LUKEXIANG Firefighter Bot Proposal

PREPARED FOR

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Description

Introduction

Firefighting is a dangerous and mortal job for humans, which is why we are slowly transitioning to firefighting robots. In this project, we will be building a miniature firefighting robot that will navigate a maze and extinguish small fires on a candle. This is a replica or test bot to extend to larger-scale firefighting robots to fight real fires. Our bot will be called “LUKEXIANG”, which is a creative reference to the makers of the bot “Luke” and “Xiang”.

Unlike most other bots with two wheels, we will have a ball caster for more stability and manoeuvrability. A ball caster is similar to the tip of a ballpoint pen; it’s able to smoothly rotate in all 360 degrees while being sturdy enough to hold plenty of weight. The ball caster is located at the bottom of the bot near the line detection. We chose this addition because a bot with 2 wheels uses nuts non-spinning objects to stabilize itself, which creates friction, and is not ideal for movement. A ball caster fixes both these problems by enhancing stability with a 3rd contact point while also not causing any friction that may be caused by wood or metal dragging along the maze.

Line detection

The line detection will consist of a phototransistor and superbright LED located at the bottom of the bot facing the ground, in front of the ball caster. When the bot is on a white line, the light emitted from the super bright LED reflects off the line and into the phototransistor, which allows the voltage to go through it. This will give a voltage of <0.8V to the chip, which converts to a digital value of 0 to the program. On the other hand, if the bot is on black, the light emitted from the super bright LED does not reflect off the line so it does not allow voltage to go through it. This will give a digital value of 1 which tells the program that it is on black.

Flame detection

The flame detection consists of the QSD123 IR detection sensor to detect the heat emitted by the candle. The sensor will be located at the front of the bot, and to ensure accuracy, will be near the exhaust of the blower fan, pointing in the same direction. This ensures the bot can find the flame and put it out knowing its location.

Flame extinguisher

The flame extinguishing process uses a 12V blower fan to extinguish the flame using a concentrated stream of air from afar. This component will be located at the top of the bot, about 20cm from the top ground. By facing directly forward and parallel to the ground, we allow the bot to have a wider range of distances it can put the flame out from. The blower fan

will turn on immediately when the flame detection sensor detects the presence of a flame and will sweep left and right until the flame is extinguished, before moving on to the next room.

Wall detection

The wall detection consists of 2 Sharp analog distance sensors. The now-discontinued GP2D12 will be replaced with the GP2Y0A21YK0F, also made by Sharp. It uses an infrared sensor and LED to detect objects between 10 to 80 cm away. The voltage the sensor receives varies depending on the distance to the wall. However, the relationship between the distance and the voltage is non-linear, so math approximations are required to calculate the distance between the bot and the wall in front of it. The distance is calculated using this formula:

$$R = \frac{\frac{6787}{V-3} - 4}{5}$$

Or

$$R = \frac{5787}{V-3} - \frac{4}{5}$$

The distance sensor will be located on the second layer on the front and left of the bot. It will be used to detect its surroundings as the bot navigates the maze.

Bot design

Our bot will have 3 layers, with the top layer approximately 17 cm above the ground. The first layer will contain the motors, wheels, and motor board. The second layer will contain the wall sensors and the sensor board. The wall sensors are best not on the third layer because the wall is just as visible on the second layer, without taking up room in the third layer where the fan and IR sensor sit. The third layer will contain the blower fan, fan board, flame detector, and LCD display. All 3 layers will be bolted together using 4 threaded rods attached to 3 wooden bases approximately 1.5 cm in thickness before sanding. Our bot will have a large 15 x 12 cm base which is large enough to provide stability and ample space for components, but also small enough to navigate through the maze without too many problems. The height of the bot will be about 20.3 cm high with the fan, which places the fan in the perfect spot to put out candles.

Strategy

Our bot will perform what is known as a depth-first search by going into every room until it completes its mission. This ensures we don’t need to hardcode anything while also efficiently exploring each room.

Materials

Name	Quantity	Price	Total	Notes	Source
16 pin socket	1	CA$ 0.39	CA$ 0.39		https://www.solarbotics.com/product/dc-16-pin
40 pin socket	1	CA$ 1.09	CA$ 1.09		https://abra-electronics.com/interconnects/sockets/machine-tooled-low-profile-sockets/40mlp-low-profile-machine-socket-40-pins-40mlp.html
Ball caster	1	CA$ 5.19	CA$ 5.19		https://www.solarbotics.com/?s=Pololu+1%2F2%22+Plastic+Ball+Caster&post_type=product&dgwt_wcas=1
Capacitor	4	CA$ 0.25	CA$ 1.00		https://www.solarbotics.com/product/cp22uf
Circuit board	1	CA$ 1.50	CA$ 1.50		amazon
Diode (1N4148)	3	CA$ 0.19	CA$ 0.57		https://www.solarbotics.com/product/d1
Fan	1	CA$ 8.89	CA$ 8.89		https://www.robotshop.com/en/12v-16cfm-33mm-blower-fan.html
Jam nuts	12	CA$ 0.32	CA$ 3.84		https://www.homedepot.ca/product/paulin-m8-1-25-class-8-metric-hex-nut-din-934-zinc-plated/1000128521
LCD screen (2 x 16)	1	CA$ 25.29	CA$ 25.29		https://www.robotshop.com/en/devantech-2x16-i2c-serial-lcd-blue.html
LED	1	CA$ 2.95	CA$ 2.95	10 pack	https://www.solarbotics.com/product/sled3mm
LED (superbright)	1	CA$ 1.10	CA$ 1.10		https://www.solarbotics.com/product/sbled
Lock nuts	12	CA$ 0.59	CA$ 7.08		https://www.homedepot.ca/product/paulin-m8-1-25-metric-pozi-lok-nylon-insert-stop-nut-zinc-plated/1000128541
M8 threaded rod	1	CA$ 16.99	CA$ 16.99	5 pack	https://www.walmart.ca/en/ip/M8-x-150mm-1-25mm-Pitch-304-Stainless-Steel-Fully-Threaded-Rods-Fasteners-5-Pcs/PRD6UZWFQJTIV43
Motor bracket	2	CA$ 1.99	CA$ 3.98		https://www.solarbotics.com/product/gmb28
Motor Driver (L293D)	1	CA$ 8.50	CA$ 8.50		https://www.solarbotics.com/product/l293d

Name	Quantity	Price	Total	Notes	Source
Motors (GM8)	2	CA$ 7.50	CA$ 15.00		https://www.solarbotics.com/product/gm8
Phototransistor	1	CA$ 0.59	CA$ 0.59		https://www.solarbotics.com/product/17700
Phototransistor (QSD123)	1	CA$ 0.90	CA$ 0.90		https://www.digikey.ca/en/products/detail/on-semiconductor/QSD123/1874443
PIC (PIC16F887)	1	CA$ 3.39	CA$ 3.39		https://www.solarbotics.com/product/pic16f887
Plywood	1	CA$ 52.98	CA$ 52.98	4' x 8' sheet	https://www.homedepot.ca/product/thd-7-16-4x8-oriented-strand-board/1000108771
Potentiometer	1	CA$ 1.22	CA$ 1.22		https://www.robotshop.com/en/rotary-potentiometer-10k-ohm.html
Resistor	7	CA$ 0.29	CA$ 2.03		https://www.solarbotics.com/?s=resistor&post_type=product&dgwt_wcas=1
Switch	1	CA$ 1.22	CA$ 1.22		https://www.robotshop.com/en/sfe-on-off-rocker-switch.html
Terminal blocks (2 position)	6	CA$ 1.69	CA$ 10.14		https://www.solarbotics.com/product/tblk2-100
Terminal blocks (3 position)	4	CA$ 1.89	CA$ 7.56		https://www.solarbotics.com/product/tblk3-100
Transistor (TIP120)	1	CA$ 1.08	CA$ 1.08		https://www.newark.com/stmicroelectronics/tip120/bipolar-bjt-single-transistor/dp/34X3382
Voltage regulator (LM7805)	1	CA$ 2.09	CA$ 2.09		https://www.solarbotics.com/product/17190
Wall sensor (GP2Y0A21YK0F)	2	CA$ 18.58	CA$ 37.16		https://www.digikey.ca/en/products/detail/sharp-socle-technology/GP2Y0A21YK0F/720159
Total			CA$ 223.71		

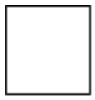
Timeline

M	T	W	T	F
Feb 28	March 1	March 2	March 3	March 4
-Luke will find the input and output numbers for the chip -Xiang will program the chips using Luke's information -Luke will start the breadboarding -Luke and Xiang will do the breadboard to make sure the flash is working with the LED	-Finish breadboarding the circuit if not finished -Xiang will supply Luke with the outputs for the motors -Xiang will start breadboarding -Luke will program the chip for the motors -Xiang and Luke will work on breadboarding	-Troubleshoot breadboarding	-Finish breadboarding the motors and record their combinations for forward and backward for each motor separately	-Xiang and Luke program for the LCD
March 7	March 8	March 9	March 10	March 11
-Xiang and Luke finish programming the LCD -Finish breadboard for LCD	-Troubleshoot the LCD breadboard	-Xiang programs line detection -Luke and Xiang program the LCD to display the number of times the phototransistor sees a black / crosses a line -Luke works on breadboard -Test line detection on breadboard	-Finish line detection breadboard if not done	-Understand wall detection and how to program it -Xiang and Luke start programming the wall detection
March 14	March 15	March 16	March 17	March 18
-Xiang and Luke program the LCD to display the wall sensor distance -Both add wall sensor to breadboard (Should take less than	-Continue on Yesterday's work	-Troubleshoot the wall sensor to LCD. -Finish wall sensor	-Luke programs the LCD to display whether or not the IR sensor detects heat and turn the fan on if it does (It shouldn't take that long if we know	-Troubleshoot if necessary -Finish the flame detection and extinguisher

M	T	W	T	F
5 min)			how to do the wall sensor) -Xiang adds IR sensor and blower to breadboard	
March 21	March 22	March 23	March 24	March 25
-Luke will start the traxmaker for the motherboard -Xiang will start the traxmaker for the motor -If Xiang is done, Xiang will check Luke's traxmaker for mistakes	-Xiang finishes traxmaker for blower fan circuit -Luke and Xiang crosscheck each other's traxmaker for errors	-Check each board for traxmaker once again before printing -Wait for Mr Webb to print them on transparent paper -While waiting, continue checking the circuit for errors and possible improvements	-Use UV light on circuit board -Put boards in etching tank -Scrub board until lines have a gold colour	-Center punch board -Drill holes in board (Xiang and Luke work in parallel)
March 28	March 29	March 30	March 31	April 1
-Xiang solders components for motherboard -Luke solders components for blower fan board and motor board	-Continue yesterday's work	-Check all components are correct and in the right position -Make sure components are not backwards	-Xiang make base for bot and attach motors -Luke connect motors to motor board -Flux and capacitor -Organize the wires	-Use the programmed chip to make sure motors are working as intended
April 4	April 5	April 6	April 7	April 8
-Drill hole in base for line detection -Connect phototransistor and superbright LED to motherboard -Make sure line detection is working	-Xiang makes the second and third layer in the workshop -Luke adds the second and third layer to the base -Organize wires to fit the design	-Install wall sensor on the second layer of the bot and connect it to the motherboard -Make sure the LCD is displaying the distance outputted by the wall sensor	-Troubleshoot	-Install IR sensor and blower fan on the third layer of the bot -Connect them to the motherboard
April 11	April 12	April 13	April 14	April 15

M	T	W	T	F
-Ensure IR sensor and blower are working as intended -Troubleshoot if not	-Program bot for maze navigation	-Program bot for maze navigation	-Program bot for maze navigation	-Program bot for maze navigation
April 18	April 19	April 20	April 21	April 22
-Program bot for maze navigation	-Program bot for maze navigation	-Program bot for flame detection and extinguisher	-Program bot for flame detection and extinguisher	-Program bot for flame detection and extinguisher
April 25	April 26	April 27	April 28	April 29
-All dates after this - work on bot design, better strategies, and overall improvements to bot, and buffer time				
May 2	May 3	May 4	May 5	May 6
May 9	May 10	May 11	May 12	May 13

Drawings



Base (wood, bolts, and fan)

Measurements, titles

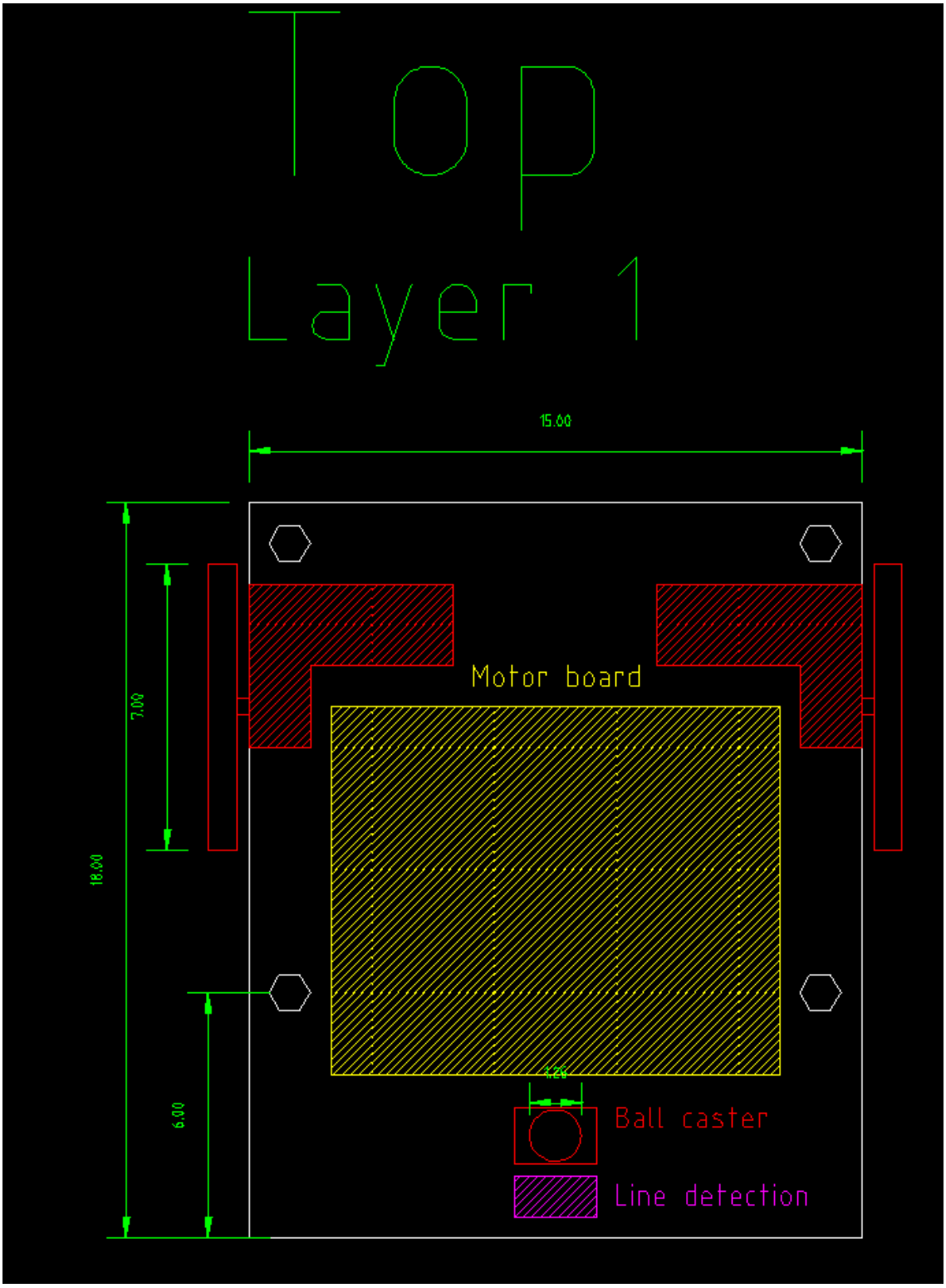
Sensors (general location)

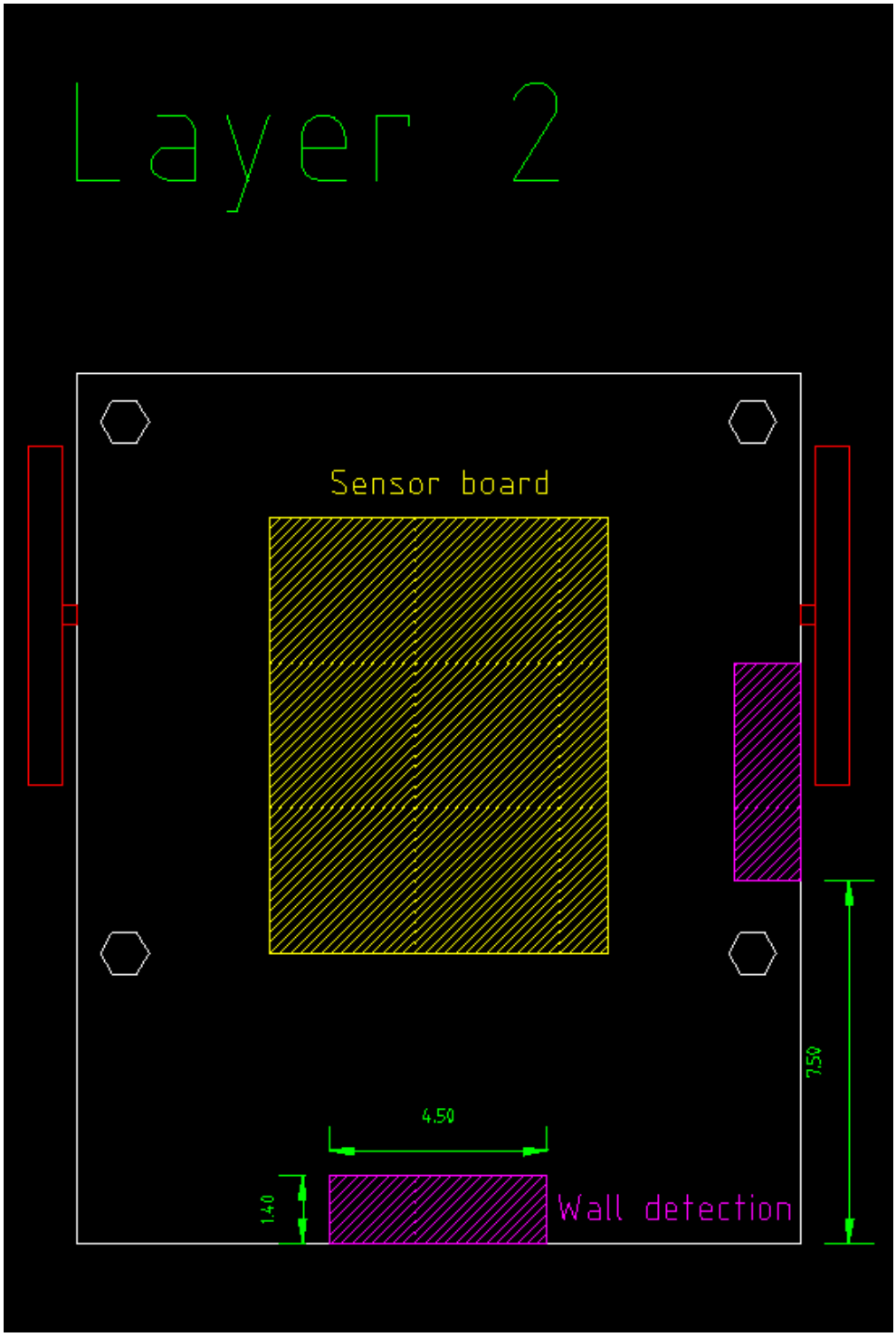
Wheels or motors

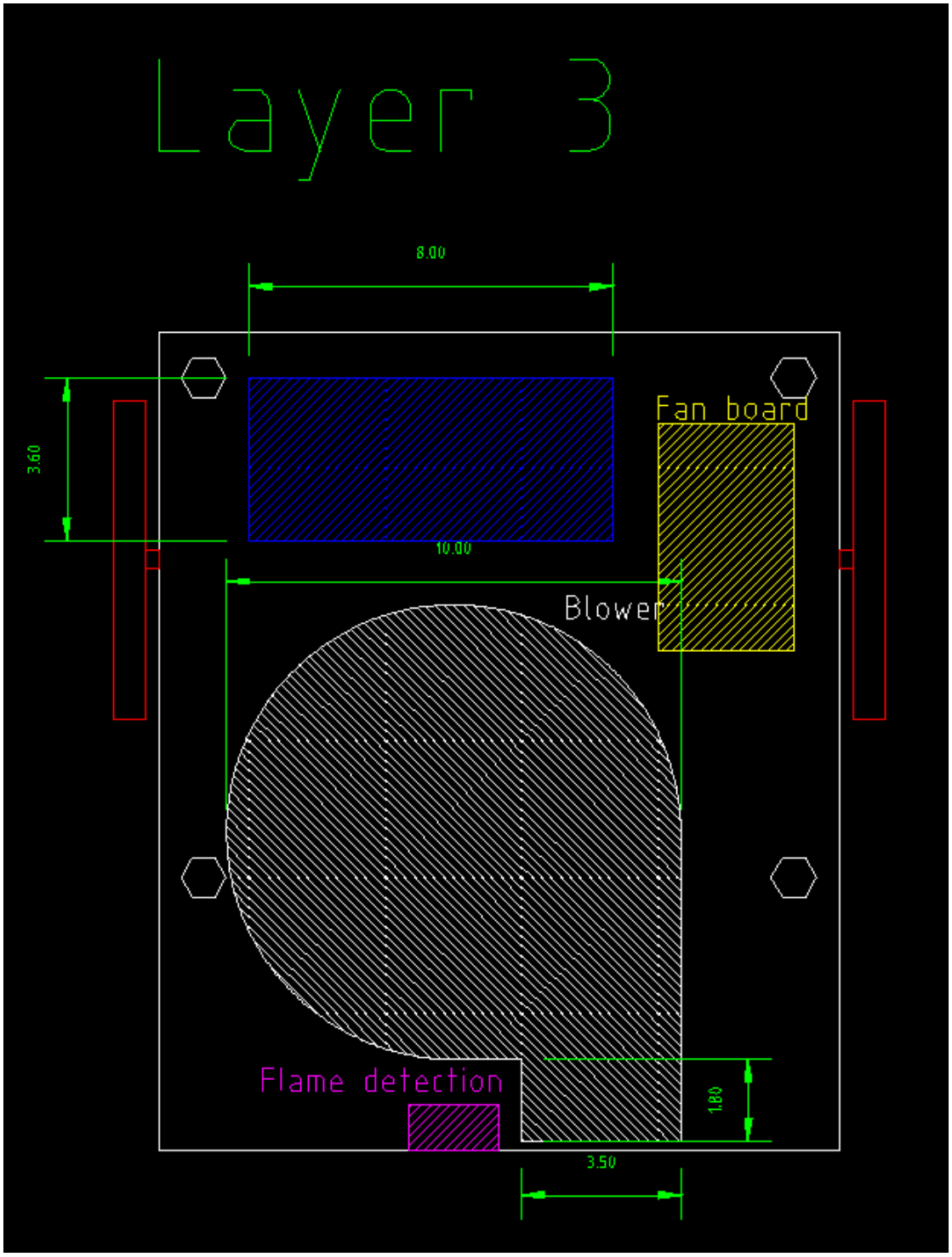
Circuit boards

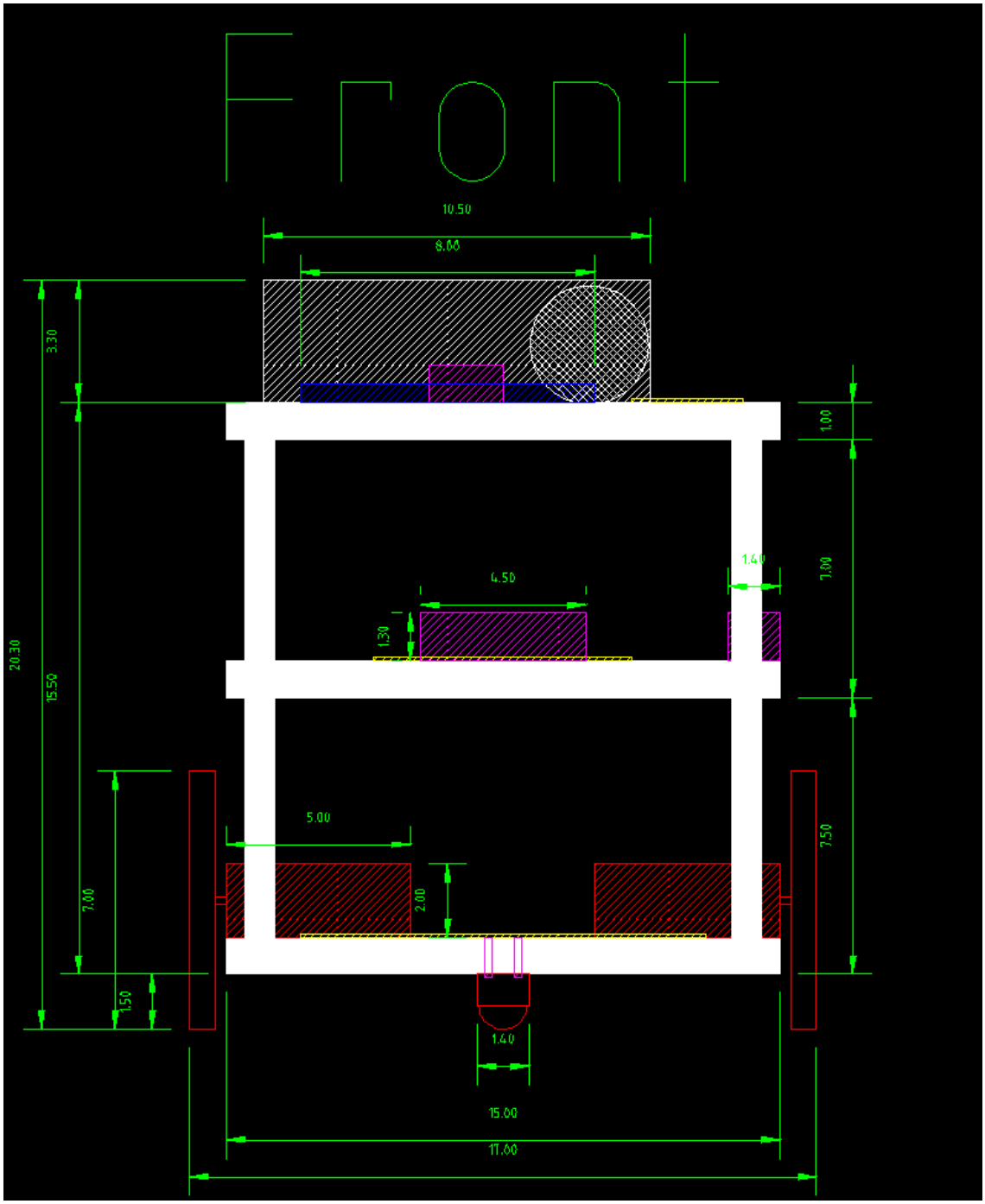
LCD screen

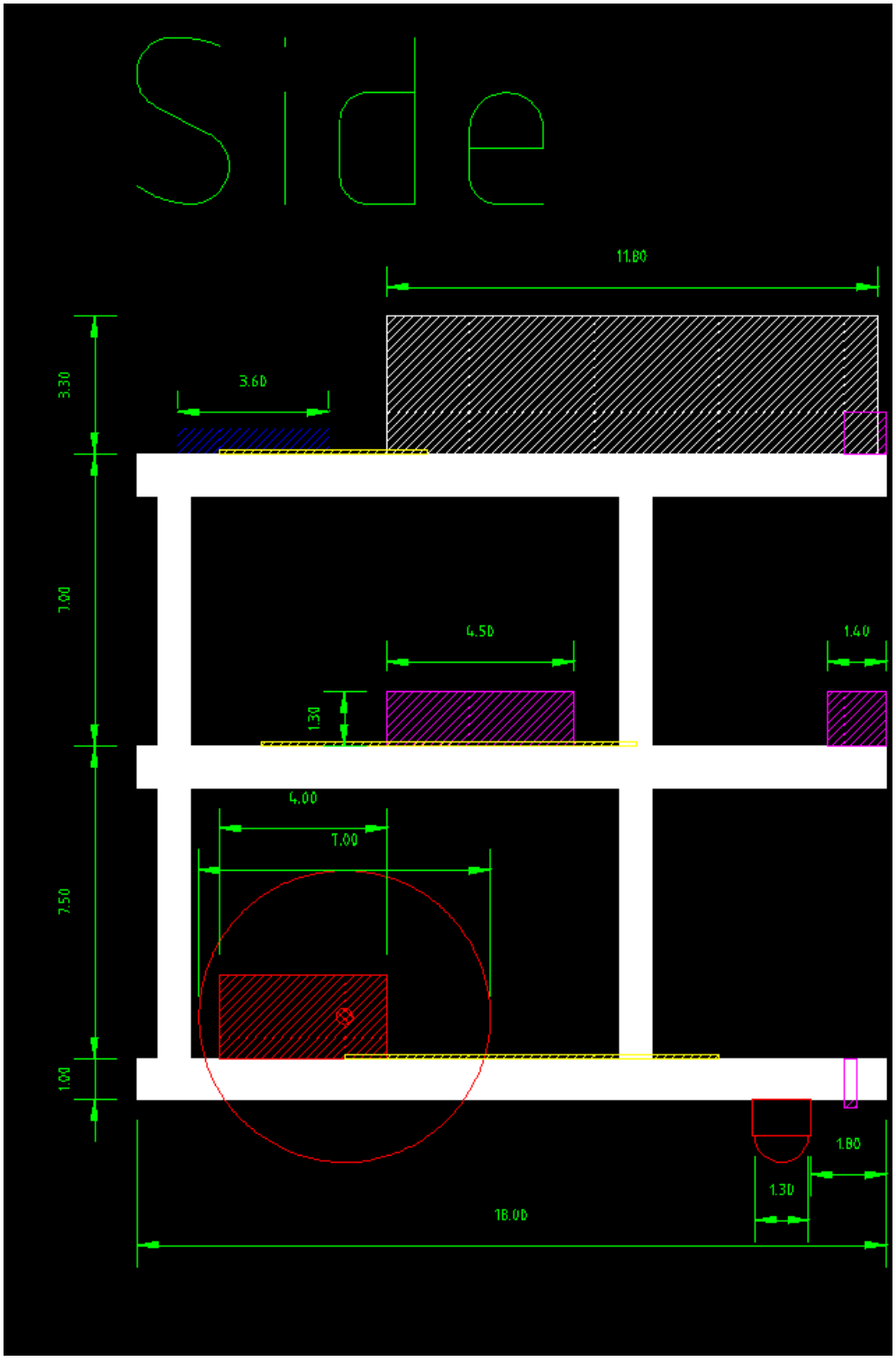
All measurements are in cm unless otherwise specified.


Top
Layer 1
15.00
18.00
7.00
6.00
Motor board
4.20
Ball caster
Line detection


Layer 2
Sensor board
4.50
1.40
7.50
Wall detection


Layer 3
8.00
3.60
10.00
Fan board
Blower
Flame detection
1.80
3.50


Front
10.50
8.00
3.30
20.30
15.50
1.00
7.00
1.40
4.50
1.30
5.00
7.50
7.00
2.00
1.50
1.40
15.00
17.00


Side
11.80
3.60
3.30
7.00
4.50
1.40
1.30
4.00
7.00
7.50
1.00
1.80
1.30
18.00