All-terrain autonomous legged robotic platform

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Introduction

- Developing an all-terrain legged robotic platform capable of maneuvering and navigating in a non-structured environment has been an area of research in recent years.

- Provides a stable motion system for robots equipped with various sensory systems, to perform tasks autonomously to reach a goal.

Introduction

- A body structure
- A muscle system to move the body structure
- A sensory system that receives information about the body and the surrounding environment
- A power source to activate the muscles and sensors
- A brain system that processes sensory information and tells the muscles what to do

Structure

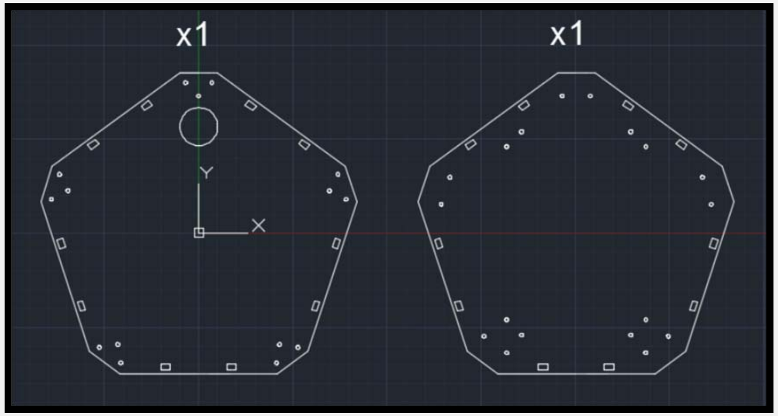
- Spiders‘ locomotion mechanism inspired the structure of this experimental robot but adjusted accordingly for maximum functionality/performance.
- Legged locomotion expects higher degrees of freedom and greater mechanical complexity than wheeled systems.

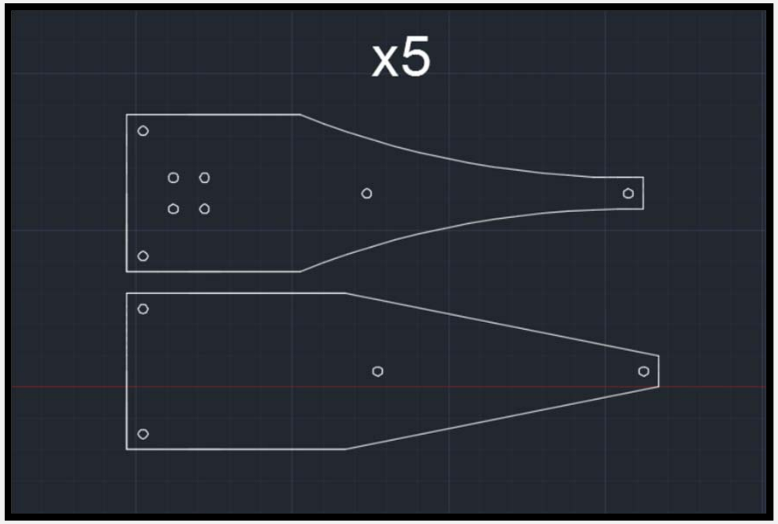
Structure

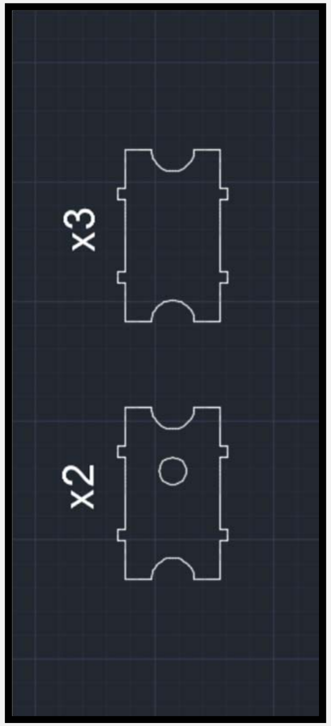
- The most suitable structure is a 5-legged robotic platform which combines the structure stability of a 6-legged robot and the lowered power consumption of a 4-legged robot.

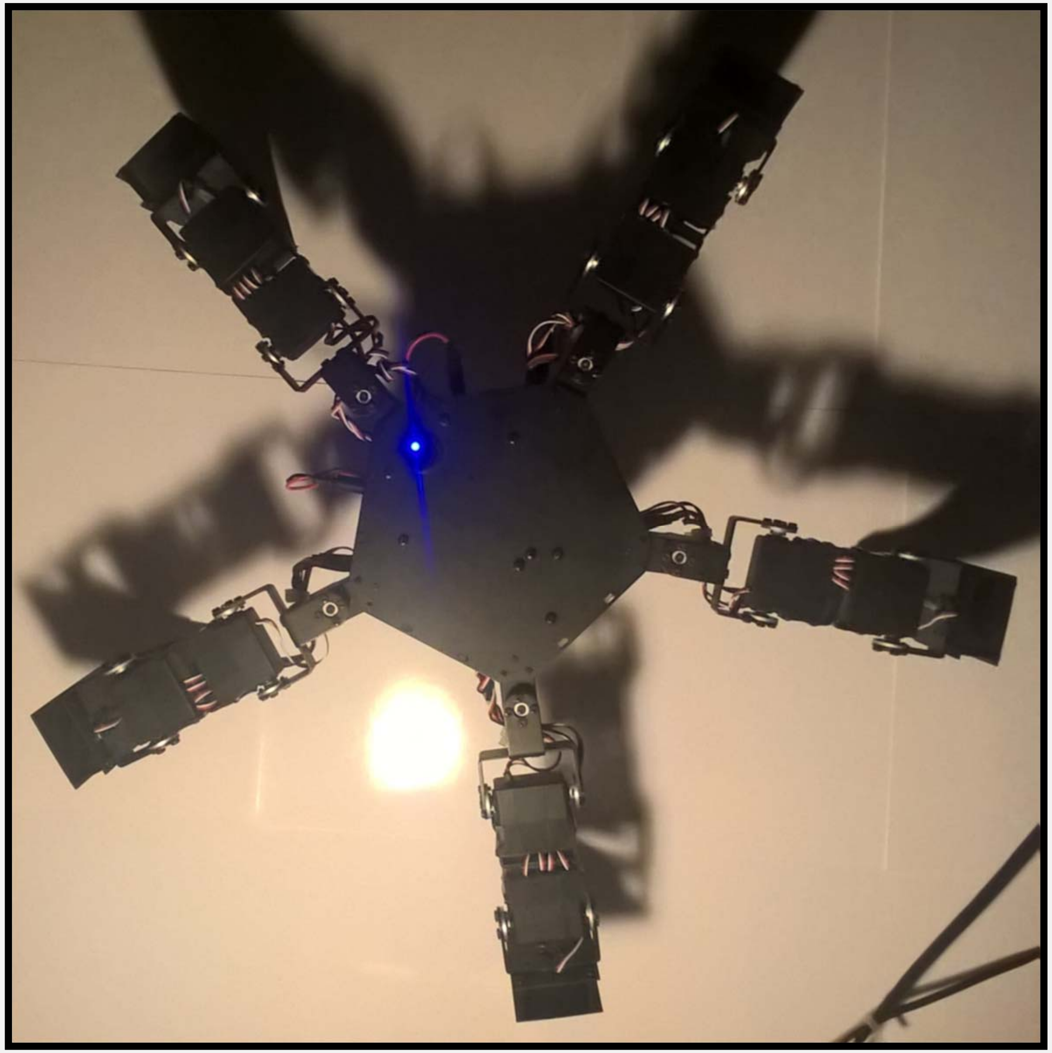
- The distribution of the working space of each leg is equal thus the body construction is symmetrical.

Structure





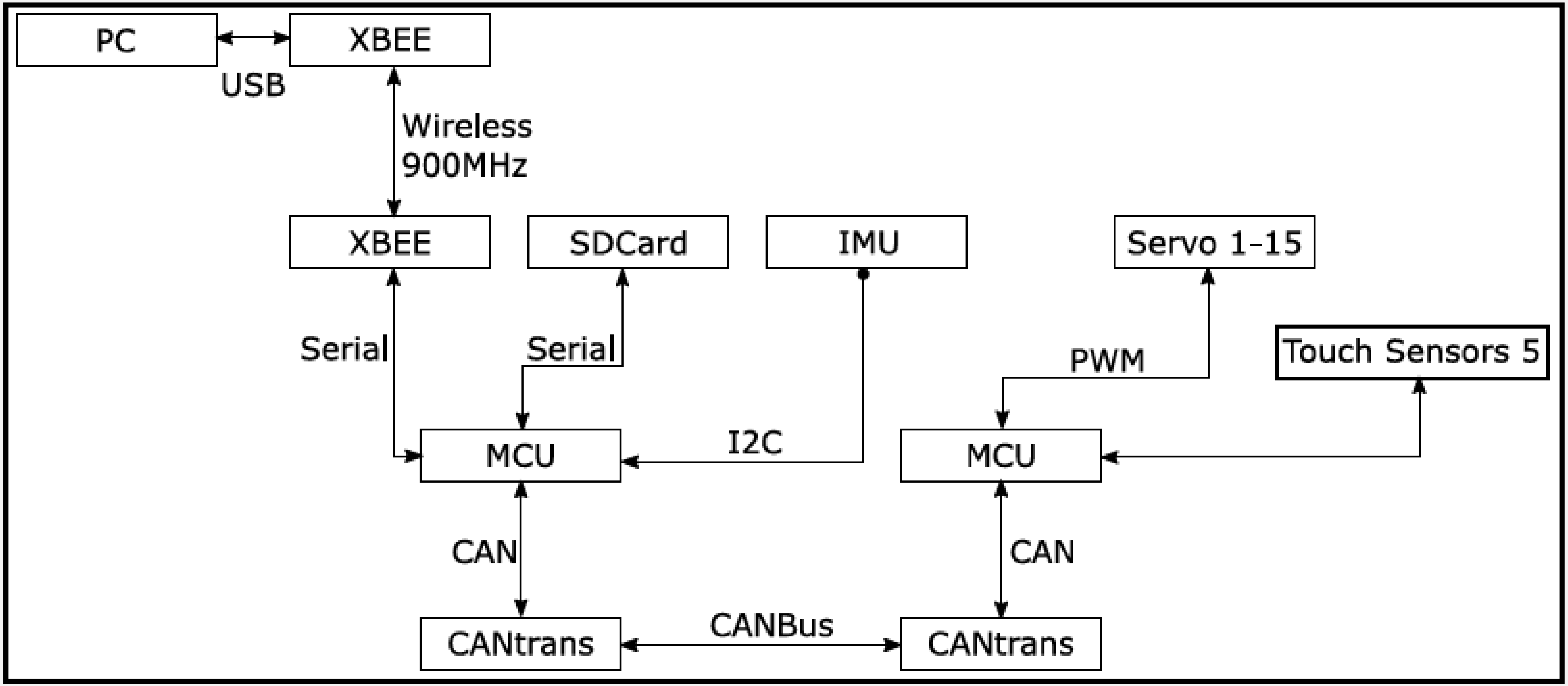




Electronic Circuit

- The brain of the robotic platform is using two microcontrollers ARM Cortex M4 running at 45MHz, each one for a specific workload.
- Equipped with a sensory system to provide the necessary feedback from the environment as well as some input/output pins for external sensors/modules.

Electronic Circuit



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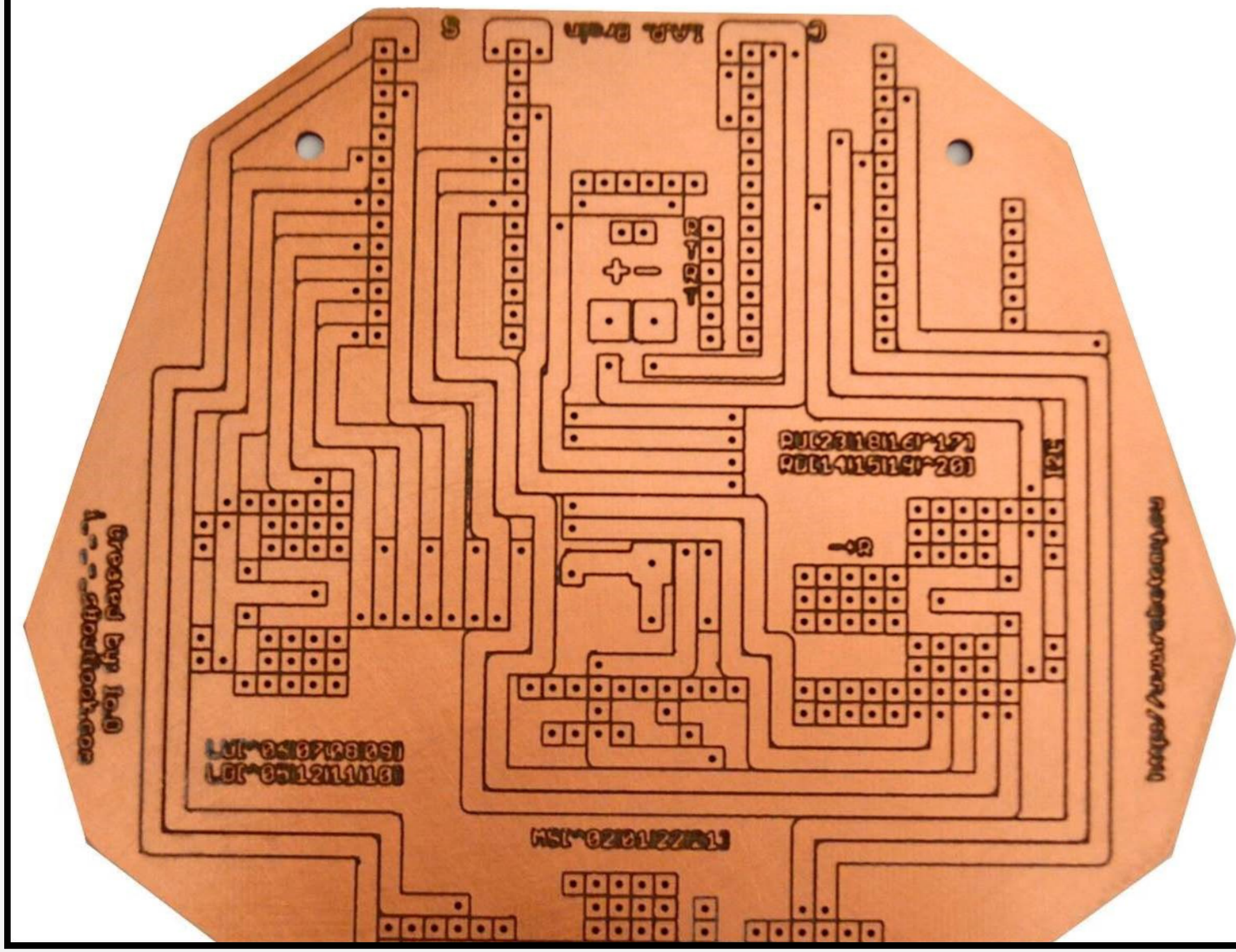

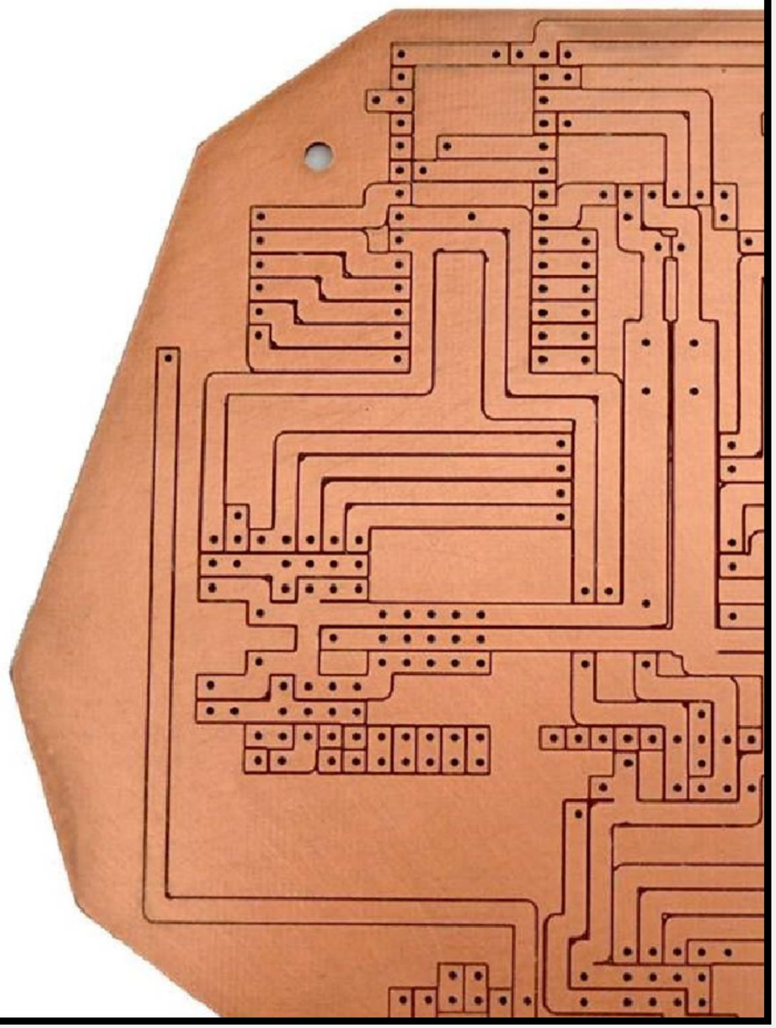

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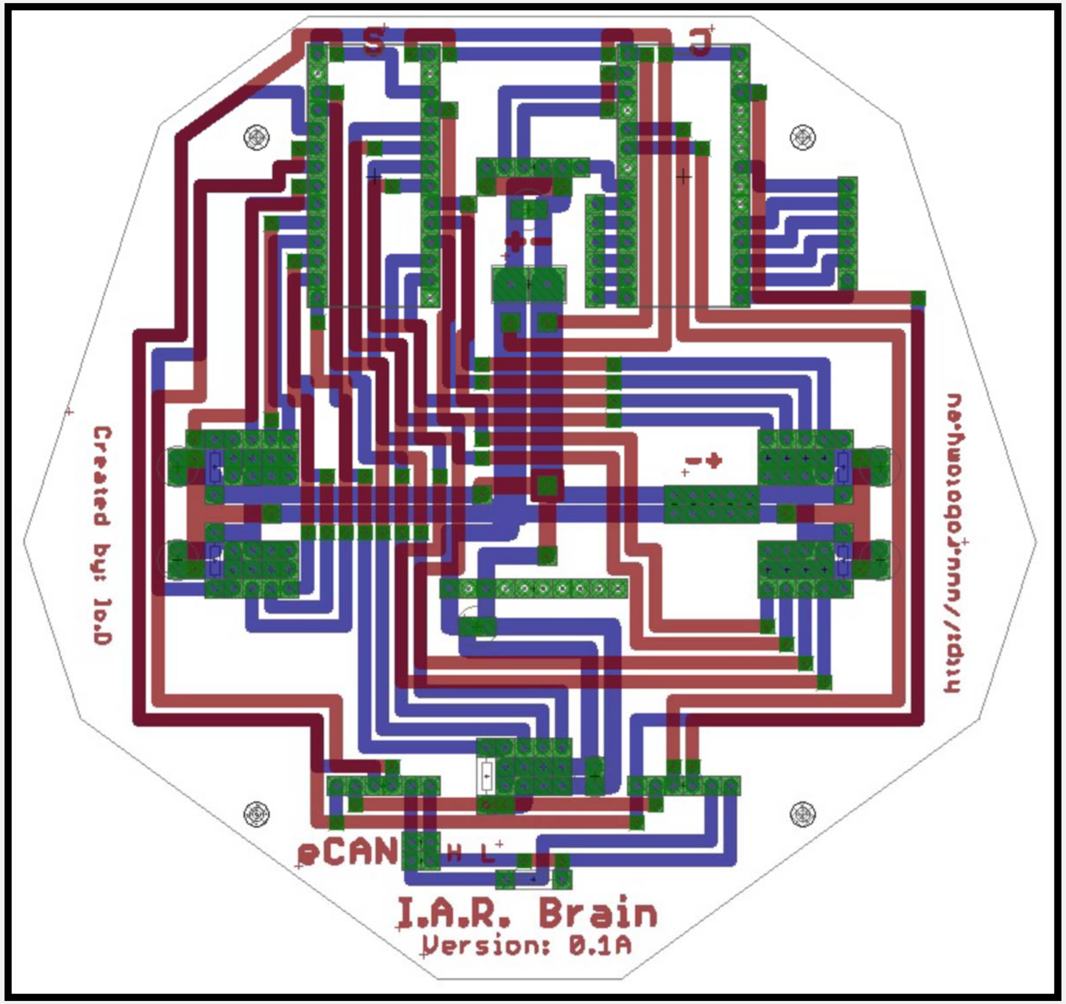

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eCAN
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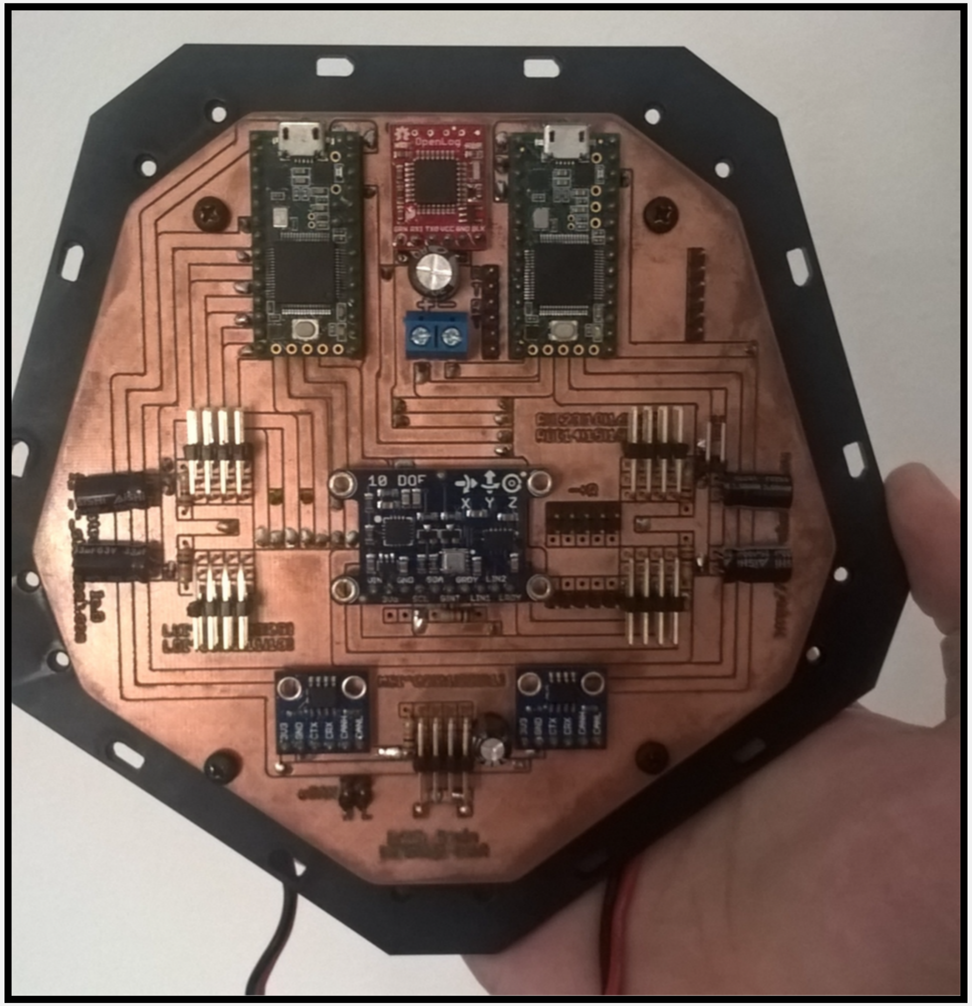

10 DOF
X Y Z

Kinematics

It is not advised control the legs directly, rather than controlling the position/rotation of the body.

Any change of the body's position is translated into changes of each leg position.

By using Inverse Kinematics, we can work out the angles of each servo, and the robot moves the way we wish.

Kinematics

The implementation is separated into two main parts:

- Body Inverse Kinematics
- Leg Inverse Kinematics

Inverse Kinematics Algorithm is based on Algebraic Solution Approach with some simple fuzzy rules to eliminate false positive actions.

To simulate acceleration and deceleration on each movement we apply a transformation to each servo's position as it moves to ease it in and out of its resting positions.

Software Design

Real-time Operating system (FreeRTOS) with an Improved Task Control Block in both microcontrollers

Adaptive Memory management scheme to avoid any memory fragmentation and provide stable and predictable operation

Unified Secured Messaging Protocol for safe interconnection of different communication protocols (Serial, I2C, CAN)

Final Results

Thank You