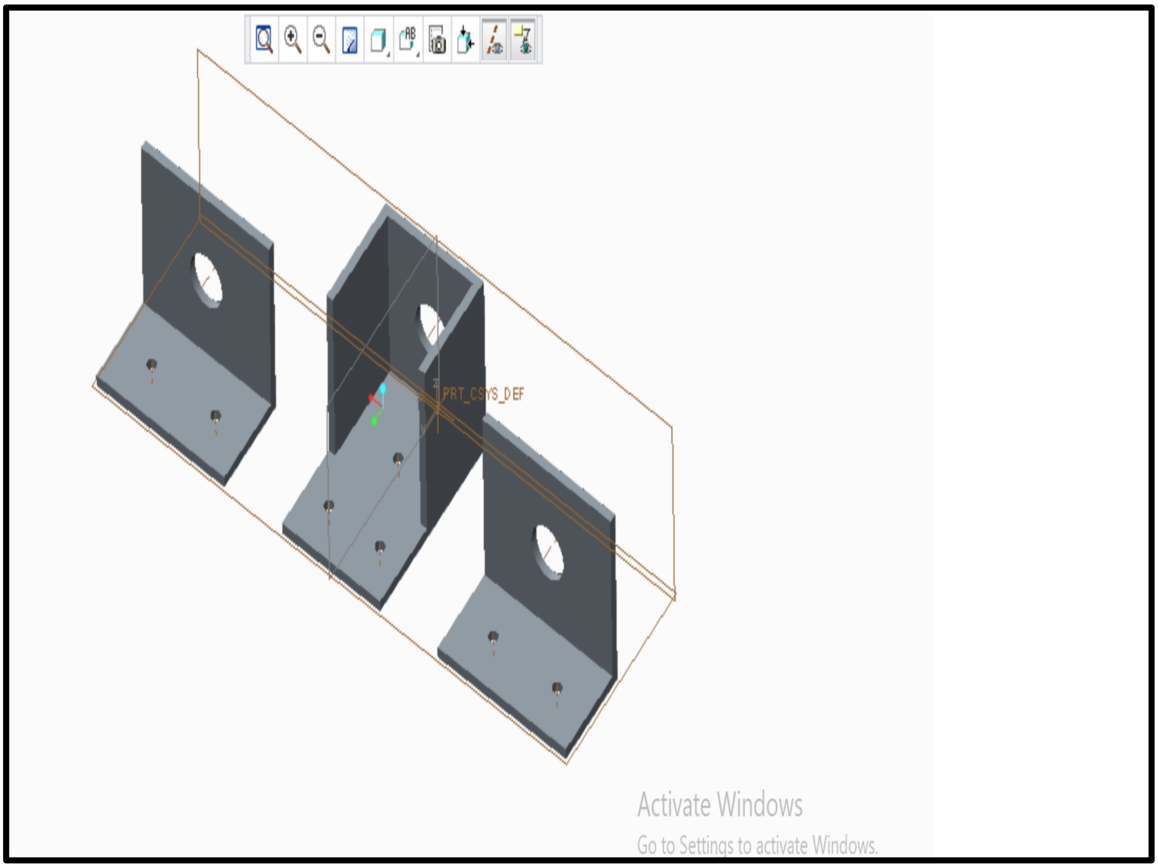
In a research done by various people, there are different types of robot which perform different functions. Like some robot are able to walk on land and some of the robots are able to swim under water as well as some robots are able to fly. All this robot are somehow inspired by the different creatures on the earth. So basic concepts of our robot is mixing different functions or abilities of different creatures to manufacture a single robot. That is combine the function of two robot so it can perform more efficiently. So, common characters of animal are extracted so that they can walk on land and swim under water.
The basic structure of the body of robot is such way that it covered from all sides and other sensors and batteries can put inside. Entire body is then go through resin. It leg robot having six legs along with six motors and batteries connected separately

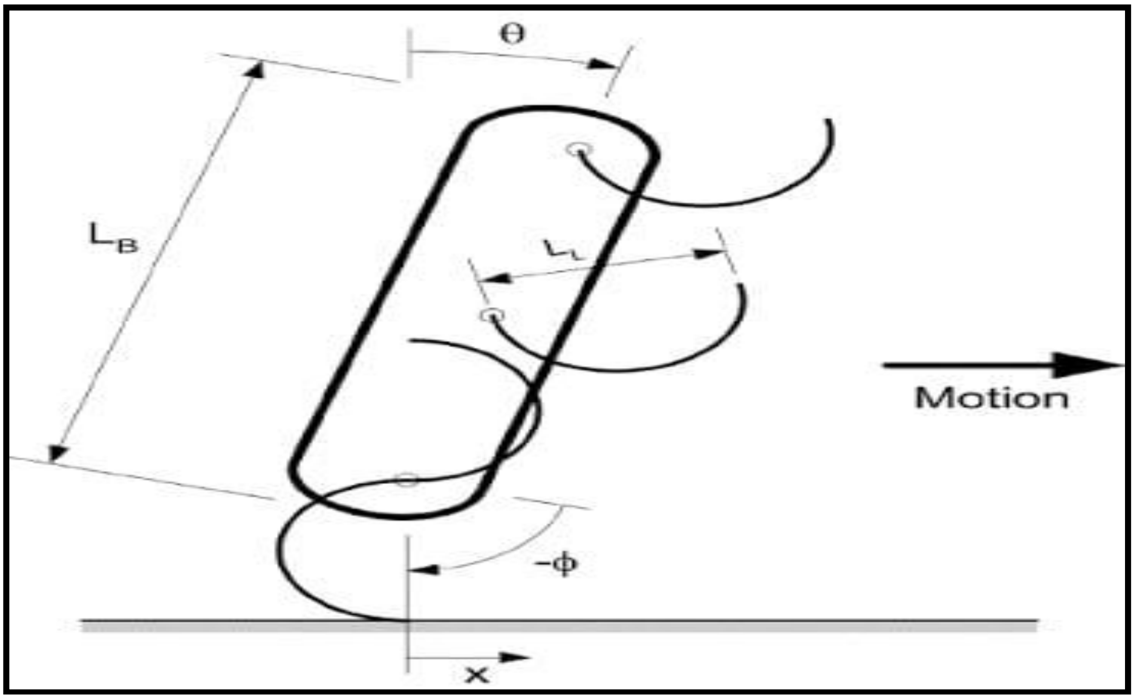


MODIFYED DESIGN OF THE ROBOT

As, we see previous structure can be quite heavy so it can make trouble to swim under water and also can not walk smoothly over land so by modifying previous structure we can decrease its weight'

The new modified structure of main body consist of single A4 size acryalic sheet and six small plates. Among these six plates four plates are of l shapes and two box shaped plates. And these are bolted on acryalic sheet.





. CONTROL STATERGY:

The present prototype robot has no external sensors by which its body state may be estimated. Thus, in our simulations and experiments, we have used joint space closed loop (\proprioceptive") but task space open loop control strategies. The algorithms that we describe in this section are tailored to demonstrate the intrinsic reliability of the compliant hexapod morphology and emphasize its ability to operate without a sensor-rich environment. Specifically, we present a four-parameter family of controllers, that yields translation and turning of the hexapod on °atterrain, without explicit enforcement of quasi-static stability. In Section V-C, we demonstrate the capabilities of this family of controllers on our experimental platform, over a wide range of terrain conditions, from °at terrain to a rough, broken surface

All controllers generate periodic desired trajectories for each hip joint, which are then enforced by six local PD controllers (one for each individual hip actuator). In this

respect, the present controller family represents one nearextreme along the spectrum of possible control strategies, ranging from purely feedforward (i.e., taking no notice of body state), to purely feedback (i.e., producing torque solely in reaction to leg and rigid body state). It seems likely that neither one of these ex tremes is best and a combination should be adopted. The simulations and experimentspresented in this paper attempt to characterize the properties associated with the sensorless feedforward extreme, which, when RHex has been endowed with sensors, we hope to complement with feedback to explore the aforementioned range.

DESIGN CALUCULATIONS:

- **Given:**
- 1)Weight = 2kg = 2*9.81 = 19.6N
- 2) Length = 4 inch =101.6 mm
- 3)Thickness (h) = 1.33mm
- 4)FOS= 4
- 5) Syt = 50 Mpa
- 6) R=101.6/2 -1.33/2 = 50.135
- 7)Ro =101.6/2 = 50.8
- 8) Ri = 50.8-1.33 = 49.47
- 9) A = 15*1.33= 19.95 mm^2

• 10) N = 150 RPM

Calculations:
Leg design
Middle two legs are in contact
Force on each leg F = 19.6/2 = 9.81 N
1) FOS = Syt/Bending stress
4=50/Bending sterss
Max .Bending Stress = 12.5 N/mm^2
2) Compressive stress = F/A
= 9.81/A
3) Max. Bending stress = Bending stress+compressive stress
Bending stress = 12.5-(9.81/A) N/mm^2

4) Bending stress = Mb* hi/(A*e*Ri)
but,
Mb =F * Rn
=9.81*50.135 = 491.824 Nmm

hi =Rn- Ri
= 50.132 – 49.47 = 0.662 mm

e = R-Rn
= 50.1 – 50.132
= 0.032 mm
Bending stress = Mb *hi/(A* e* Ri)
12.5 –(9.81/A) = 491.824 *0.662/(A*0.032*49.47)
A = 19.95 mm^2
A = thickness * width
19.95 = 1.33* width
width = 15 mm

• **Motor Selection :**
Torque = F* L
= 9.81 * 101.6
= 996.696 Nmm

Power = 2*3.14*N*T/60
= 2*3.14*150*996.696/60
= 15.648 KW

. Selection of Material:
Common materials used for wind lens are ABS Acryalic Sheet and PVC Pipe following datasheets gives important properties of both materials.

Properties	**ABS**
Physical Properties	
Density	1.04 g/cc
Melt Flow	18 - 23 g/10 min
Mechanical Properties	
Hardness, Rockwell R	103 - 112
Tensile Strength, Yield	42.5 - 44.8 MPa

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Elongation at Break	23 - 25 %
Flexural Yield Strength	60.6 - 73.1 MPa
Izod Impact, Notched	2.46 - 2.94 J/cm
Thermal Properties	
Maximum Service Temperature, Air	88 - 89 °C
Deflection Temperature at 1.8 MPa (264 psi)	88 - 89 °C
Flammability, UL94	HB

Properties	**Acryalic Sheet**
Physical Properties	
Density	1.19 g/cc
Water Absorption	0.130 – 0.800 %
Mechanical Properties	
Hardness, Rockwell R	94 - 105
Tensile Strength, Yield	54 - 69 MPa
Elongation at Break	3 – 6.40 %
Flexural Yield Strength	81 MPa
Thermal Properties	
Maximum Service Temperature, Air	Below 73 °C
Flammability, UL94	HB

Properties	**PVC Pipe**
Physical Properties	
Density	1.4 g/cc
Melt Flow	18 - 23 g/10 min
Mechanical Properties	
Hardness, Rockwell R	1 - 70
Tensile Strength, Yield	35 – 50 MPa
Elongation at Break	20 - 40 %
Thermal Properties	
Maximum Service Temperature, Air	50 - 80 °C
Flammability, UL94	V0

ABS is consider for 3D prints where aesthetics is important. And it is also easily available. **ABS** is best suited for applications where strength, ductility, machinability and thermal stability are required. Hence ABS is used. **PVC** pipe is also used becaused it is light in weight and the required shape of leg is achieved by the PVC pipe easily. **RESINE** is used to make it water proof. And the **ACRYALIC SHEET** is used as base.

CAD MODEL:
As, discussed before plates are design through 3D printing

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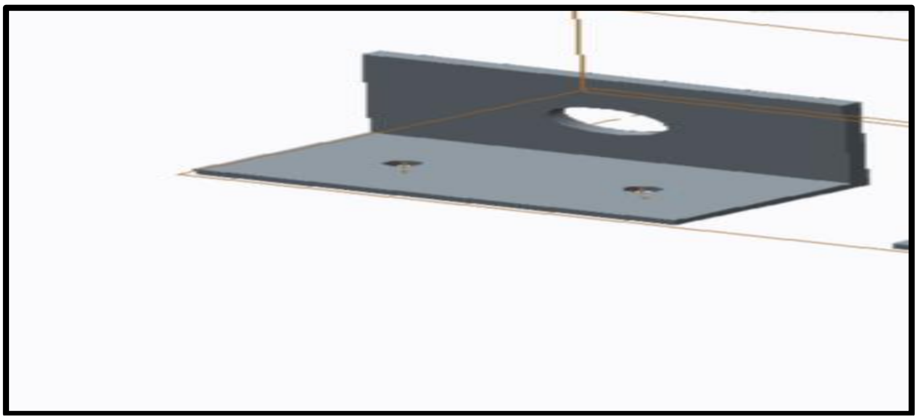
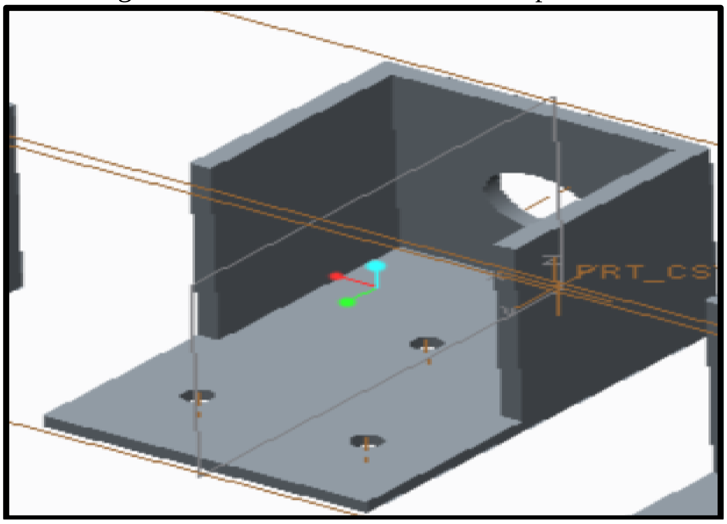
Geometries for CAD models:

General common dimensions used in cad models are based on design calculation and as per model requriment.

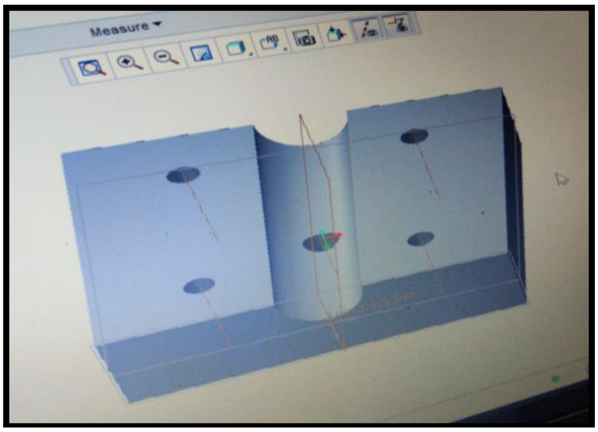
1) Small hole size = 3mm   Large hole size = 14 mm   Thickness of plate = 3 mm



2) Small hole size = 3mm Large hole size = 14mm Thickness of plate = 3mm



1) Thickness of the plate =7 mm Bolt holes (small holes) = 2mm   Semicircle Diameter (Motor Shaft Diameter) = 6 mm



. Conclusion:

Insect robot was design from the ground up with the needs of research in the mind. All components are to be design to be as light weight and high performance as possible. The knowledge for all the research paper are to be incorporated within the prototype. We are trying to design and development the bionic micro robot with the six legs based on arduino which can able to walk or climb on land as well as able to swim underwater.

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