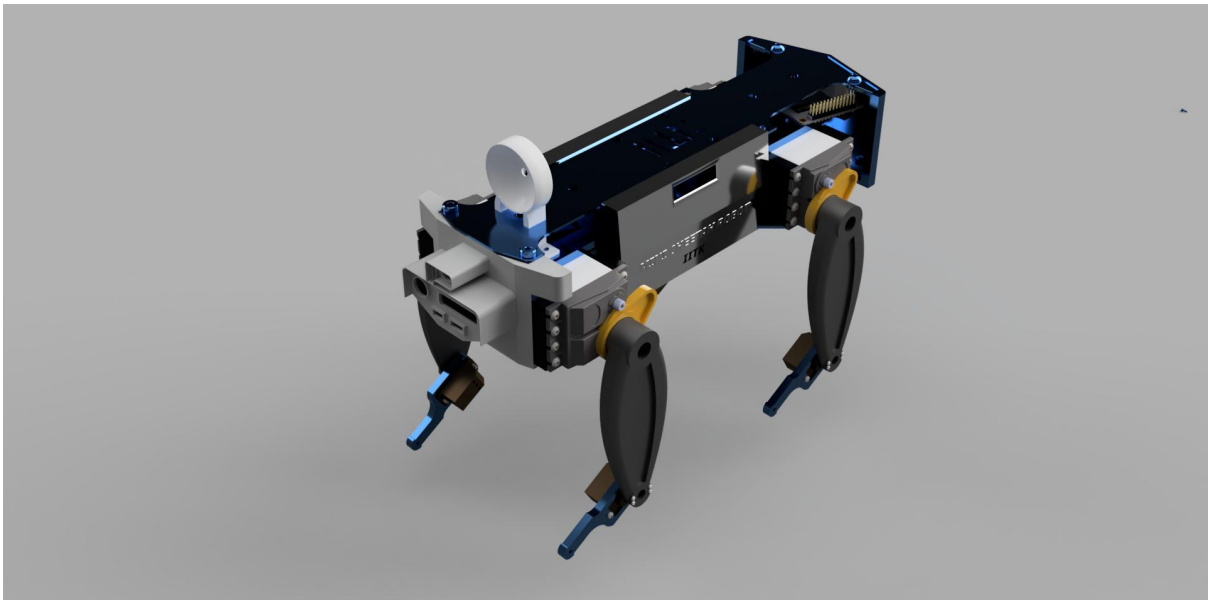
TA201A : Manufacturing Processes-I

Department of Material Sciences and Engineering
Fall Semester 2021-22, IIT Kanpur

PROJECT REPORT
Section: W2 Group: 2

PROJECT TITLE: QUADRUPED ROBOT



Course Instructor: **Dr. Shashank Shekhar**
Tutor: **Shikhar Jha**
TAs: **Sushrita Dash** and **Md Redad Mehdi**
Lab-in-charge: **I.P. Singh**

GROUP MEMBERS

ROLL NO.	NAME
200760	RAJ VARDHAN SINGH
201025	SURYANSHU KUMAR JAISWAL
200658	P R ANAND MAHESH
200240	AYUSH DHINGRA
201011	SUHANI
200665	PARAMVEER SINGH CHOUDHARY
200007	AASTIK GURU
200529	KULDEEP GUPTA
200838	SAHIL SINGH

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ACKNOWLEDGEMENT

We would like to express our sincere gratitude to our Tutor - Shikhar Jha sir and our Lab Technical Personnel Mr. I.P. Singh for their support and instruction in this project. Their support and guidance were instrumental throughout the execution of our project.

We would also like to thank Professor Shashank Shekhar, our course instructor, for providing us with this opportunity to explore our creativity and design the whole process of manufacturing something through lab manufacturing processes. We thank our TAs, Ms. Sushrita Dash and Mr. Md Redad Mehdi for their valuable guidance.

Any omission in this brief acknowledgement does not imply lack of gratitude.

INTRODUCTION

As its name suggests, Quadruped Robot has four legs and it can be used to carry small loads from one place to another. It can smoothly bend its limbs and move and the power is supplied through a Lipo battery of 8000 mah.

It has various parts which are interconnected through joints and adhesives.The middle chamber plays a major role in controlling the robot, consisting of many subparts including the circuit system. Camera sensors are used ,which helps in automated movement of the bot. It uses a cooling fan to avoid excessive heating. It also has a headlight to work in the dark. Covering is also provided on all sides. Finally the limbs are designed very efficiently for smooth locomotion of the robot which mimics animal walking gait and they have certain advantages like walking on terrain and extremely rough surfaces. Obstacles can impede the movement of wheeled vehicles, where a quadruped can adapt to avoid obstacles by adjusting its height.

MOTIVATION

We present a quadruped robot [QR] for dynamic locomotion. The robot is designed using commercial -off-the-shelf components and rapid prototyping methods. It can perform dynamically stable jumping, bounding, turning in place, and braking using camera sensors.

It presents advanced design solutions in both controls and mechanical structure for this class of robots making it a unique robot that can perform dynamic maneuvers in different terrains. However, its custom motors and components make it an expensive research platform. The goal of the QR is to provide a more accessible platform at a fraction of the cost and the weight while maintaining many of the dynamic characteristics.

We have got motivation for this project from MIT's mini cheetah robot .

WORK DISTRIBUTION

S.NO.	NAME	WORK CONTRIBUTION
1	RAJ VARDHAN SINGH	Fusion-cooling fan and its orthographic sketch;Contribution in Lab Report
2	SURYANSHU KUMAR JAISWAL	Fusion - the top outer part covering, orthographic view of components, research,cost analysis , contribution in Lab Report
3	P R ANAND MANEESH	Fusion- Design of the Motor, Orthographic and isometric views of components,research and contribution in Lab Report , Explosive views of Leg, Front Part, Motor .
4	AYUSH DHINGRA	Fusion: the front part and its orthographic sketch,Contribution in Lab Report
5	SUHANI	Fusion:- Upper leg, Joint of Upper leg, Orthographic Views of these two + lower leg, joining disc, headlight, Cooling fan, back cover, bottom plate. Contribution in Lab Report and slides.
6	PARAMVEER SINGH CHOUDHARY	Fusion:- Bottom leg, Bottom jeg joint ,Bottom leg joining disk,Leg Battery and Battery Joint , Assembly of Leg.Orthographic view of assembled leg.
7	AASTIK GURU	Fusion:-Middle plate of Inner Chamber and its orthographic sketch,Cost Analysis, Contribution in Lab report
8	KULDEEP GUPTA	Research on manufacturing materials,cost reduction technique and hardware description
9	SAHIL SINGH	Fusion and Orthographic views: Bottom Plate, Back Cover, Headlight, Side Covering, Battery Case; Assembly of the bot; Contribution in Lab Report; Animation

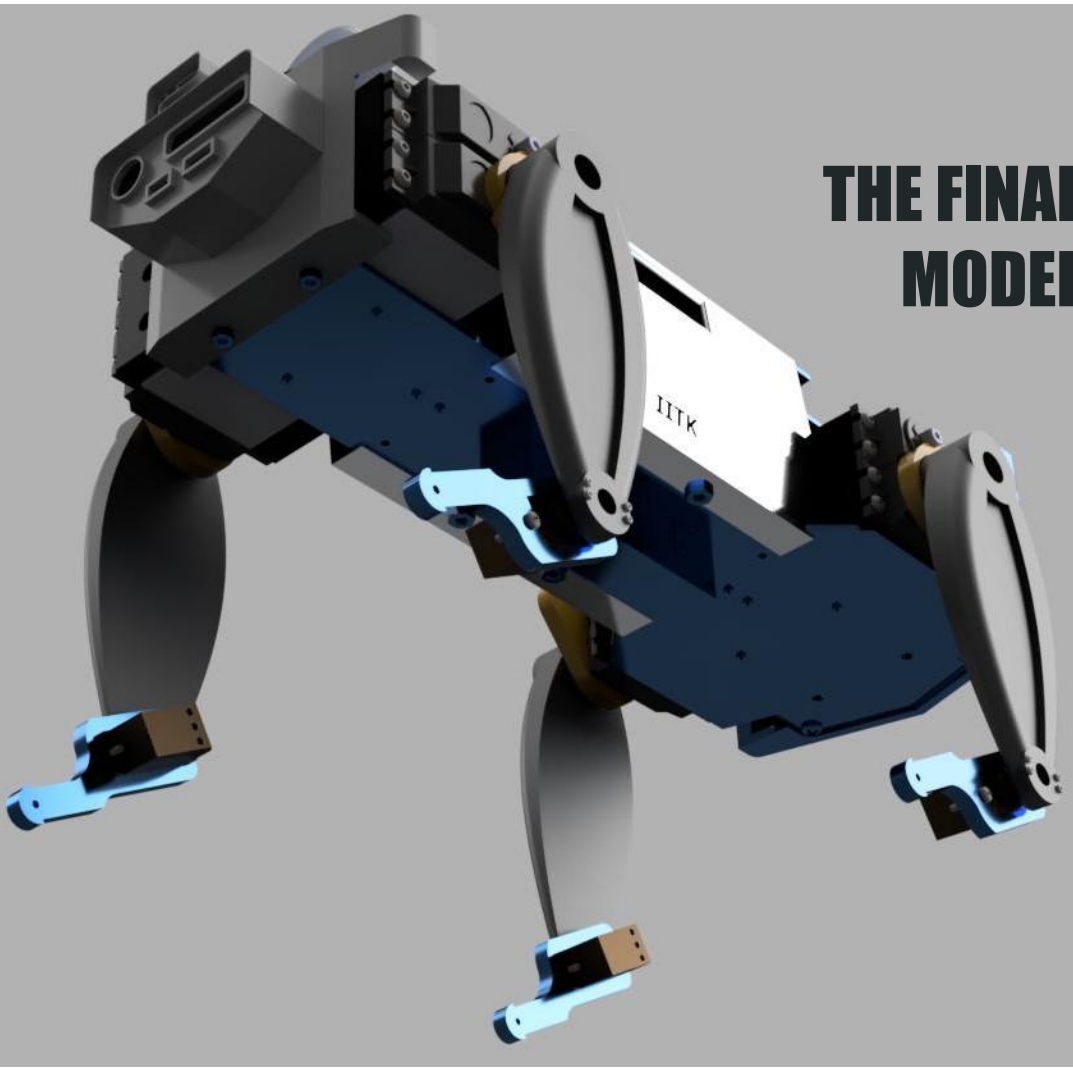
TIMELINE OF THE PROJECT

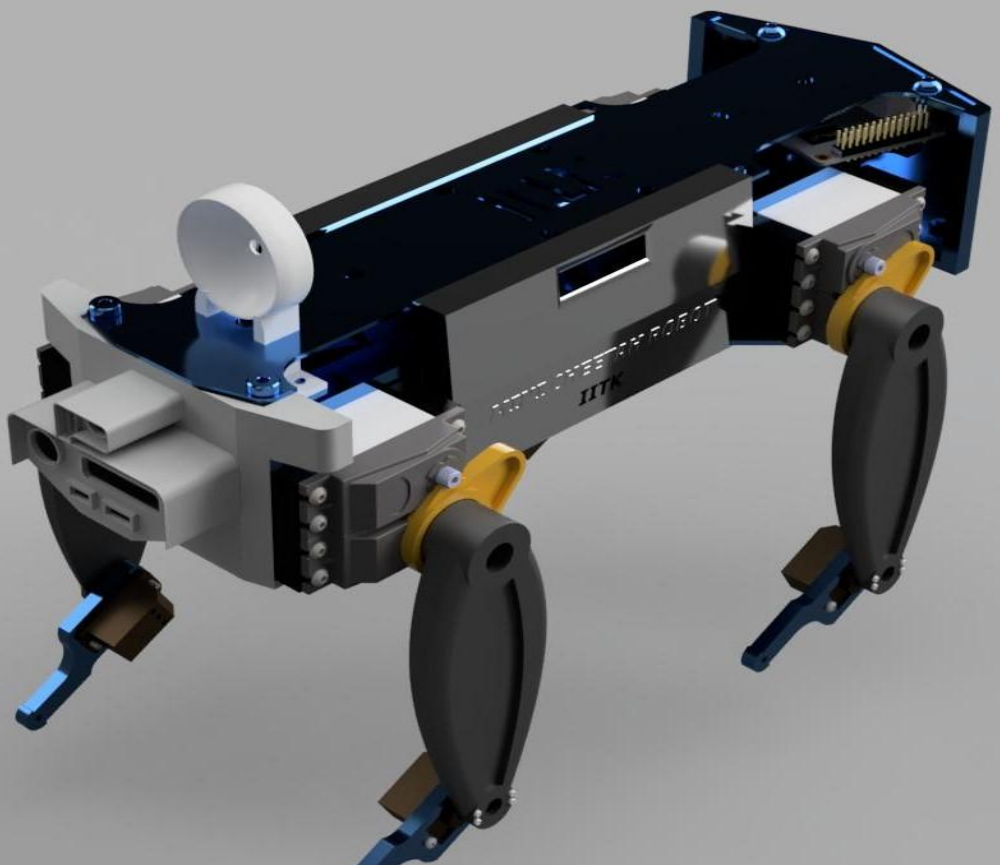
Week 1	Discussion for project proposal
Week 2	Suggested 6 project ideas and finalization of idea after discussion with tutor, TAs and lab incharge
Week 3	List of parts and research on manufacturing processes for each of them. Started work on drawings
Week 4	Made orthographic and isometric drawings of each part and full assembly. Prepared 1st draft of the project report
Week 5	Final project report, Animation and Video presentation

LIST OF COMPONENTS

S. No.	Name of the Component
1	Back Cover
2	Side Covering
3	Bottom Plate
4	Upper Plate
5	Upper leg
6	Lower leg
7	Joint of Upper leg
8	Middle part of Inner Chamber
9	Cooling Fan
10	Headlight
11	Battery Case
12	Front part
13	L Shaped Clamp
14	Joining Disc
15	Motor
16	Screws, Nuts and Bolts

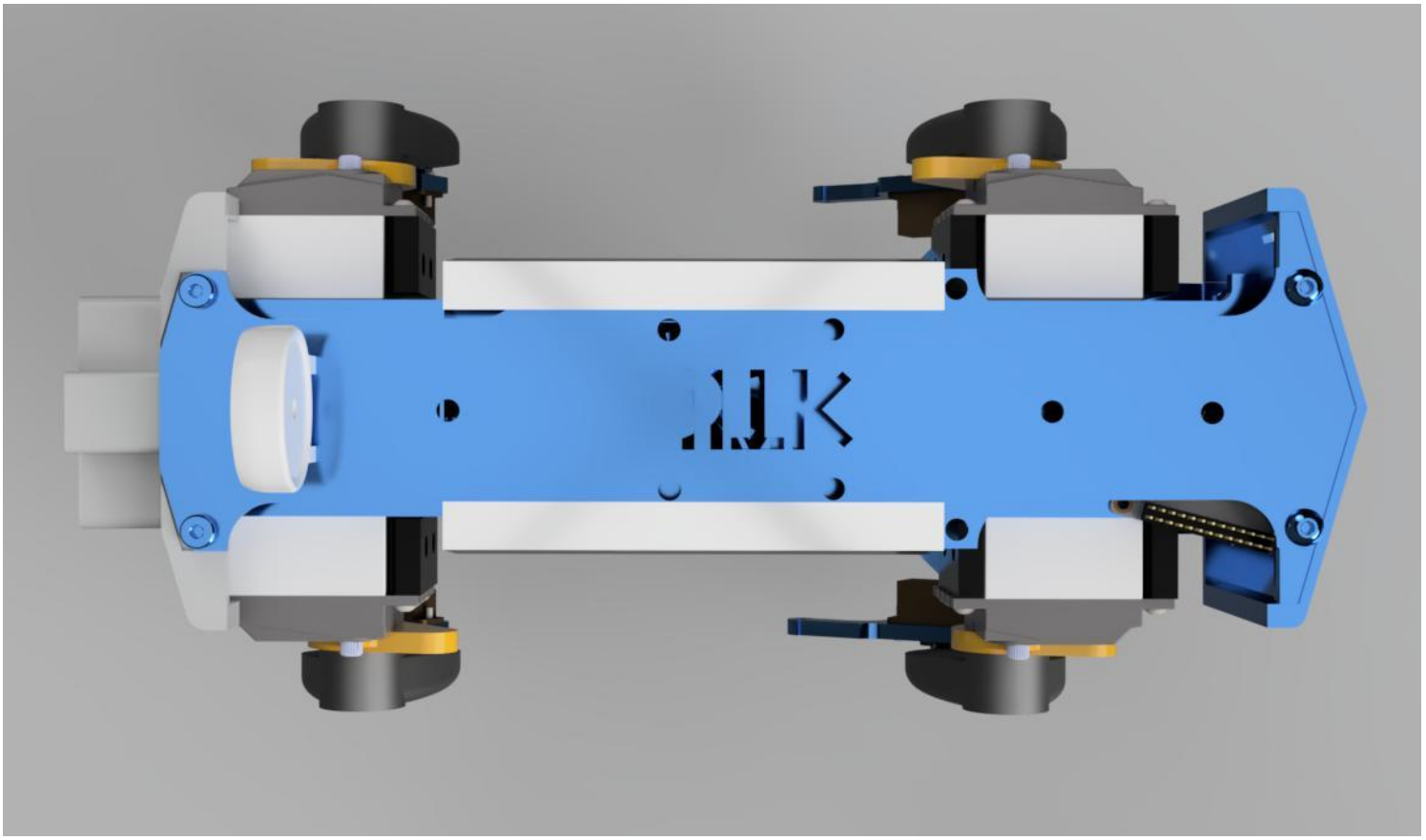
THE FINAL MODEL



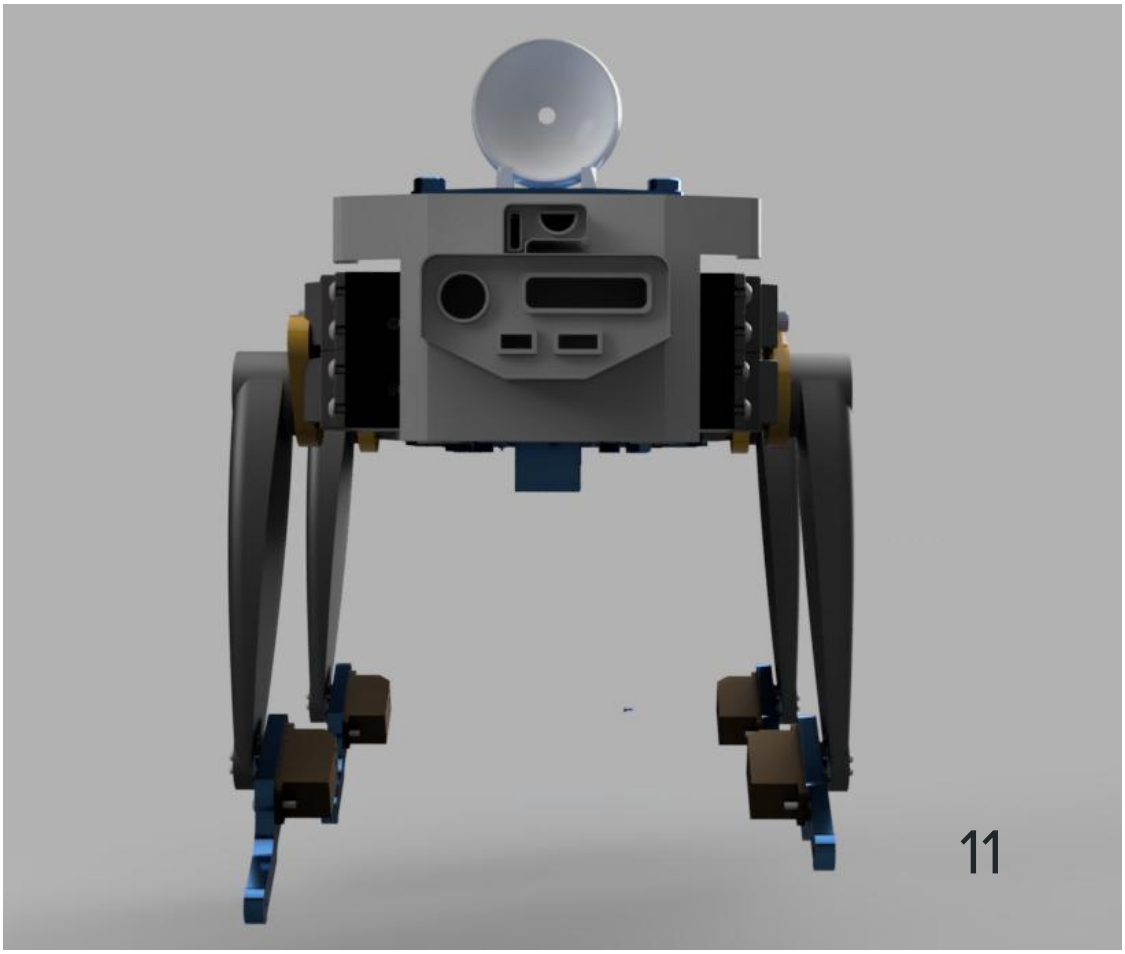


VIEWS OF THE MODEL

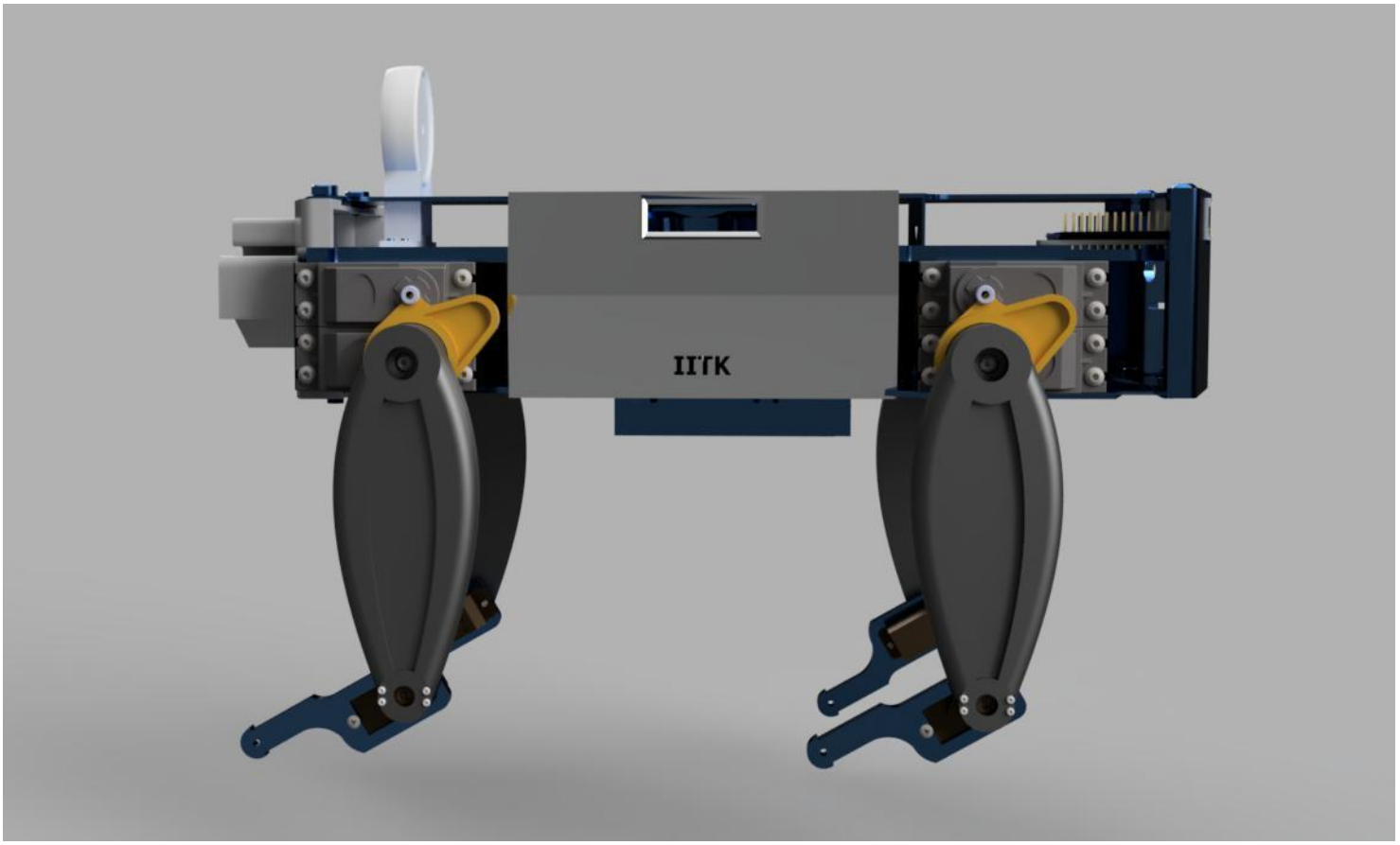
Top View



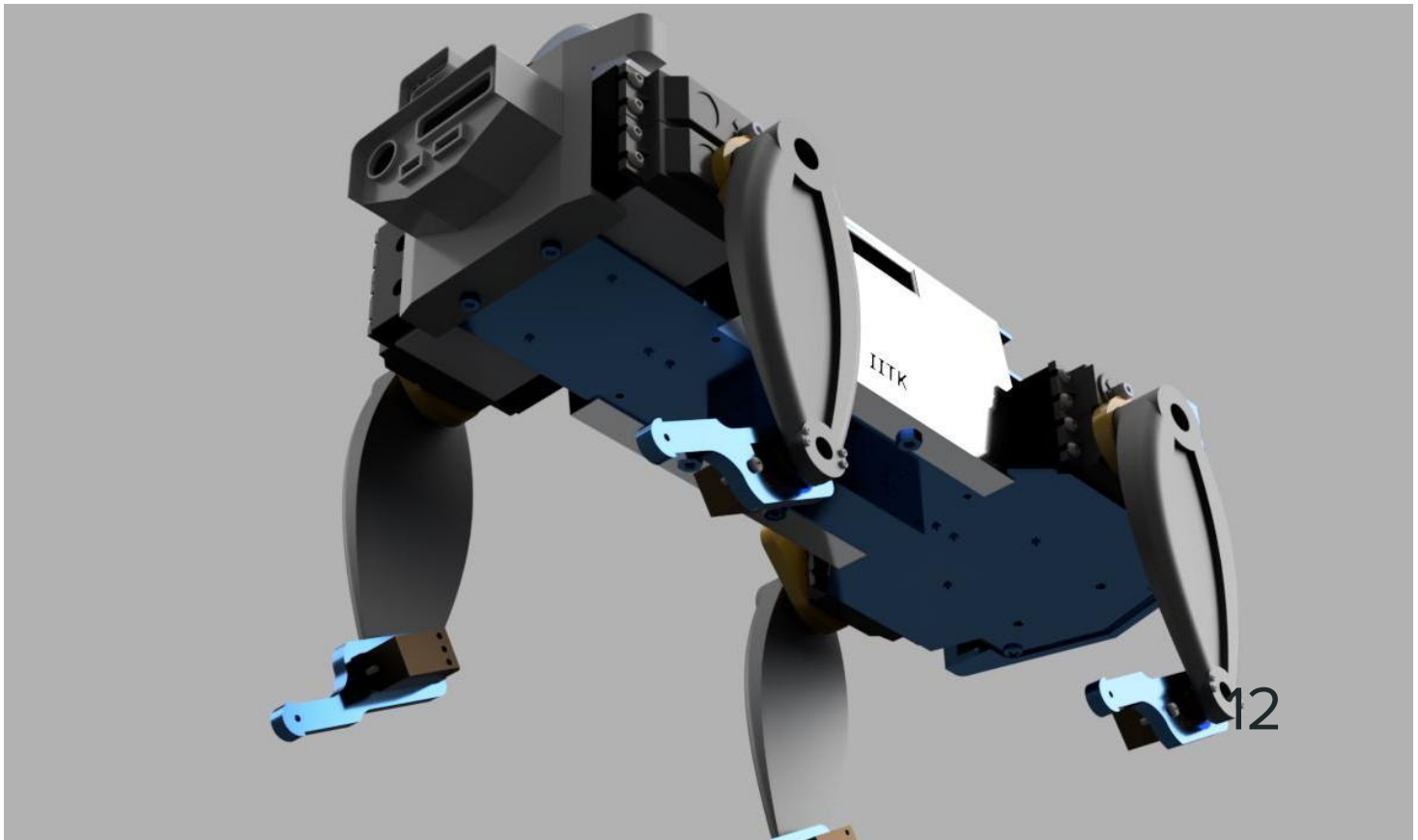
Front View



Right Side View

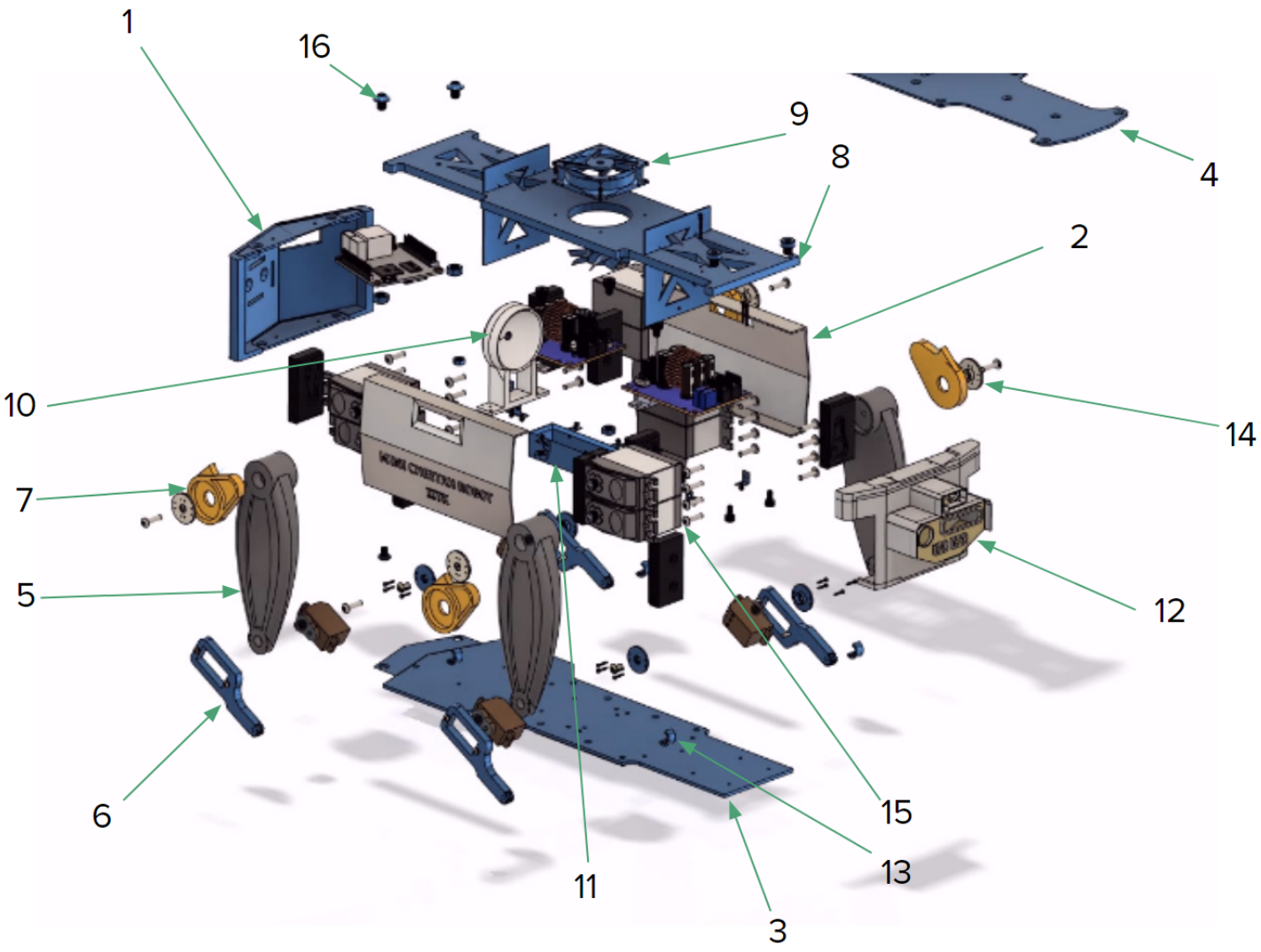


Isometric View



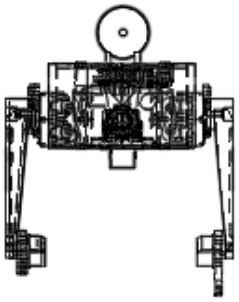
Exploded View of the Bot

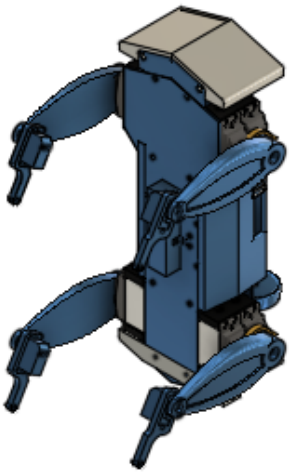
Note: Labelling is done in accordance with the part numbers mentioned above

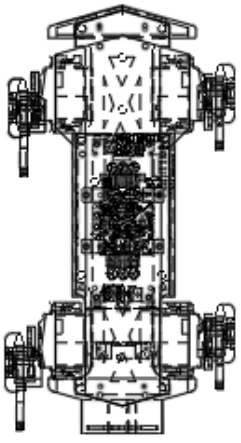


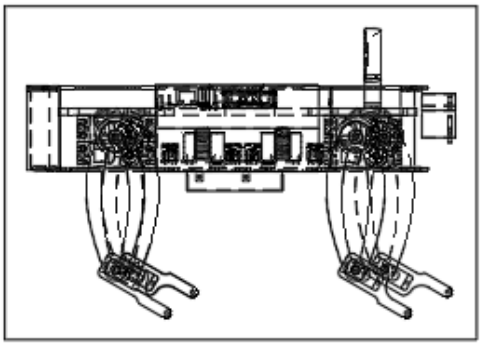
DRAWING OF THE ROBOT ASSEMBLY

Overall dimensions of the bot
= 321*165*175*mm









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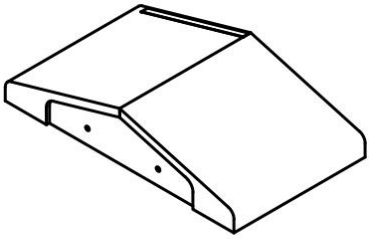
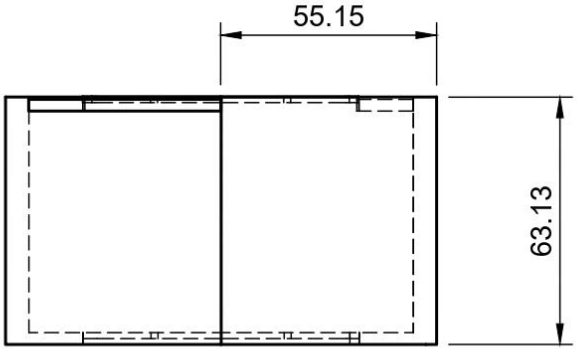
ORTHOGRAPHIC AND ISOMETRIC VIEWS OF THE COMPONENTS

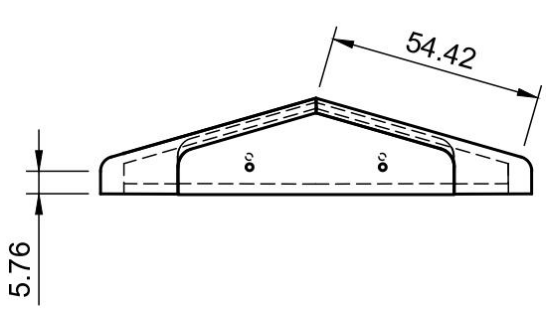
1. BACK COVER



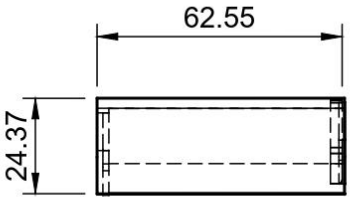
ISOMETRIC VIEW

TOP VIEW





FRONT VIEW



RIGHT VIEW

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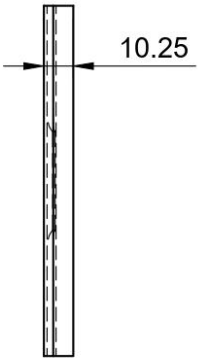
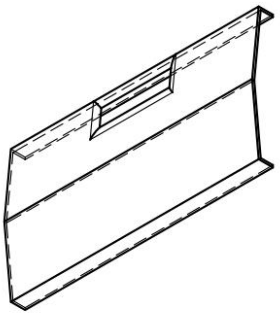
2. SIDE COVERING



TOP VIEW



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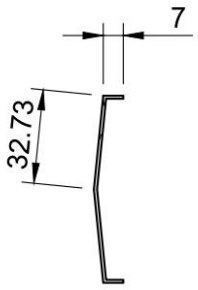
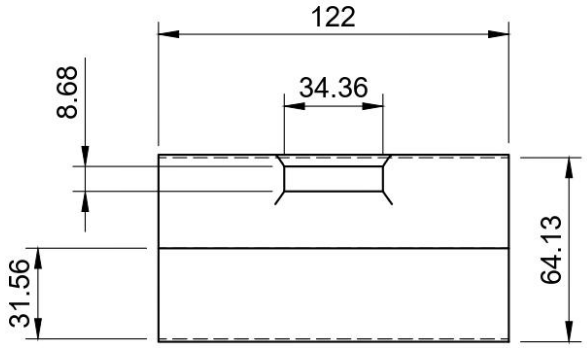


FRONT VIEW



RIGHT SIDE VIEW

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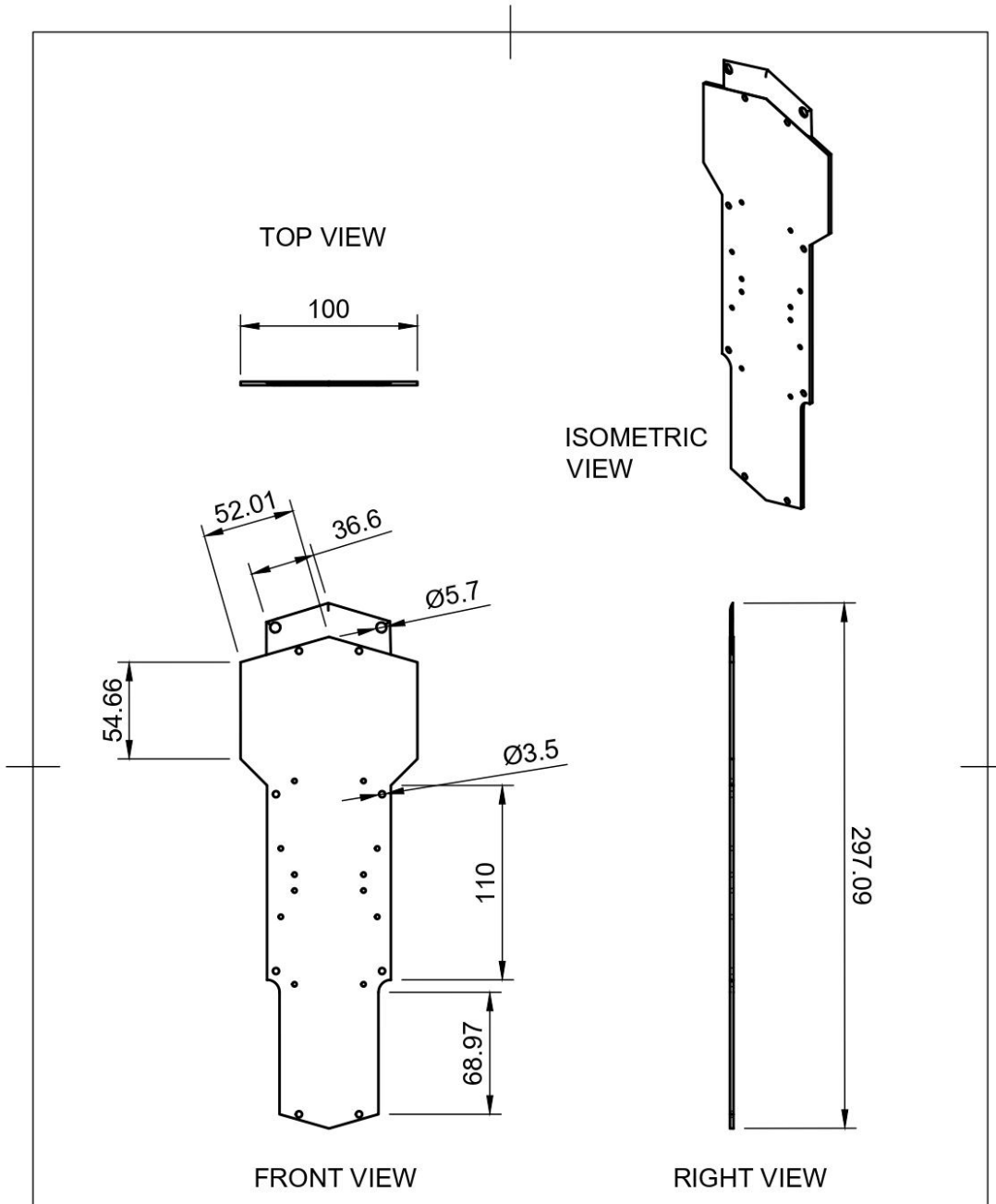
3. BOTTOM PLATE



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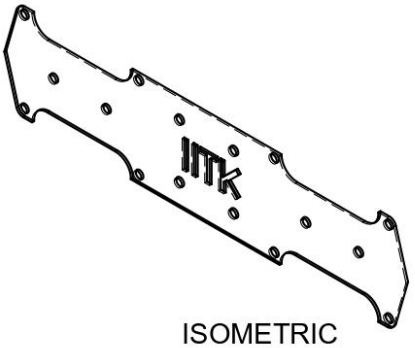
4. UPPER PLATE



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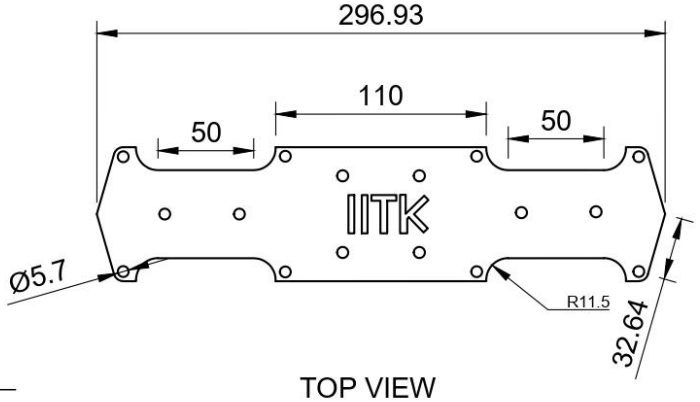
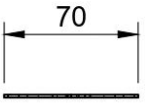


TOP VIEW

FRONT VIEW



RIGHT SIDE VIEW

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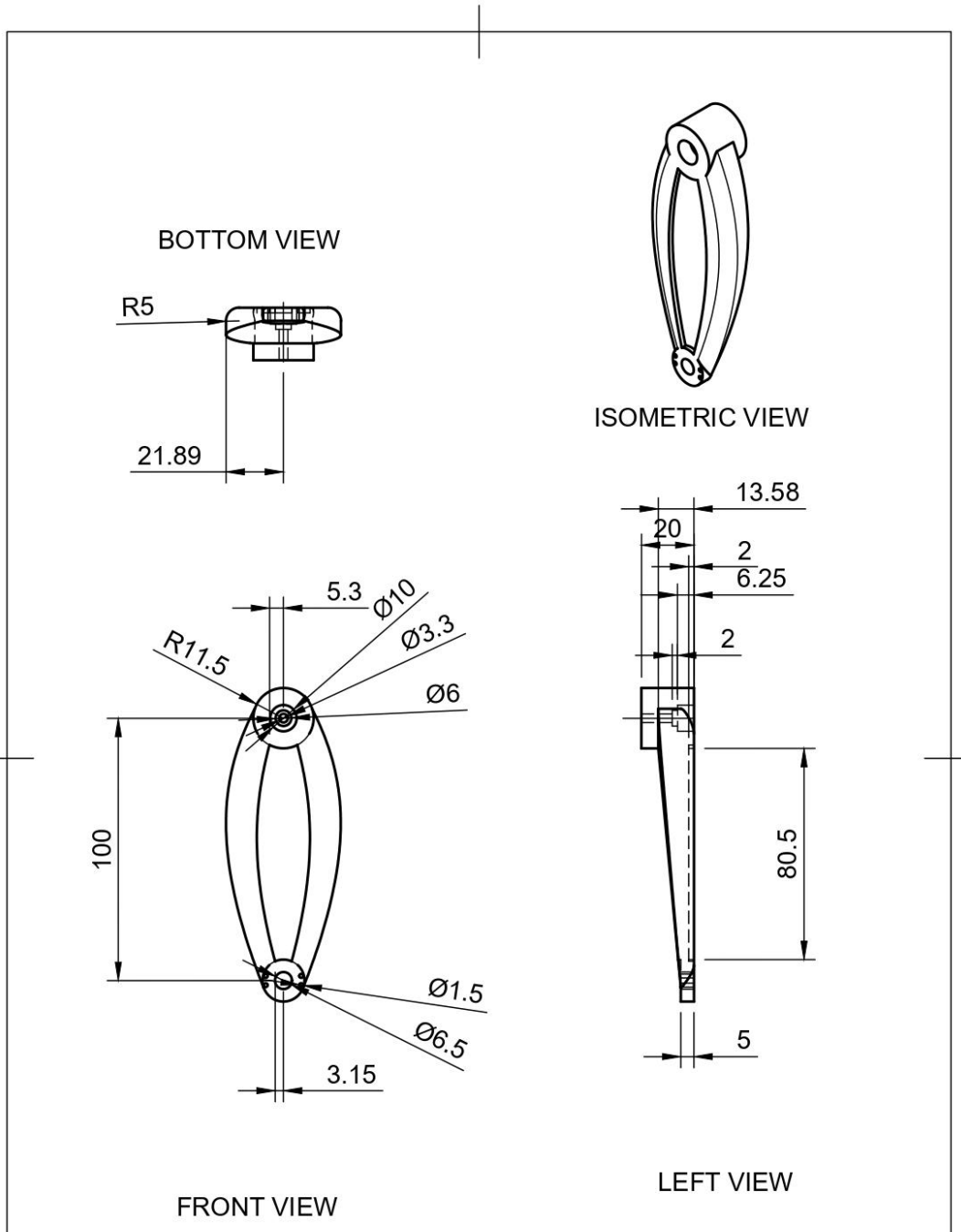
5. UPPER LEG



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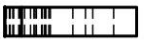
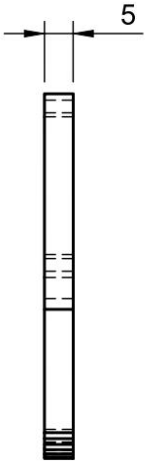
6. LOWER LEG

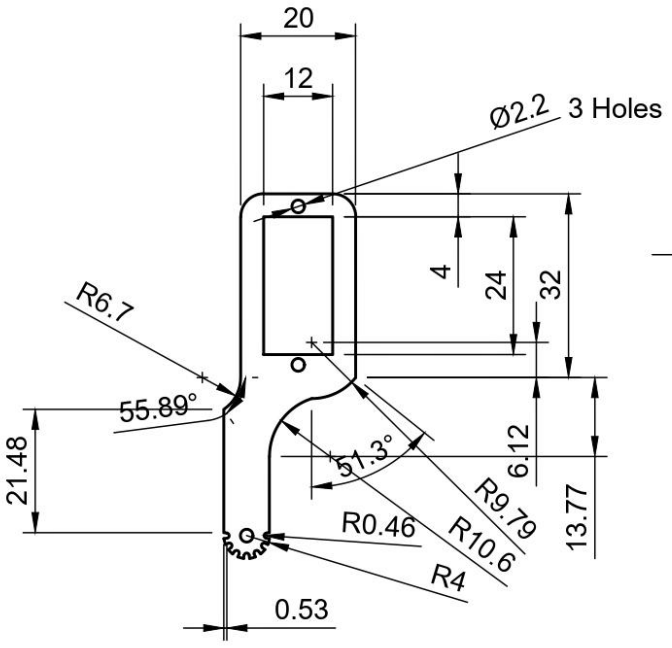
ISOMETRIC VIEW

TOP VIEW





LEFT VIEW



FRONT VIEW

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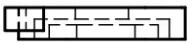
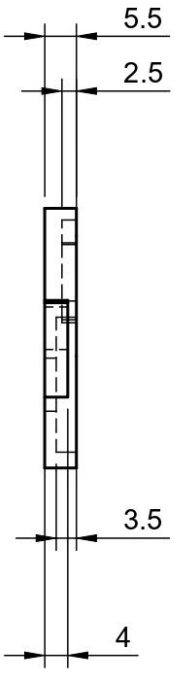
7. JOINT OF UPPER LEG

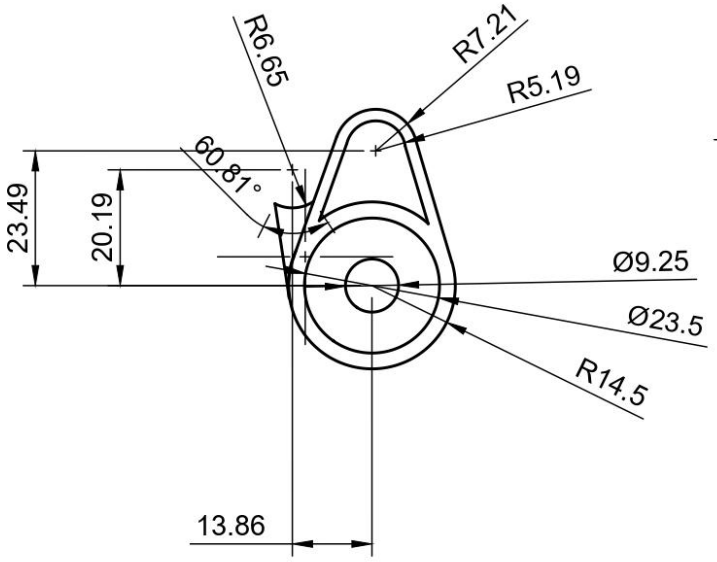
Isometric View



Top View



Side View



Front View

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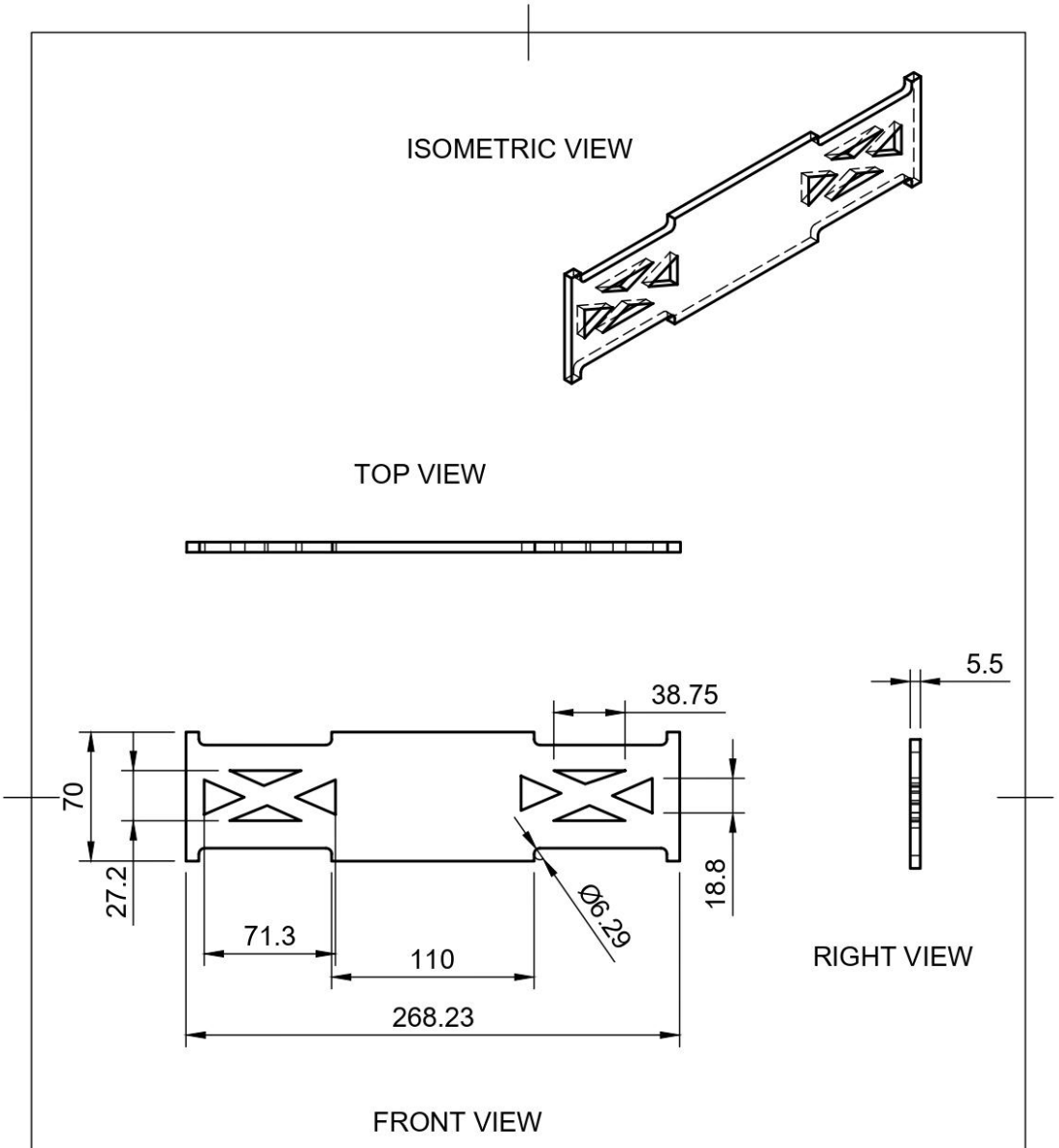
8. MIDDLE PART OF INNER CHAMBER



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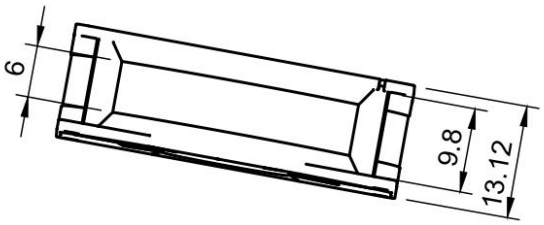
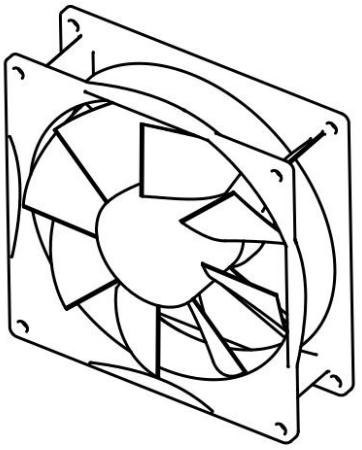
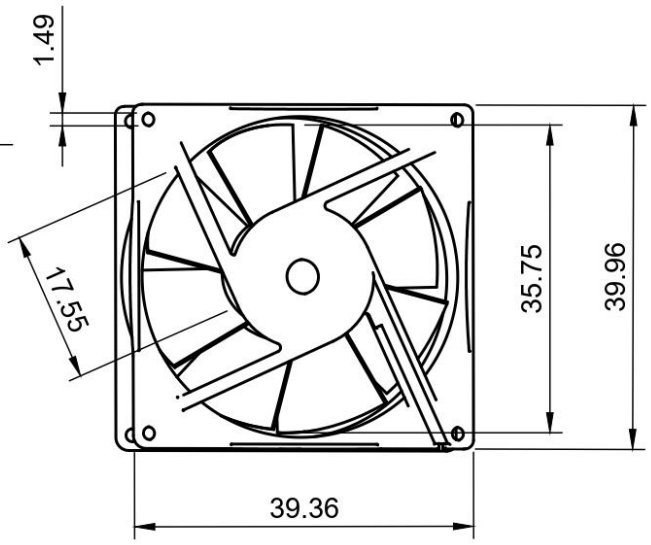
9. COOLING FAN



TOP VIEW



ISOMETRIC VIEW



FRONT VIEW

SIDE VIEW

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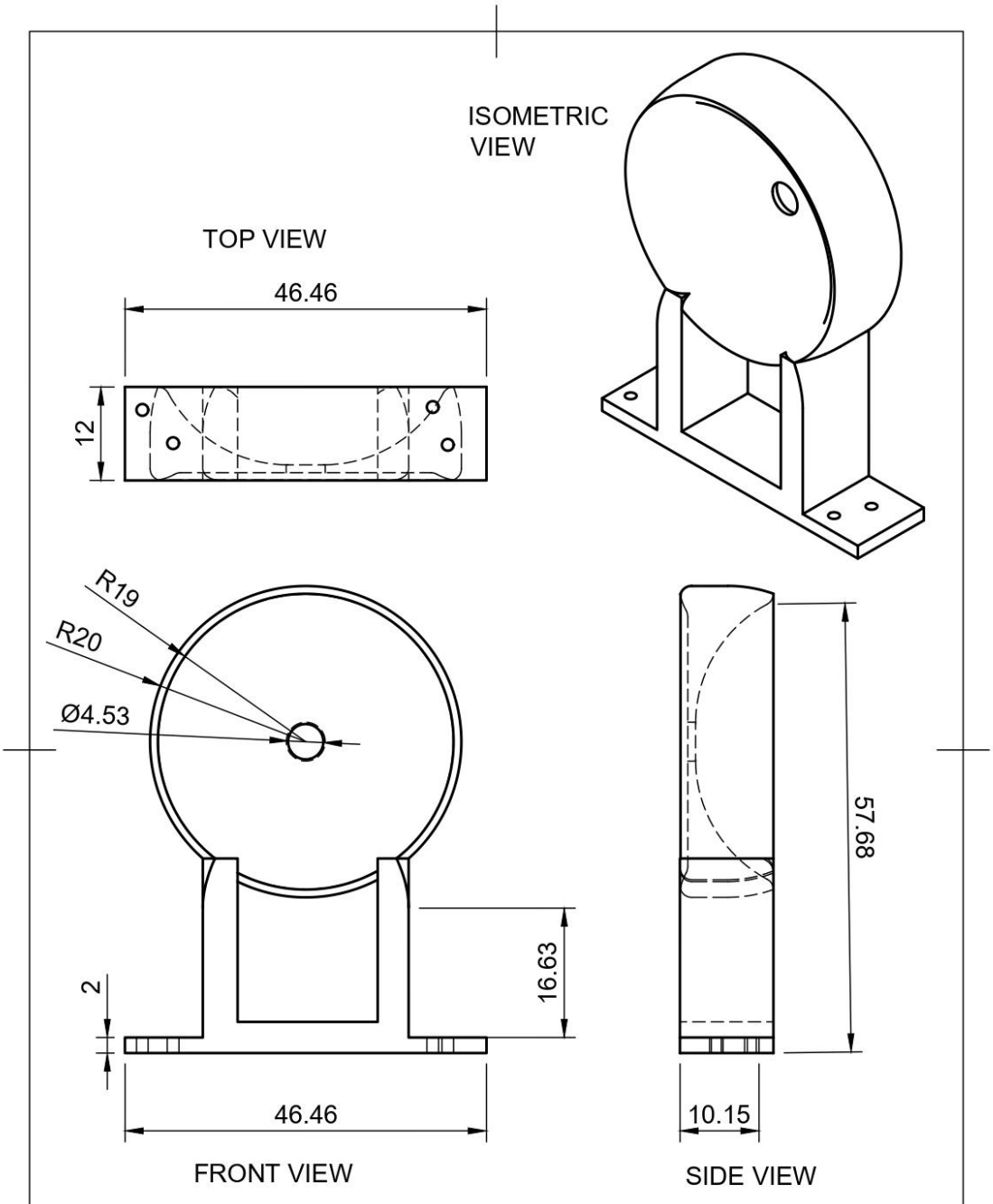
10. HEADLIGHT



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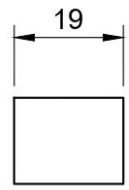
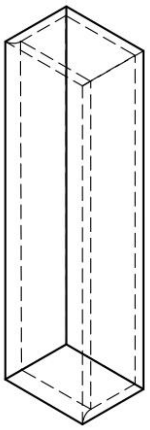
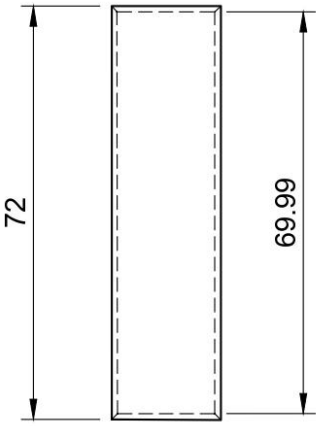
11. BATTERY CASE



TOP VIEW



ISOMETRIC VIEW



FRONT VIEW

RIGHT SIDE VIEW

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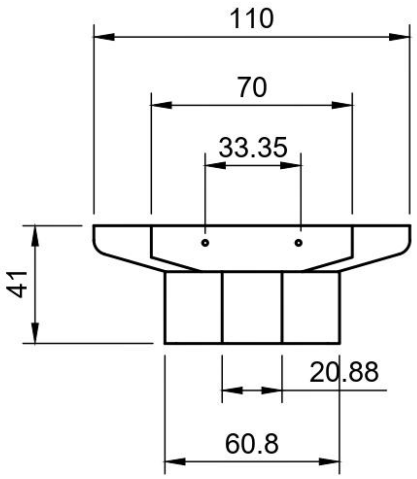
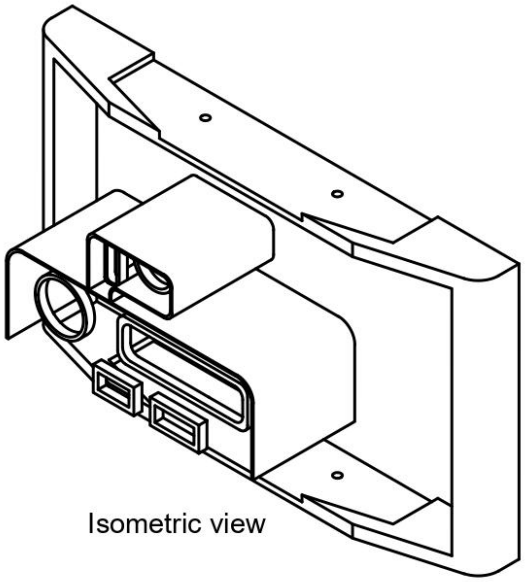
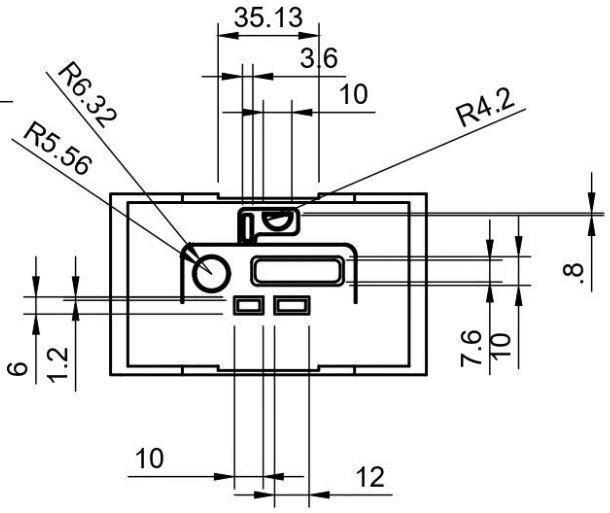
12. FRONT PART



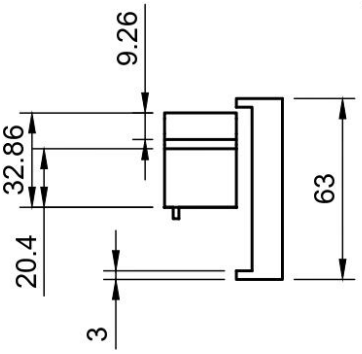
Top View



Isometric view



Front View



Right Side view

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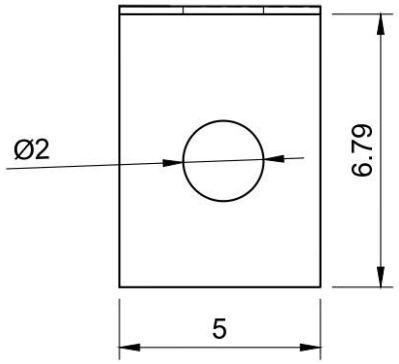
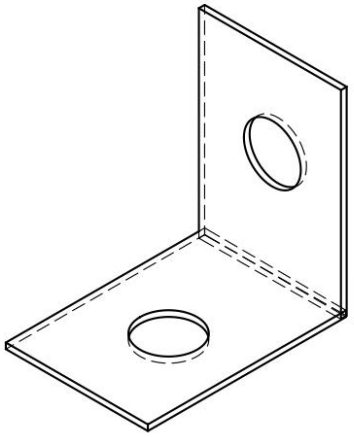
		Document type	Document status
SCALE - 1:2		Title: FRONT PART	DWG No.: 12
			Rev. / Date of issue / Sheet: 1/1

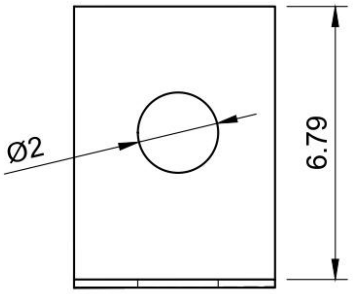
13. L-SHAPED CLAMP



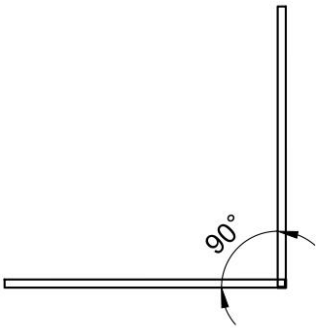
TOP VIEW



ISOMETRIC VIEW



FRONT VIEW



RIGHT SIDE VIEW

Dept.	Technical reference	Created by	Approved by
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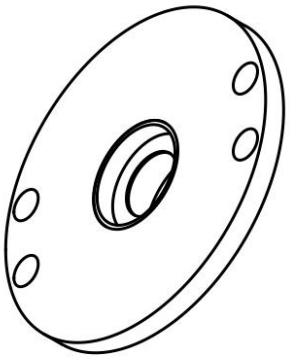
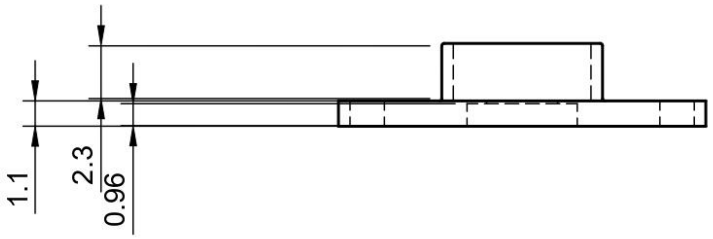
		Document type	Document status
Scale - 7:1		Title: L-SHAPED CLAMP	DWG No.: 13
			Rev. / Date of issue / Sheet: 1/1

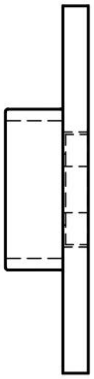
14. JOINING DISC

Isometric View

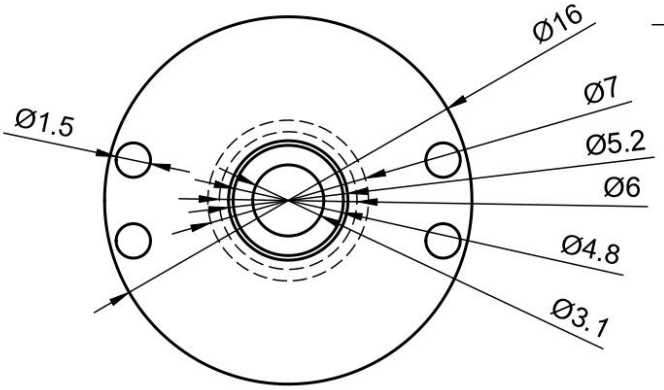


Top view





Side view



Front View

Dept.	Technical reference	Created by	Approved by
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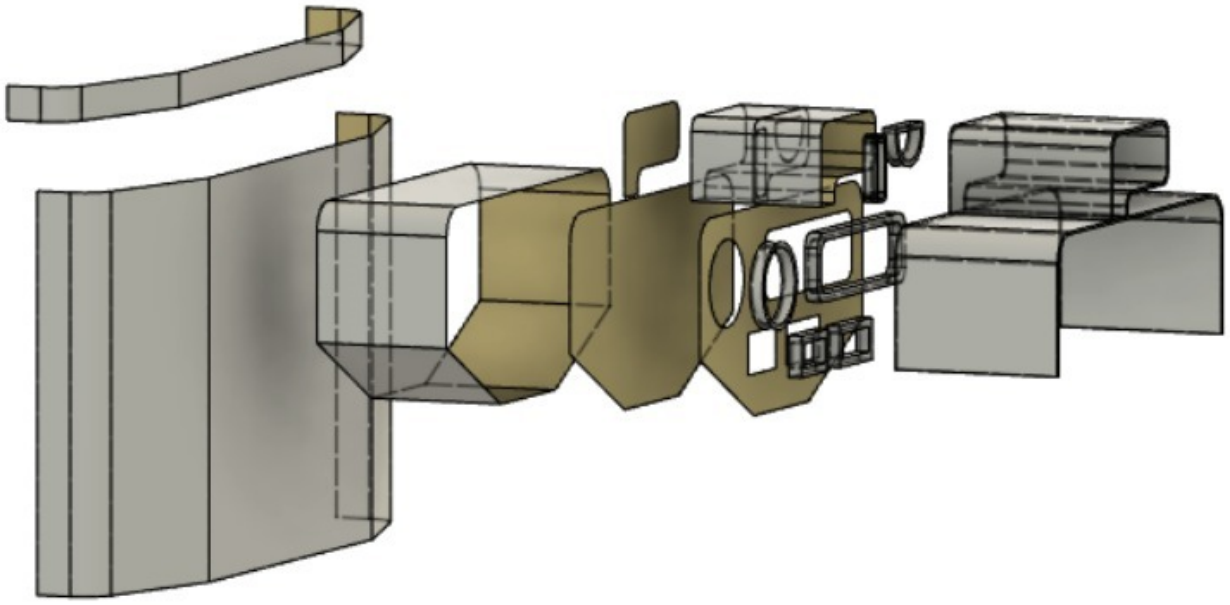
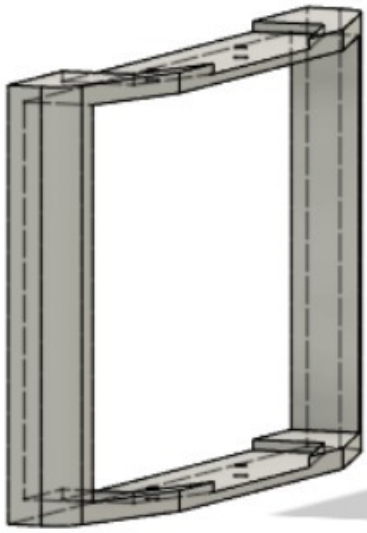
		Document type	Document status
Scale - 4:1		Title: JOINING DISC	DWG No.: 14
			Rev. / Date of issue / Sheet: 1/1

EXPLODED VIEW OF COMPLEX PARTS

Front Part





Assembly of a Single Leg

Manufacturing Processes Of Each Component

S. No.	Name of the Component	Quantity	Material(s) used	Processes used	Joining Process
1	Back Cover	1	Steel	Sheet metal [Shearing, Bending and Drilling]	screws for joining
2	Side Covering	2	Steel	Sheet metal [Shearing, Bending and Drilling]	screws for joining
3	Bottom Plate	1	Steel	Sheet metal working	screws for joining
4	Upper Plate	1	Steel	Sheet metal [Shearing and drilling]	screws for joining
5	Upper leg	4	Aluminium for Casting	Casting and Drilling	Screws for joining
6	Lower leg	4	Aluminium for Casting	Casting and Drilling	Screws for joining
7	Joint of Upper leg	4	Aluminium for Casting	Casting	Screw and Adhesive
8	Middle part of Inner Chamber	1	Steel	Sheet metal shearing	Welding
9	Cooling Fan	1	Aluminium and Steel	Sheet metal bending	Welding

10	Headlight	1	Aluminium and plastic polycarbonate	Injection moulding	Welding and adhesive
11	Battery Case	1	Polypropylene resin	Cracking process	Adhesive and screws
12	Front part	1	Aluminium	Casting, Sheet metal [Shearing, Bending and Drilling]	Screw and Adhesive
13	L Shaped Clamp		Mild Steel sheet	Sheet Metal Cutting and Bending	Screws
14	Joining Disc	4	Mild steel discs	Rolling, Drilling	Screws
15	Motor	8	Steel and Polypropylene resin	Sheet metal shearing and bending	Screws and Adhesive
16	Screws, Nuts and Bolts	60	Stainless steel	Forging and Threading	Nil

Cost Analysis

S.no.	Component	Dimension	Quantity	Material Cost (Rs)	Processing Cost (Rs)
1.	Back Cover	110.3x63.13x24.37	1	56.76	250
2.	Side Covering	122x90x1	2	7.24	200
3.	Bottom Plate	297x100x2	1	9.8	100
4.	Upper Plate	297x69.5x1.5	1	6.82	100
5.	Upper Leg	115x44x20	4	11.5	600
6.	Lower Leg	63x23x5	4	4	300
7.	Joint of Upper Leg	30 gm	4	30	100
8.	Middle Part of Inner Chamber	269x70x5.5	1	10.12	100
9.	Cooling Fan	Part 1: 40x40x14 Part2: 132mm^2x 0.25mm	1	Part 1: 8 Part 2: 3	500

10.	Headlight + Glass	Part 1: 47x25x12 Part2: 16336.28mm ^3	1	Part 1: 2 Part 2: 10	100
11.	Battery Case	75x19x15	1	6.72	25
12.	Front Part	Volume= 14795.43 mm^3	1	16	400
13.	L-shaped Clamp	13.6x5x0.2	30	150	300
14.	Joining Disc	Volume= 724 mm^3	1	2	100
15.	Nut and Bolt	Multiple	60	300	

Electronic parts are mentioned below:

16.	LiPo Battery		5	1750	
17.	Servo Motor		8	1500	
18.	PCB		2	1000	
19.	Socket Board		1	50	
20.	Light		1	50	

Total Material Cost of Manufacturing Parts = **Rs 533.96**

Total Processing Cost of Manufacturing Parts = **Rs 3175.00**

Total Cost of Manufacturing Parts = **Rs 3709**

Total Cost of Electronic Parts = **Rs 4350**

Overall Cost of the Bot = **Rs 8059**

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- https://en.m.wikipedia.org/wiki/Casting
- https://en.m.wikipedia.org/wiki/Sheet_metal
- https://grabcad.com/library/diy-quadruped-robot-1
- Course content of TA201 (manufacturing processes-1).
- All designing and drawing are made through Fusion 360 software.