A documentation on Manual Bot 2018

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Disclaimer: This document only specifies the robot built from electronic standpoint.

Description:

Robotics and Automation Center, IOE Thapathali Campus has been participating in the **“International Robotics Competition”** organized at **TechFest** since the last four years. To continue this trend, RAC decided to take part in the IRC at TechFest 2018 hosted by **IIT Bombay**, Powai Lake, Mumbai, India along with few other competitions. To take part in the competition, a manually operated robot and an automatic robot were built. This document only discusses on the built of the manual robot for the competition.

As stated, a manually operated robot was required with the capability of lifting a light-weighted square block of certain dimension (exact dimension is specified in the theme) and also capable of shooting a projectile on a magnetic target. The full requirements for the robot is mentioned in the theme attached below.

Link: https://github.com/RoboticsThapathali/IRC2018/blob/master/IRC/IRC.pdf

Specifications:

- The specifications of the manual robot built is as follows:
- Height: 280mm, Length: 240mm, Breadth: 210mm
- Weight: 2.3 kg (including the batteries)
- STM32 BluePill as the brains of the robot
- Controlled by 2.4 GHz Radio Controller (FS-i6s)
- Laser guided shooting mechanism controlled by two servos
- Gripper controlled by two servos and a 100 RPM DC motor
- Three Modes – General , Grip and Shoot
- 7 hours run time on a single charge
- On board ON/OFF Switch

Problems Faced

1. PCB Design

I. STM32 Footprint

Error:

Footprint for STM32 BluePill was not found in the standard library in KiCad. A custom library was made for the development board by measuring the dimensions with a vernier calliper. This self-made library did not quite fit the module. Using vernier calliper was a good idea but the precision was not guaranteed because of the compiled calculation errors.

Solution:

Placing the development board on a standard perf-board (matrix board) gave a proper idea on its footprint. Then, 2.54 mm (10 mils in KiCad) separation gap between each pins was decided and a footprint was made accordingly.

<u>Tip: Use a connector (male or female) of 2.54 mm separation with the required number of pins to ease the footprint design.</u>

II. Motor Driver Placement

Error:

Integrating a module onto a pcb is not that easy. Using the motor driver module in the pcb was much more of a hassle.

Solution:

The solder on the pins of the motor driver was heated using soldering iron and were pushed such that each pins protruded downwards instead of up.

Error:

Due to the incorrect dimensions in the pcb made for the bot, the pin alignment was thrown by a substantial amount. This caused the protrusions of screw terminal block from the motor driver to connect with the screw terminal in the pcb. A power line was thus short-circuited with ground.

Solution:

The protrusions were trimmed off and the bottom of the motor driver was them insulated with black tape.

III. Buck Converter Footprint

Error:

The footprint for the buck converter was made in kiCad. + and - pins were not considered properly during the footprint making. This caused a mirror image of the actual pins to be formed.

Solution:

Buck converter was placed upside down and soldered on the pcb.

2. Power Off Error:

Error:

The bot powered off at a very random intervals.

Solution:

All the wires were checked and rechecked to ensure proper connections. All the loose connections were soldered and taped securely.

3. Logic Level Error

Error:

The STM32 microcontroller is a 3.3V logic device where as the Motor driver used a logic of 5V.

Solution:

A logic level converter as show below was used to solve this problem.

Link: https://www.sparkfun.com/products/12009

4. Power

Error:

4 servos drew about 3-4 Amps of current at 5V. A stable 5V supply with capacity of at least 5 Amps was required.

Solution:

A 5Amp Buck converter was used to supply the power to the servos. Additionally, the module also powered STM32, laser diode , buzzer and some leds.

Code:

Link: https://github.com/RoboticsThapathali/IRC2018.git

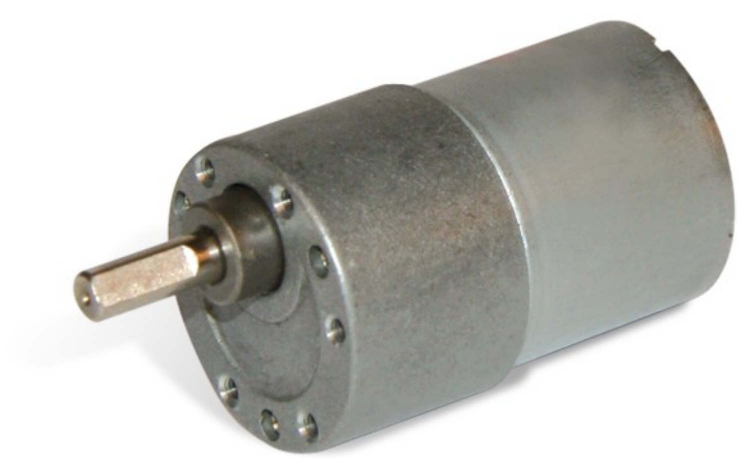
Parts Description

1. Motor

- 12v 200 rpm DC gear motor
- 4 motors used for locomotion
- 60 rpm motor used for moving gripper up and down

Why?

Using a 200 rpm geared motor provided enough torque and speed for our intended purpose. In fact, speed was found to be much more than desired. This was optimized in the hardware itself by limiting the voltage (actually limiting the duty cycle) sent to the PWM pins by connecting the PWM output of STM32 directly to the motor driver (with no logic converter in between).



2. L298N Motor Driver

- Heavy-duty dual H-bridge controller
- Can be used to drive two DC motors at up to 2A each
- Logic voltage of 5V
- Motor drive voltage of 5 to 35V DC
- Maximum power of 25W
- The controller has fast short-circuit protection diodes, and a nice heat sink to keep the L298N cool.

Product link: https://www.hackster.io/now/l298n-motor-module-service-ba0f56

Datasheets:

a) Module : http://www.handsontec.com/dataspecs/L298N%20Motor%20Driver.pdf

b) IC : https://www.sparkfun.com/datasheets/Robotics/L298_H_Bridge.pdf

Why?

- Handles 2A current
- Modifiable to fit the pcb
- Easy available and relatively low priced

3. STM32 BluePill

- Architecture: 32-bit ARM Cortex M3
- Operating Voltage: 2.7V to 3.6V
- CPU Frequency: 72 MHz
- Number of GPIO pins: 37
- Number of PWM pins: 12
- Analog input Pins: 10 (12-bit)
- USART Peripherals: 3
- I2C Peripherals: 2
- SPI Peripherals: 2
- Can 2.0 Peripheral: 1
- Timers: 3(16-bit), 1 (PWM)
- Flash Memory: 64KB
- RAM: 20kB

Proudct Link: https://www.ebay.com/itm/STM32F103C8T6-ARM-STM32-Minimum-System-Development-Board-Module-For-Arduino-/201529768817

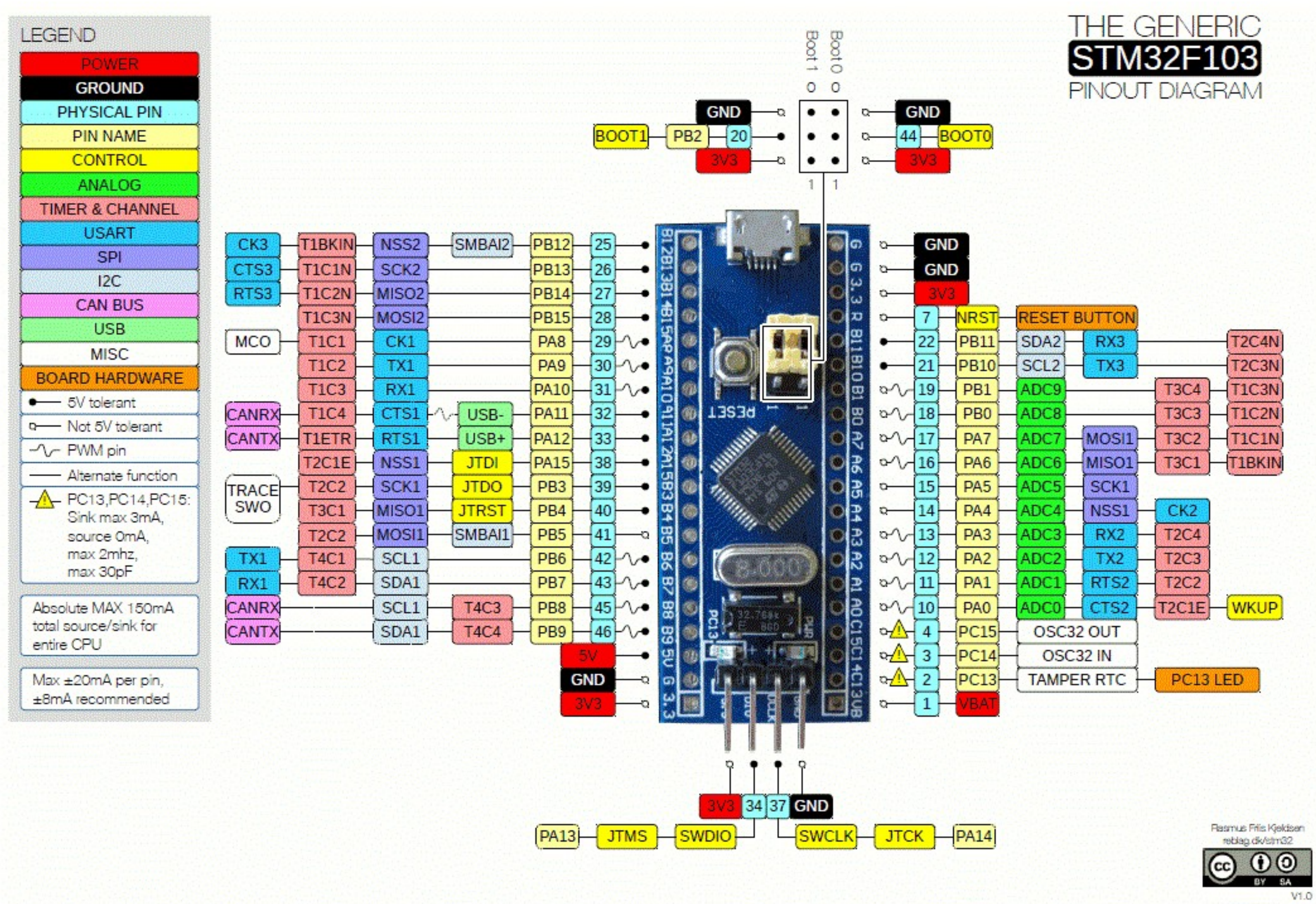
Why?

- 32-bit CPU and ARM Cortex M3 architecture
- much more faster and more capable than arduino
- onboard a 5V to 3.3V voltage regulator IC
- most of its GPIO pins are 5V tolerant

Datasheet:

https://www.st.com/content/ccc/resource/technical/document/reference_manual/59/b9/ba/7f/11/af/43/d5/CD00171190.pdf/files/CD00171190.pdf/jcr:content/translations/en.CD00171190.pdf

https://www.st.com/resource/en/datasheet/stm32f103c8.pdf



4. Buck Converter

- 5A high power, high efficiency and low ripple with power indicator
- Non-isolated buck module (BUCK)
- Input voltage: 8-36V (input please try not to exceed 38V)
- Output voltage: 1.25-32V continuously adjustable
- Output Current: 0-5A
- Output Power: 75W
- Operating temperature: -40 to +85 degrees

Product Link: https://probots.co.in/xl4015-step-down-buck-converter-adjustable-max-output-36v-5a.html#description

Why?

- Supplies 5V to the servos, STM32, buzzer and leds
- Capable of supplying enough current to the servos

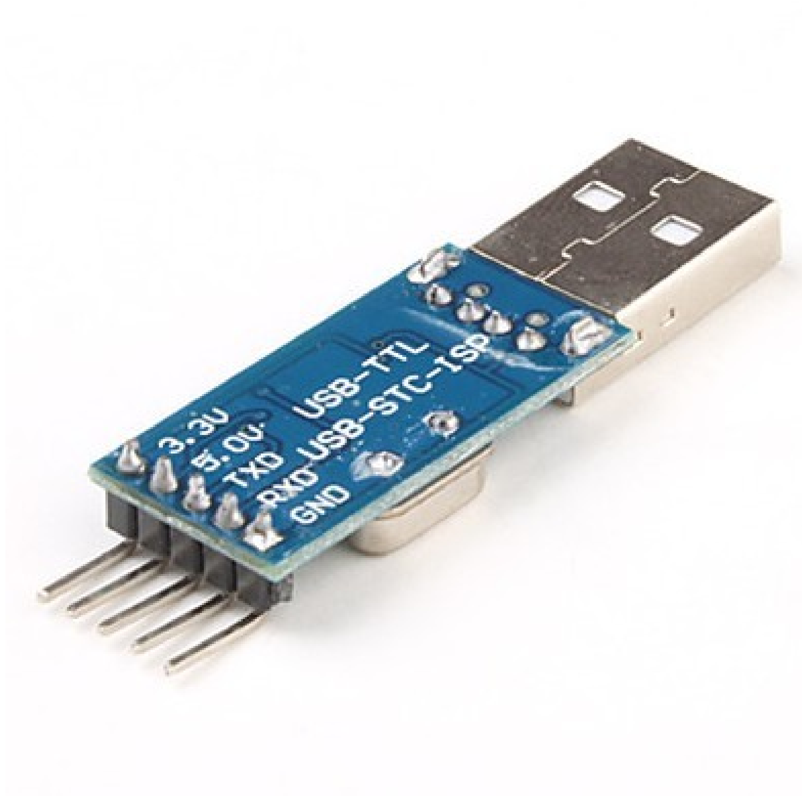
5. USB-TTL

It is a small USB to TTL serial tool, using the CP2102 chip. You can use it to connect serial devices to your PC via USB port.

Product Link: https://potentiallabs.com/cart/buy-usb-ttl-coverter-online-hyderabad-india

Why?

- To program the STM32 through USB



6. FS-i6S

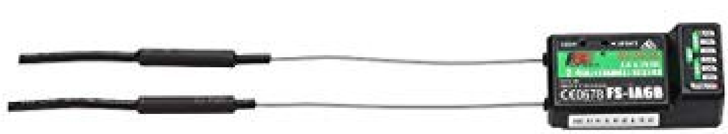
The FS-i6S transmitter and FS-iA6B receiver constitute a 10 channel 2.4GHz AFHDS 2A digital proportional computerized RC System.

Product Link: https://www.banggood.com/Flysky-FS-i6S-2_4G-6CH-AFHDS-Transmitter-With-FS-iA6B-Receiver-p-1024018.html?ID=22442482&cur_warehouse=CN

Why?

- 10 channel receiver available with the Transmitter
- Easy to use and has all the potentiometer springs intact.
- Flexibility in bot functionality
- Supports iBUS

User Manual: https://www.flyingtech.co.uk/sites/default/files/product_files/FS-i6S-MANUAL-EN-20161001.pdf



7. Servo

- Model: MG995
- Weight: 55 gm
- Operating voltage: 4.8V~ 7.2V
- Servo Plug: JR
- Stall torque @4.8V : 10 kg-cm
- Stall torque @6.6V : 12 kg-cm

Product Link: https://robu.in/product/towerpro-mg995-metal-gear-servo-motor/

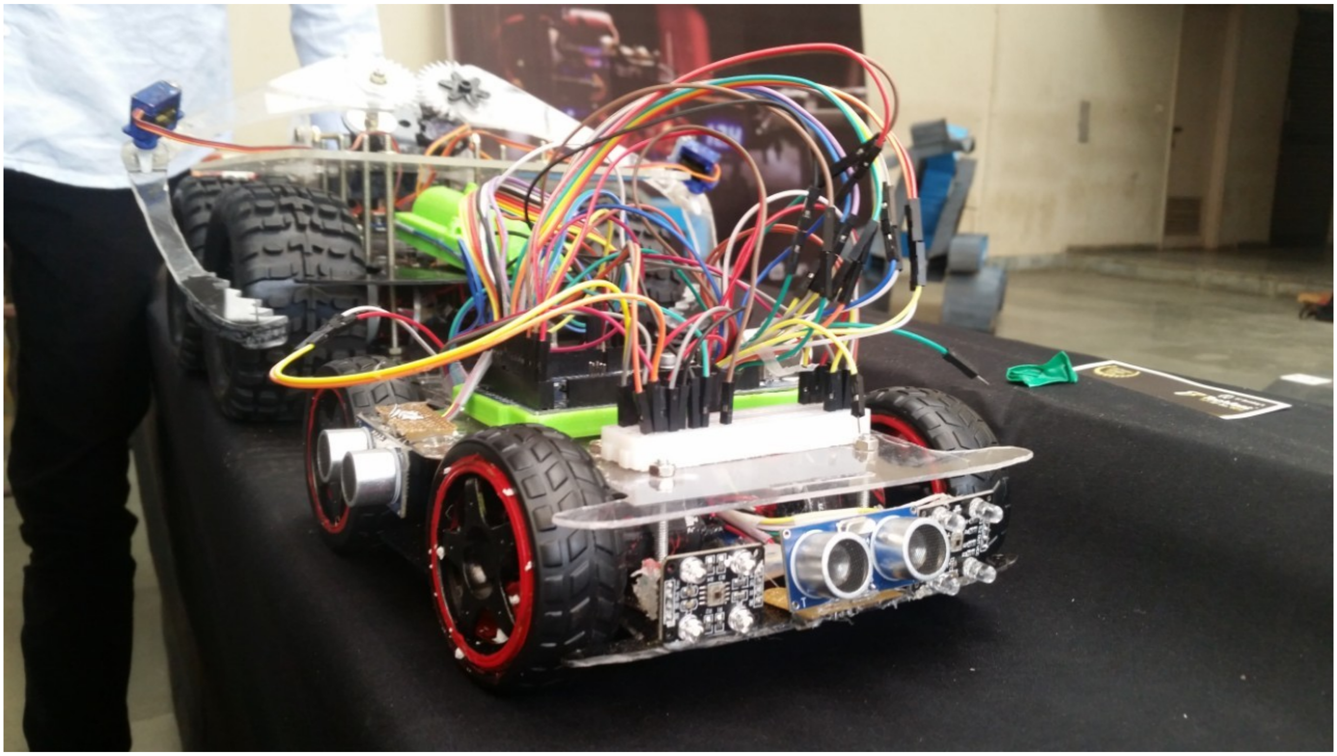
Total Cost

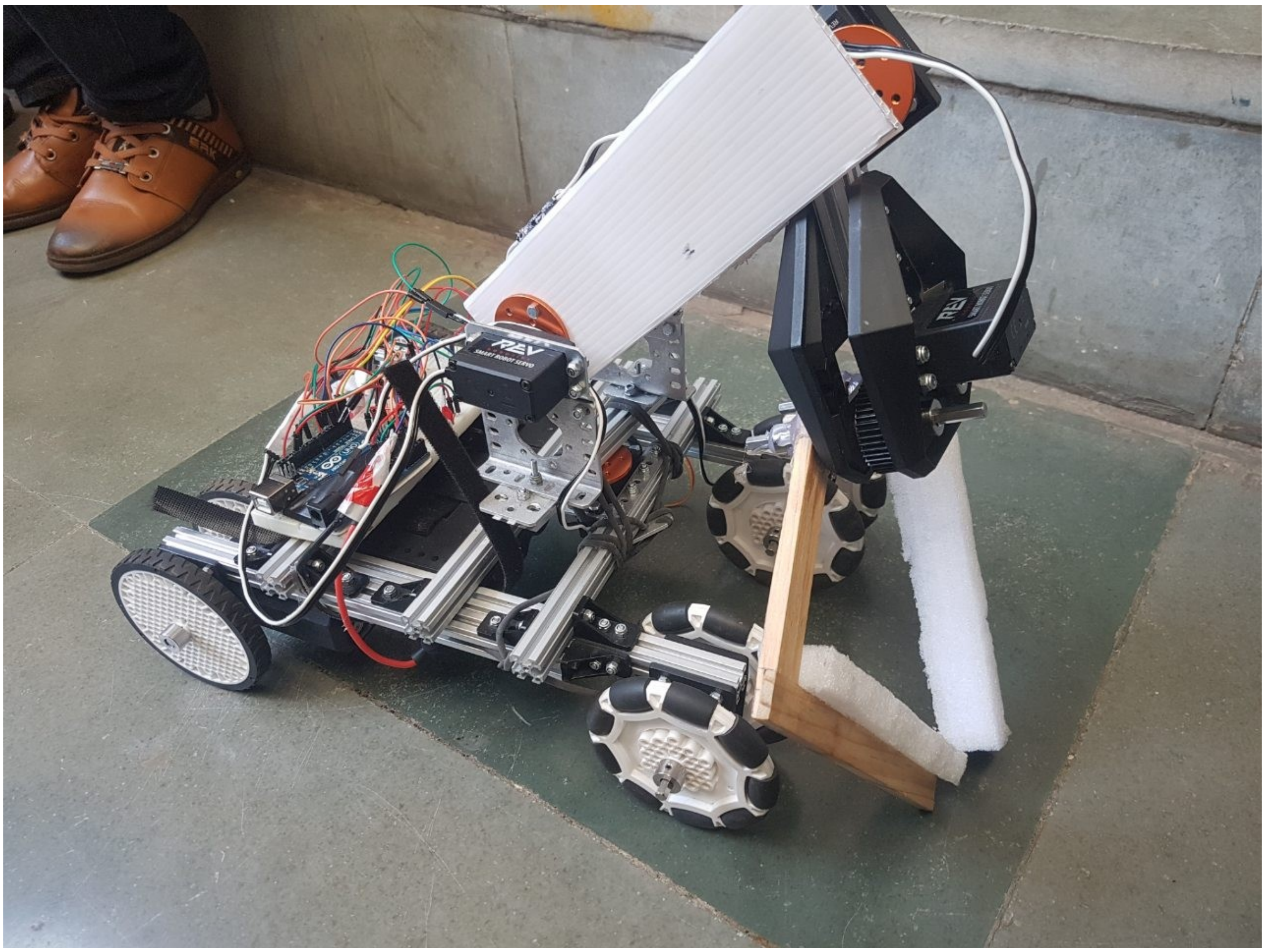
S.N	Components	Quantity	Price per piece	Total Price
1.	DC gear motor 200 rpm	6	800	4800
2.	DC gear motor 60 rpm	1	850	850
3.	L298N	4	550	2200
4.	MG995 Servo	5	1250	6250
5.	STM32 BluePill	4	600	2400
6.	Servo Bracket	4	350	1400
7.	Buzzer	2	35	70
8.	FS-i6s	1	9200	9200
9.	AA Rechargeable Battery	4	125	500
10.	AA Battery Chargers	2	250	500
11.	Male Headers	3	20	60
12.	Female Headers	3	25	75
13.	USB TTL	1	350	350
14.	Lipo Battery	2	3800	7600
15.	PCB	1	250	250
16.	Switch	2	30	60
17.	LED	10	1	10
	Total	**55**	**18486**	**36575**

Appendix:

Arena At IIT Mumbai:

Bots from different countries:




REV
SMART ROBOT SERVO