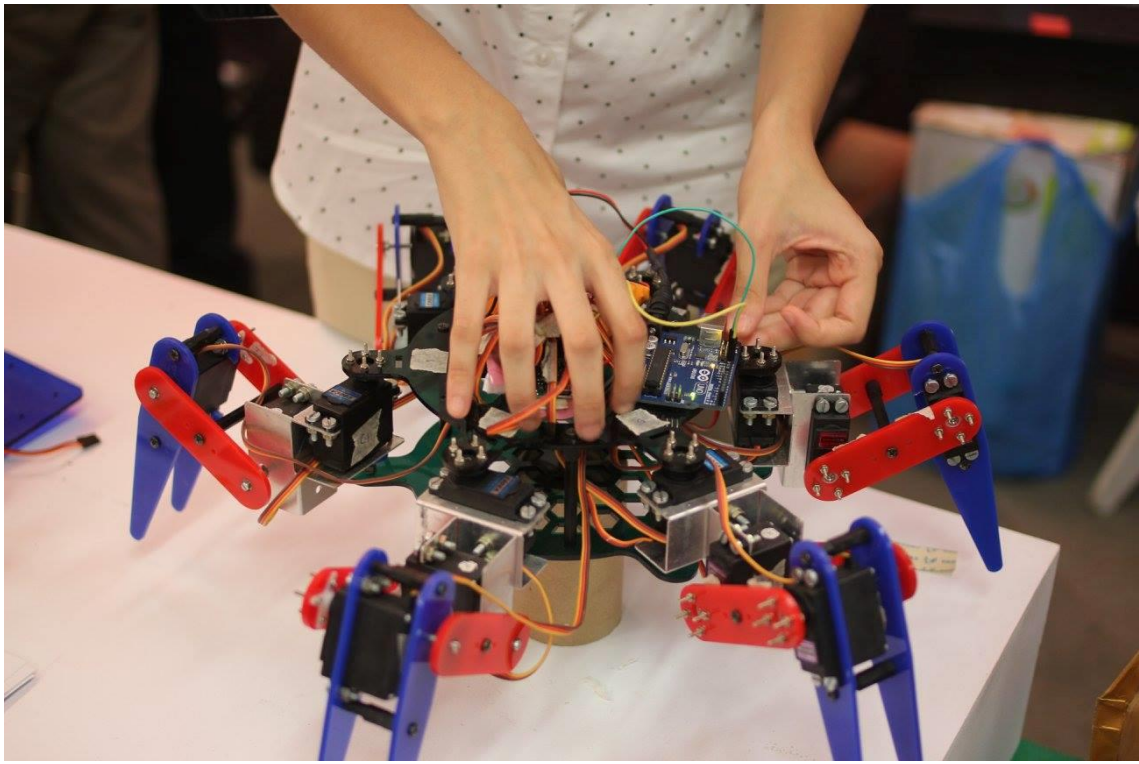
chalopede

what?
Bachelor's thesis project: Design and Prototyping of Multilegged Walking Mechanism

where?
Homi Bhabha Centre for Science Education, Tata Institute of Fundamental Research

when?
Aug '14 – May '15

who?
A team of three girls.
Collectively worked on every aspect of the project from initial mechanism selection to final prototyping and testing.



Chalopede is a six-legged walking robot developed by our team as a part of our bachelors thesis project in mechanical engineering. The aim of the project was to design and build a walking mechanism for uneven terrain. Such mechanisms would be further developed for applications in planetary surveillance, internal inspection of machines, surveillance of calamity struck areas etc. After weighing various parameters a six-legged mechanism that follows an alternating tripod gait inspired by the arthropods was selected. Following an iterative design process a fully functional prototype was successfully developed.

robotics|walking mechanism|CAD|electronics|arduino|rapid prorotyping

Selection of Mechanism

Parameters	Theo Jansen	Klann Linkage	Biped	Quadruped	Hexapod	8 legged
Ability to walk on uneven surface (50)	2	2	5	4	5	5
Resources (40)	4	3	4	4	5	3
Stability (40)	3	3	2	3	4	5
Control (30)	4	4	2	2	3	2
Cost (30)	4	4	1	2	2	1
Maneuverability (20)	2	2	5	3	4	4
Weight (30)	4	4	1	3	4	3
Simplicity of mechanism (20)	4	4	2	3	4	3
Manufacturability (30)	4	4	2	3	3	3
Total	**980**	**940**	**810**	**900**	**1130**	**980**

Selecting a mechanism was the first and most critical decision of the project. The team started with a literature review followed by a quantitative analysis to compare the mechanism based on a list of parameters. A hexapod mechanism was selected for further detailed design and testing.

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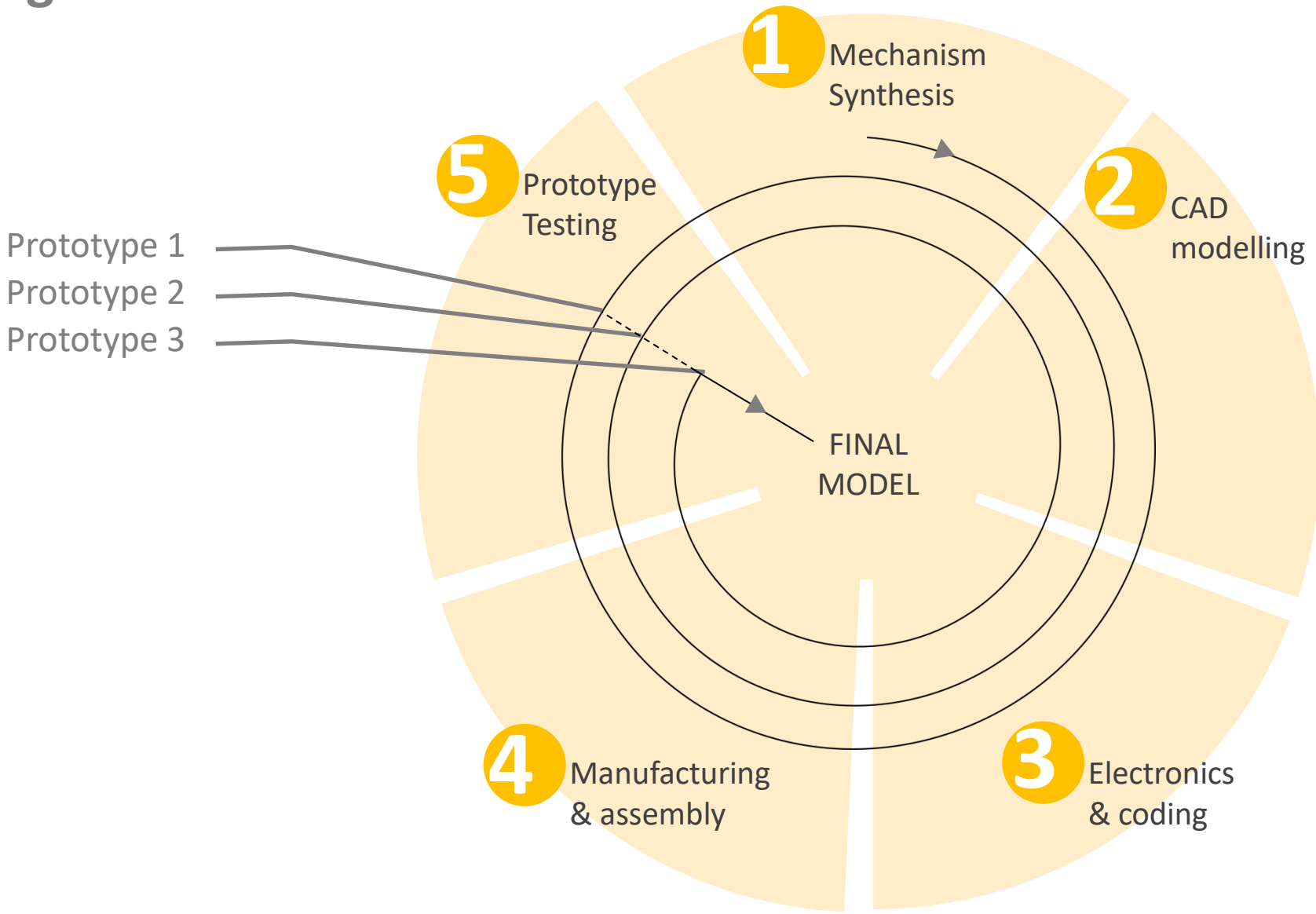
Design Process



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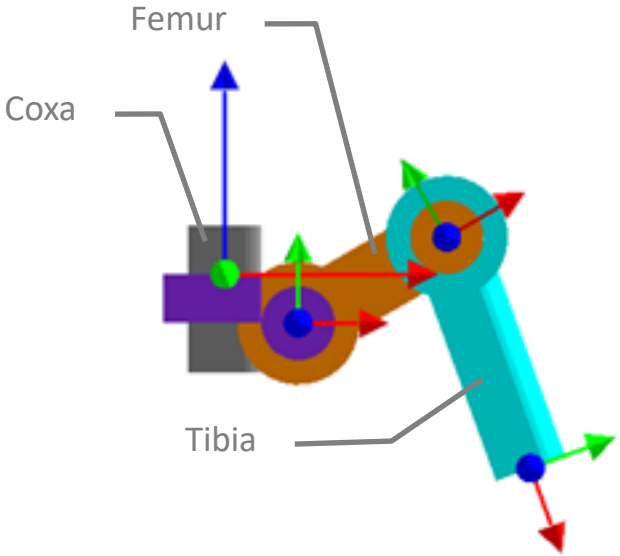
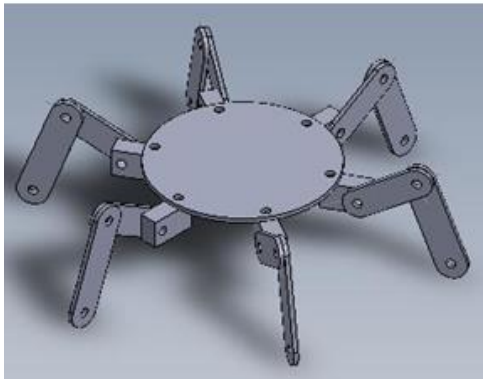
1 Mechanism Synthesis

Our team performed direct and inverse kinematics to determine optimum length of each link and rotation angles of each joint. This was followed by CAD modelling of a stick model to simulate and verify the stride and step height.

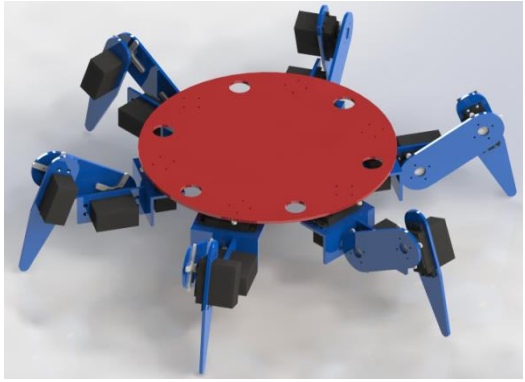


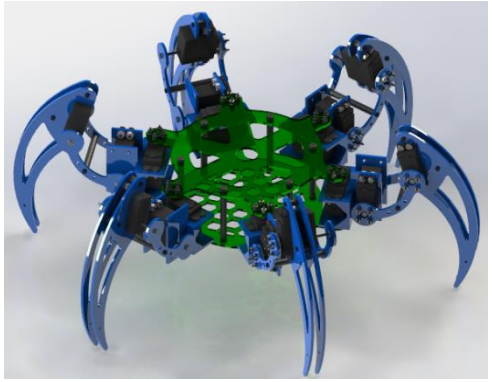
Leg Anatomy

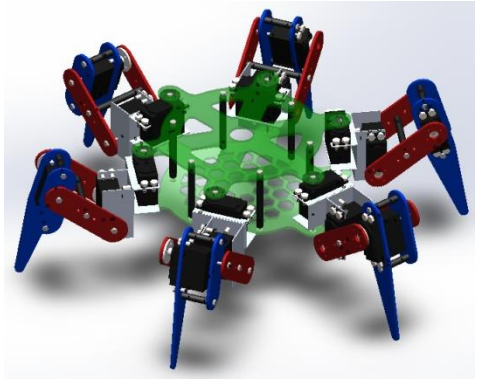


Stick model

2 CAD modelling







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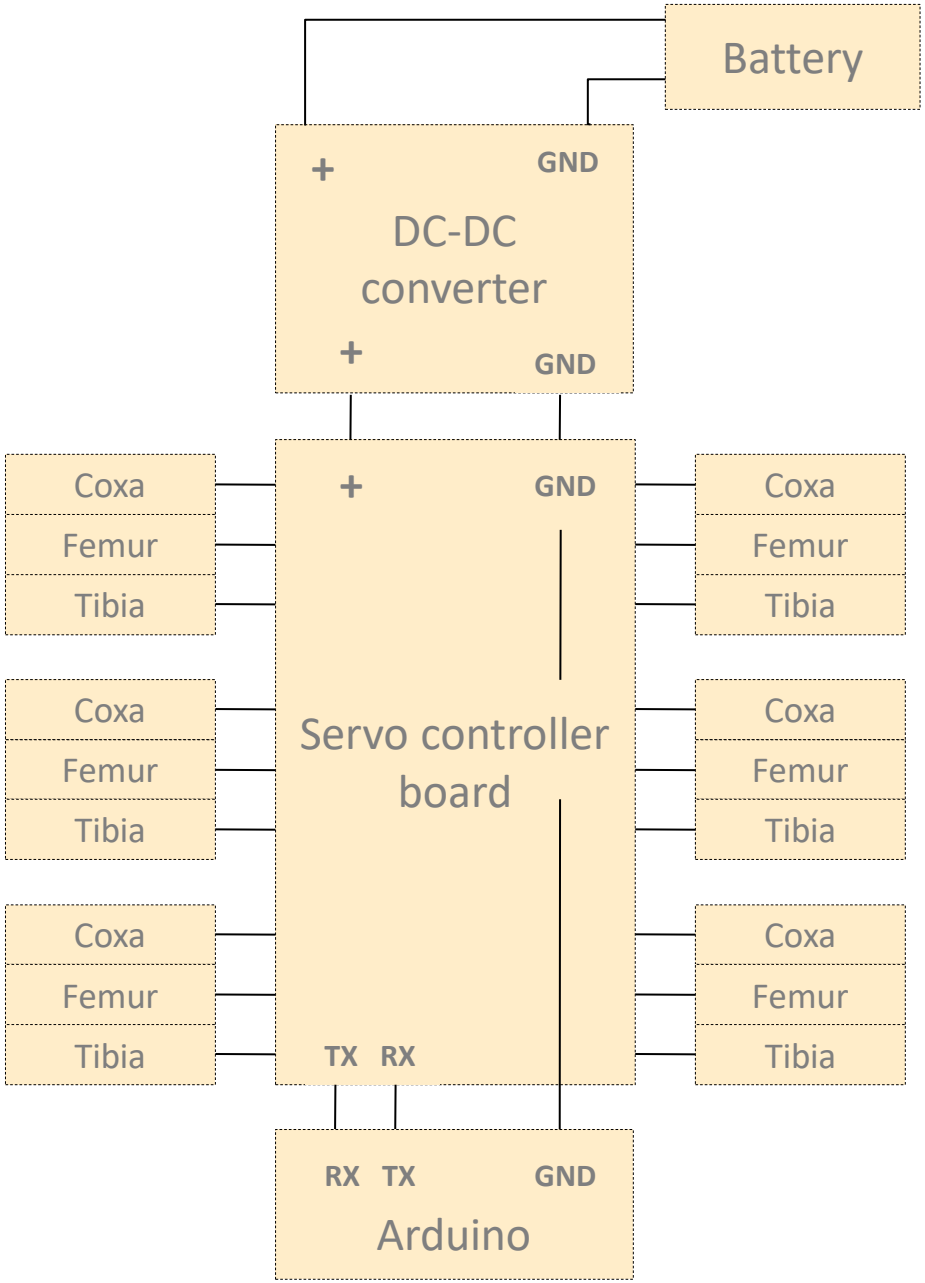
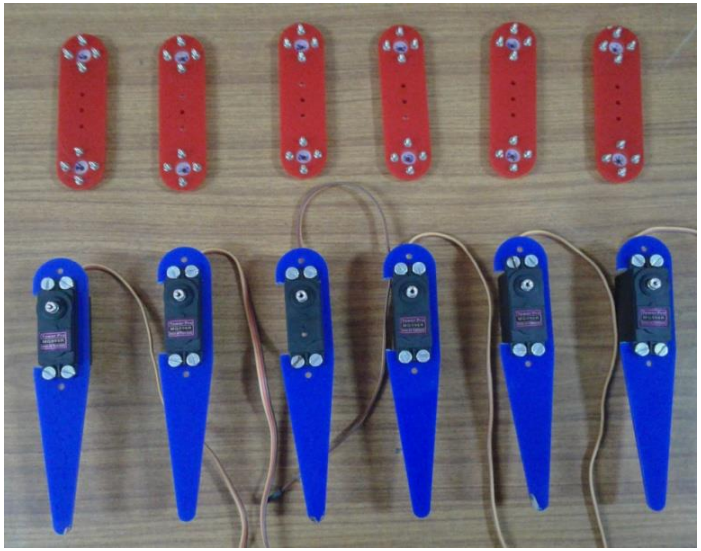
3 Electronics & coding

An electronics system was designed to power and control 18 servo motors (3 on each of six legs). It was then tested for power and load requirements.
Open source Arduino platform was used to program the alternate walking tripod gait as observed in the cockroaches.



4 Manufacturing & assembly

Most components were manufactured by laser cutting Acrylic sheets. After the fracture of coxa servo joints in prototype 1 aluminium brackets were used in prototype 3.



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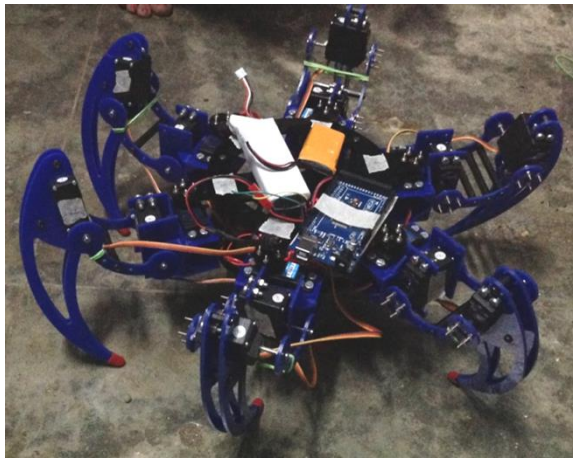
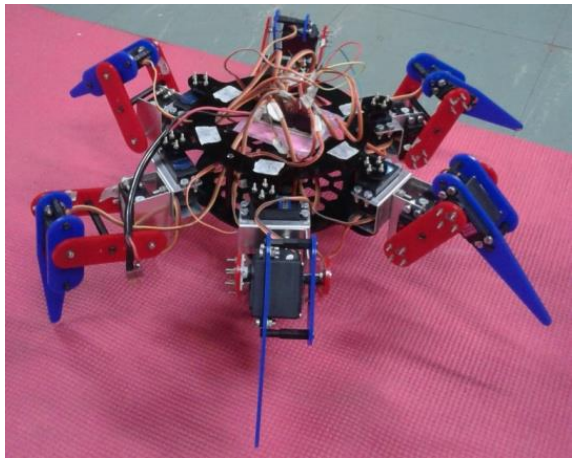
5 Prototype Testing

- Sturdy
- Stands stable on 6 legs
- Servo bracket broke while testing
- Chassis over designed



- Longer Tibia
- Lighter chassis
- Highly unstable due to flexing of Tibia
- Cannot stand on 6 legs
- Unable to walk due to excessive flexing



- Sturdy
- Longer tibia like proto 2 but form like proto 1
- Stronger Aluminium servo brackets
- Stands stable on 6 legs
- Successfully walked on uneven terrain