Firefighter Proposal

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Introduction

The purpose of this document is to explain the features and strategies of the Leon-Jeff Firefighter robot. As a team, we realized that in order to make a successful robot we need to focus on the fundamentals of a good robot (bot). These fundamentals are fire detection and navigation. Fire detection is the process in which a robot finds a major heat source (candle) using an infrared (IR) sensor. Bot navigation consists of using efficient and reliable algorithms in order to navigate the maze.

Description

Wall Detection

The Leon-Jeff Firefighter will strive to be unique by utilizing an original wall detection system. A typical way of orienting the sensors is to place one wall sensor on the left side of the robot and another one permanently mounted on the front. Using this format, the bot will struggle to maintain its position parallel to the wall. While this may be fine when traversing along a wall section, this poses an issue when the bot is performing a turn. The robot may catch the corner of the wall when turning, or end its turn in an irregular position because of starting the turn not parallel to the wall. The irregularity in angles when making turns makes it hard to troubleshoot and test a robot that has front and side mounted wall sensors. The Leon-Jeff Firefighter bot proposes to use a unique setup of its sensors in order to provide a more reliable and consistent wall detection system through the use of one fixed wall detection sensor on the rear-left side of the bot and one rotatable sensor on the front.

One GP2D12 IR wall detection sensor will be mounted on the rear-left side of the robot, while the other will be attached to a stepper motor on the front of the bot. The IR sensor mounted on the stepper motor will be able to rotate 360 degrees which will allow the front sensor to face all directions around the bot. There are a number of benefits to this sensor configuration. When the IR sensor attached to the stepper motor is facing the left side, the robot can determine the angle it is facing relative to the left wall and allow it to make small adjustments to the drive wheels in order to traverse the wall quickly and accurately. Since the bot will be initiating all turns already parallel to the wall, the robot will be able to make more accurate 90 degree turns.

Having both sensors permanently mounted on the left side will not help determine whether there is a wall directly in front of it. It is for this reason that the front IR wall sensor will be mounted on the stepper motor so that the sensor can constantly swivel back and forth, searching for walls in front of the bot, as well as maintaining optimal left wall tracking capabilities. The main priority of the Leon-Jeff Firefighter is consistency and reliability, and the wall detection system will play a large part in achieving this priority.

Flame Detection

The Leon-Jeff Firefighter will use the QSD123 IR light detection sensor to detect any major heat sources that the robot comes close to. The sensor will be mounted at the front of the robot, allowing the bot to look for any heat radiating off the walls of the maze. This allows the robot to quickly check for a candle's presence when it enters a room without performing any additional maneuvers.

Flame Extinguish

After detecting fire using the flame detection system, the bot will move to extinguish it by using a blower fan with a 16 cubic feet per minute flow rate. The fan will blow out the candle from a safe distance. This system will be turned on using a high current transistor such as a TIP120, which will be able to support the 800 milliampere current draw by the blower fan.

Line Detection

In order to navigate the maze, the robot requires both the use of wall detection combined with line detection. Line detection allows the bot to determine which room it has entered as each room has a white line painted across the opening. This allows for the robot to cross the line and increment a room counter allowing it to know its position in the maze. The line detection system will use a super bright light emitting diode (LED) to emit visible light directed down towards the floor of the maze. The floor of the maze is mainly black which absorbs almost all visible light emitted by the bot's LED, whereas the white painted lines will reflect the visible light. A phototransistor will be used to detect visible light. If the phototransistor detects light, then the bot is overtop of a white line. If no light is detected, then the bot is not overtop of a white line. Based on these two cases our robot will know when it enters a room. This is helpful for determining when we need to enable the flame detection system in order to extinguish the fire.

Robot Shape and Design

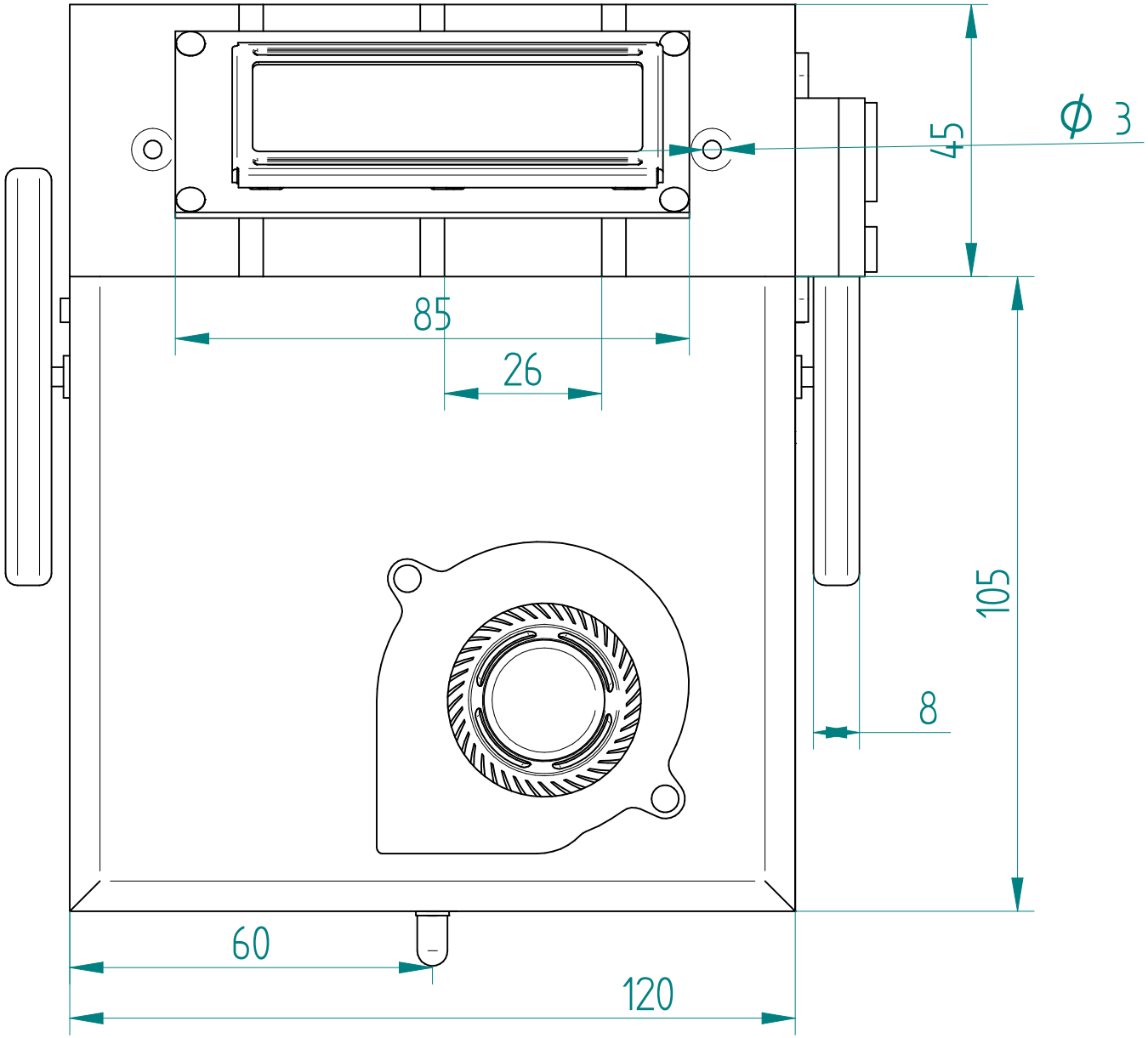
The Leon-Jeff Firefighter robot will be constructed with a custom designed 3D printed layered chassis using polylactic acid (PLA) filament combined with threaded rods. The 3D printed chassis will allow for the precise and neat assembly of all the bot's systems. The bottom layer of the chassis will have a rectangular shape and will be connected to the rectangular top through four M8 threaded rods bolted onto the corners. The assembly will be easy to open for troubleshooting, as the electronics inside will be accessible and easy to dismantle. The two GM8 motors will be mounted at the back of the lower chassis plate, with wheels attached to their axles. The flame suppressing fan will be mounted at the front of the top chassis along with the flame detection system. As the flame will be situated on top of a block of wood in the maze, the top mounted fan will ensure that the bot is able to reach any flames that need extinguishing. The liquid crystal display (LCD) is conveniently mounted on the top layer, which allows for easy access and troubleshooting in the event anything goes wrong. The robot will have a base that will be approximately 12 centimeters wide and 15 centimeters long which will be able to contain all necessary circuits while ensuring that the robot is still maneuverable and fit easily in the maze.

Material List:

Part	*Source*	*Model*	*Amount*	*Cost*	*Total Cost*
Sockets					
16 pin Socket	ABRA Electronics Corp.	N/A	2	$0.09	$0.18
40 pin Socket	ABRA Electronics Corp.	N/A	1	$0.21	$0.21
Capacitors					
Capacitor 0.1 uf	ABRA Electronics Corp.	N/A	1	$0.07	$0.07
Capacitor 1 nf	ABRA Electronics Corp.	N/A	3	$0.99	$2.97
Capacitor 1 uf	ABRA Electronics Corp.	N/A	2	$0.09	$0.18
Capacitor 1000uf	ABRA Electronics Corp.	N/A	3	$0.35	$1.05
Interface Components					
Liquid Crystal Display	Aliexpress	SPLC780D	1	$3.00	$3.00
DIP Switch	ABRA Electronics Corp.	N/A	1	$1.13	$1.13
Reset Switch	ABRA Electronics Corp.	N/A	1	$0.49	$0.49
PICs and ICs					
Motor Driver	Digi-Key Electronics	L293D	2	$5.97	$11.94
PIC	Digi-Key Electronics	PIC16F887A	1	$2.33	$2.33
Dual Differential Comparator	Digi-Key Electronics	LM393	1	$0.05	$0.05
Detectors, Emitters and Transistors					
NPN Darlington Transistor	Digi-Key Electronics	TIP120	1	$0.81	$0.81
Phototransistor	Mouser Electronics	PN168	1	$0.99	$0.99
Light Emitting Diode	Digi-Key Electronics	Super Bright Led	1	$0.22	$0.22
Phototransistor	Digi-Key Electronics	QSD123	1	$0.72	$0.72
Infrared Distance Sensor	RobotShop	GP2D12	1	$11.33	$11.33
Motors, Wheels and Voltage Regulators					

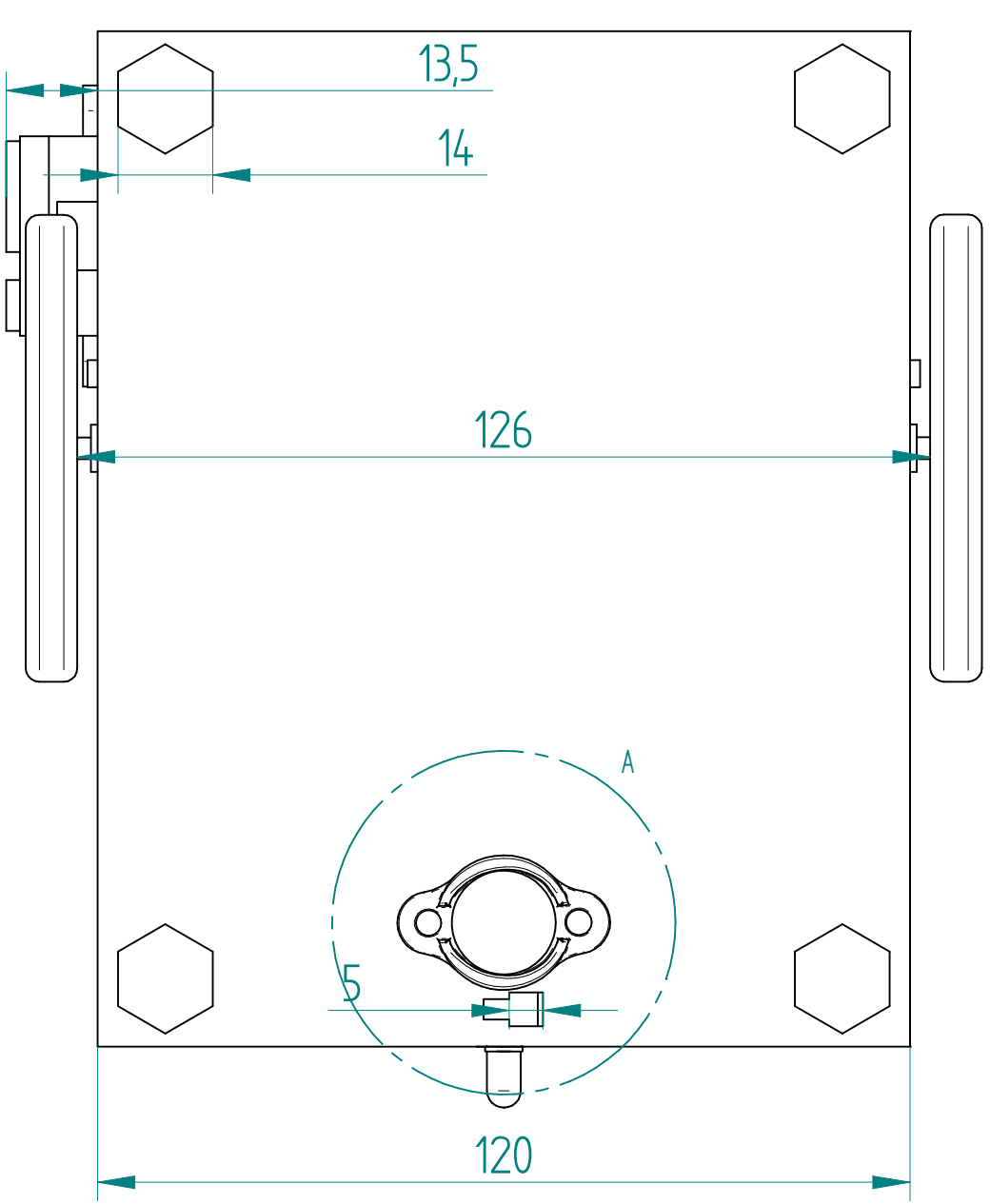
Motors	Solarbotics Ltd.	GM8	2	$7.76	$15.52
Stepper Motor	Adafruit	28BYJ-48	1	$6.75	$6.75
Wheels	Solarbotics Ltd.	GMPW	2	$4.39	$8.78
Ball Caster	Canada Robotix	N/A	1	$2.59	$2.59
Voltage Regulator	ABRA Electronics Corp.	7805	1	$0.42	$0.42
Resistors and Trimpots					
Trimpot 10k	ABRA Electronics Corp.	N/A	1	$1.33	$1.33
Trimpot 20k	ABRA Electronics Corp.	N/A	1	$1.59	$1.59
Resistor 1M ohm	ABRA Electronics Corp.	N/A	1	$0.15	$0.15
Resistor 1k ohm	ABRA Electronics Corp.	N/A	2	$0.05	$0.10
Resistor 10k ohm	ABRA Electronics Corp.	N/A	5	$0.06	$0.30
Resistor 100 ohm	ABRA Electronics Corp.	N/A	1	$0.05	$0.05
Resistor 220 ohm	ABRA Electronics Corp.	N/A	2	$0.06	$0.10
Resistor 330 ohm	ABRA Electronics Corp.	N/A	1	$0.06	$0.06
Connectors and Fasteners					
Terminal Blocks (4 pack)	ABRA Electronics Corp.	N/A	3	$1.95	$5.85
Jam Nuts	Fastenal	M8	8	$0.06	$0.48
Lock Nuts	Fastenal	M8	8	$0.20	$1.60
Motor Mount	Solarbotics Ltd.	N/A	2	$2.03	$4.06
Building Material					
Threaded Rod	The Home Depot	M8	2	$7.49	$14.98
3D Filament	Filaments.ca	N/A	1	$29.99	$29.99
Total					$132.37

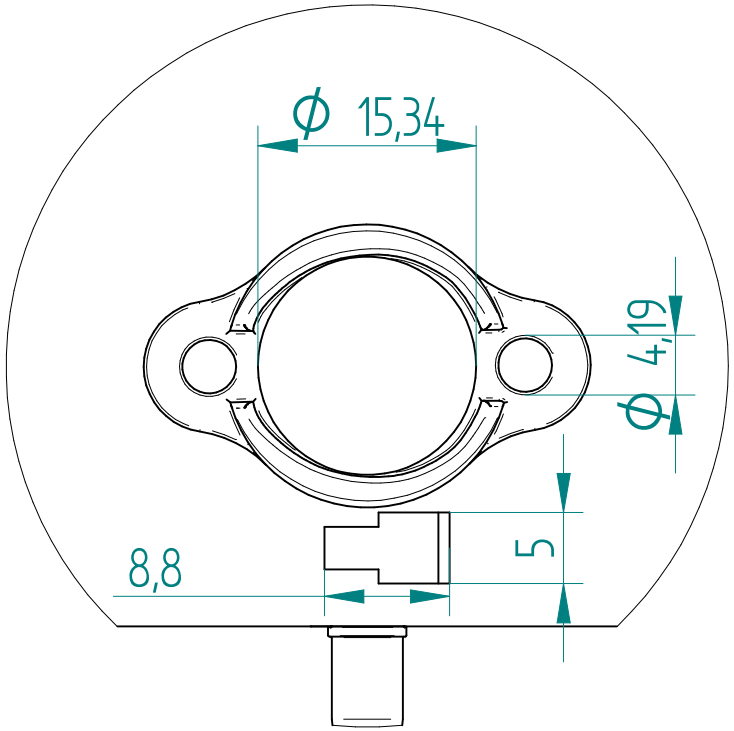
Drawings:



Top View

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN MILLIMETERS





DETAIL A

Bottom View

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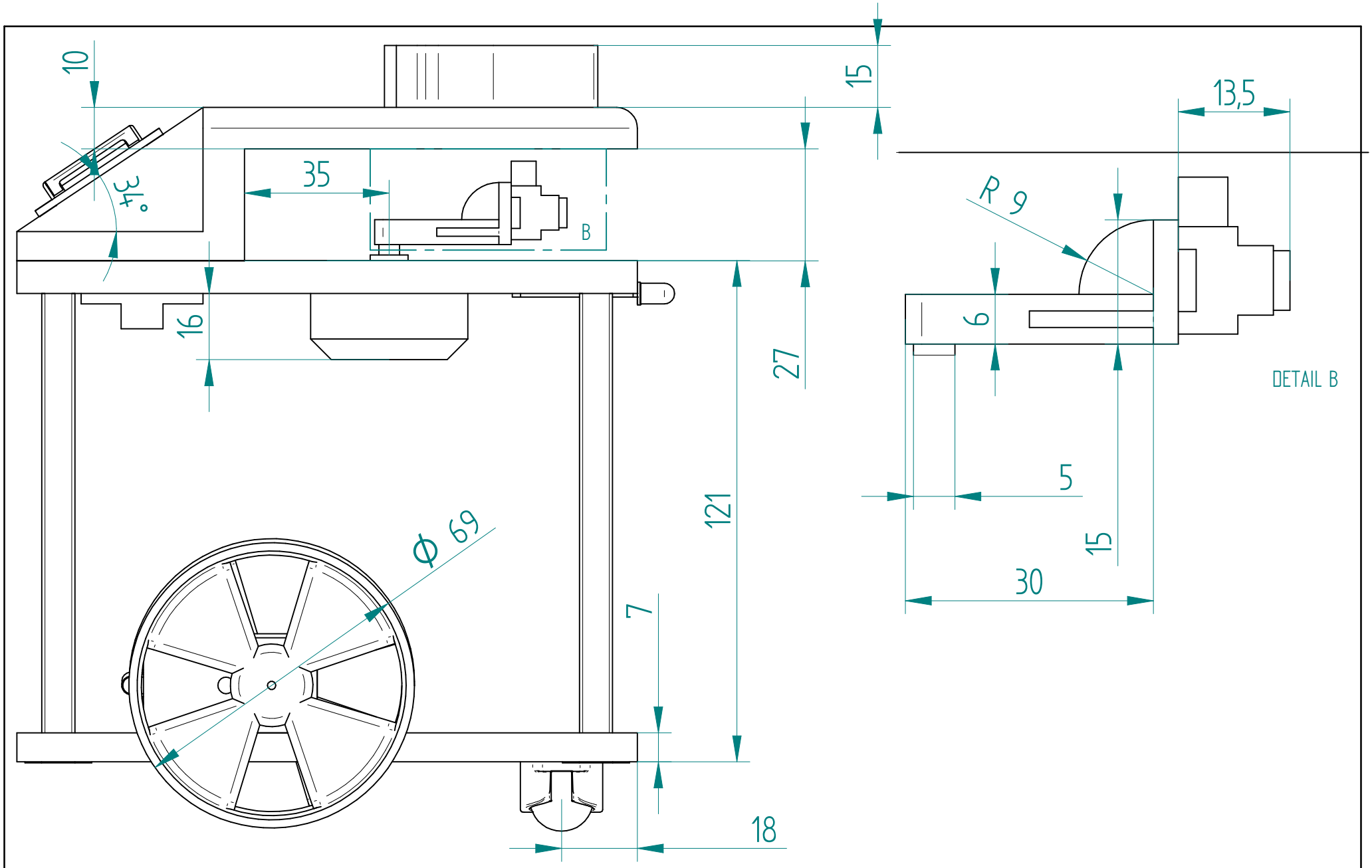

Right View

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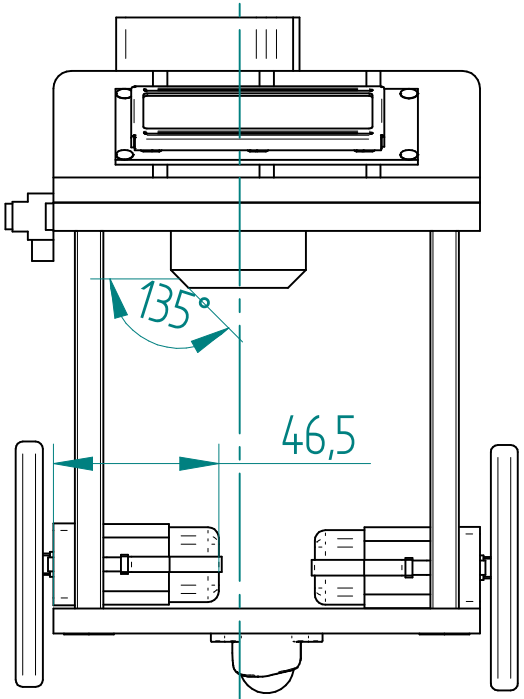
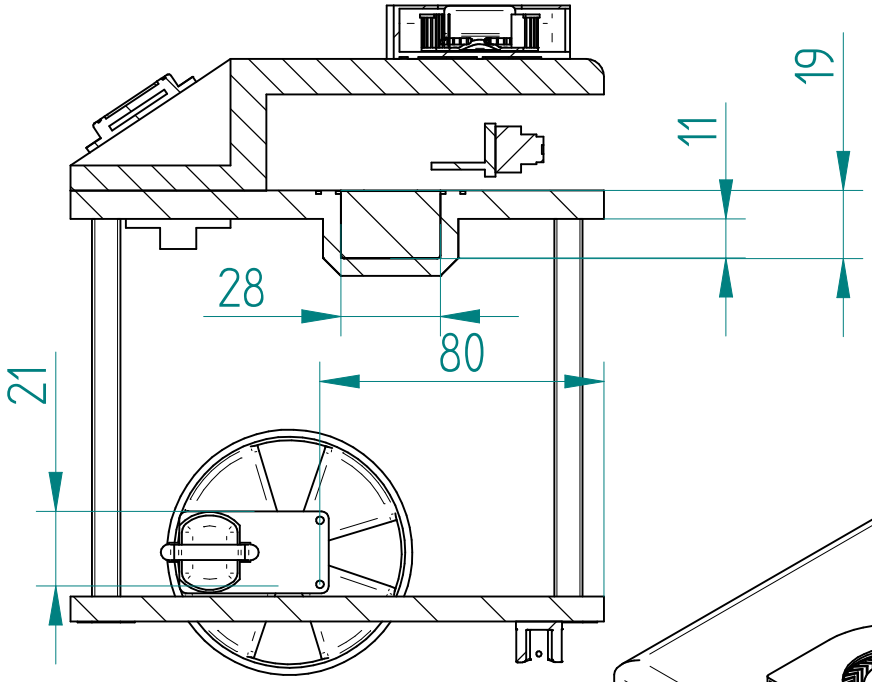
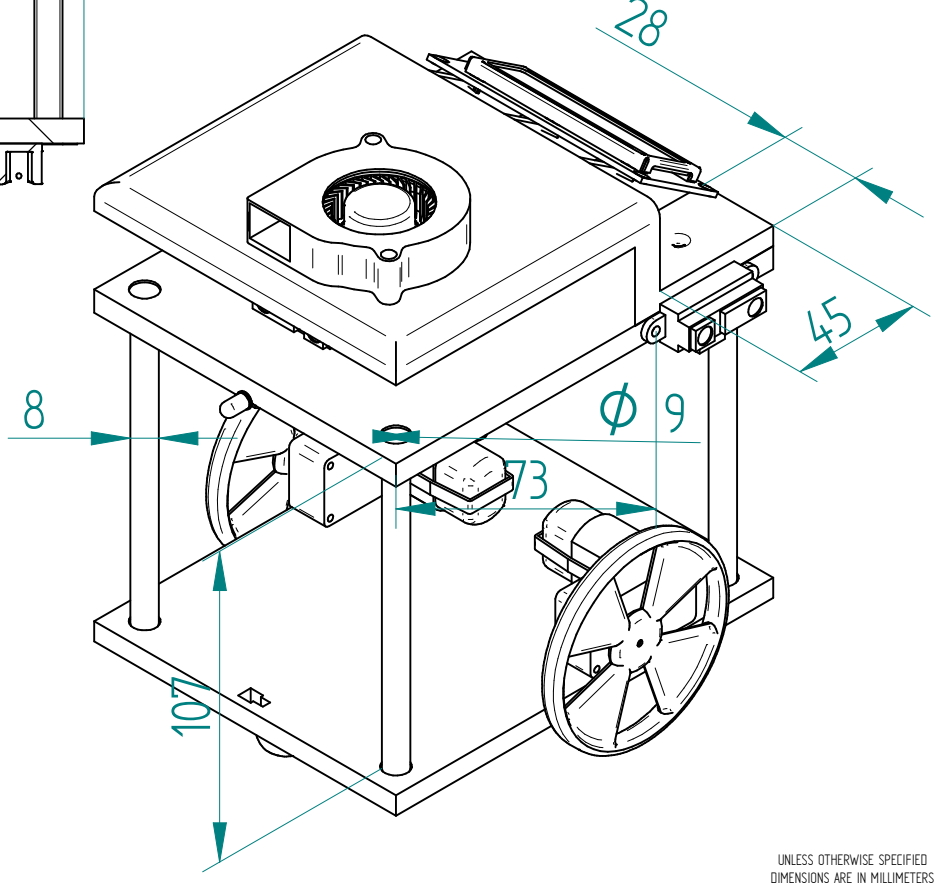


Back Section View

C



SECTION C-C



Isometric View

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