Group No.3

BASC

BATMAN'S **A**TTEMPT TO **S**AVE **C**ATWOMAN

PROPOSAL REPORT

EN2532 – Robot Design and Competition

13.06.2020

Overall Strategy

- We have divided the task into six subtasks.
  - Line following
  - Wall following & pillar detection
  - Circle navigation
  - Box manipulation and color detection
  - Ramp navigation
  - Gate area navigation
- We thought of handling each subtasks in a modular manner
- Switching between line following and wall following will be done by using the line follower and TOF sensors in each side
- Box manipulation:
  - A gripping mechanism for the box
  - Two color sensors will be used
- Ramp navigation will be done using a feedback loop of gyroscope and motors

Sensors

The Raykha S8 IR sensor module

The TCS 3200 color sensor modules

2 sensors

one on the gripper to detect the front face

The other sensor to detect the bottom surface

VL530LX TOF sensor for distance measurement

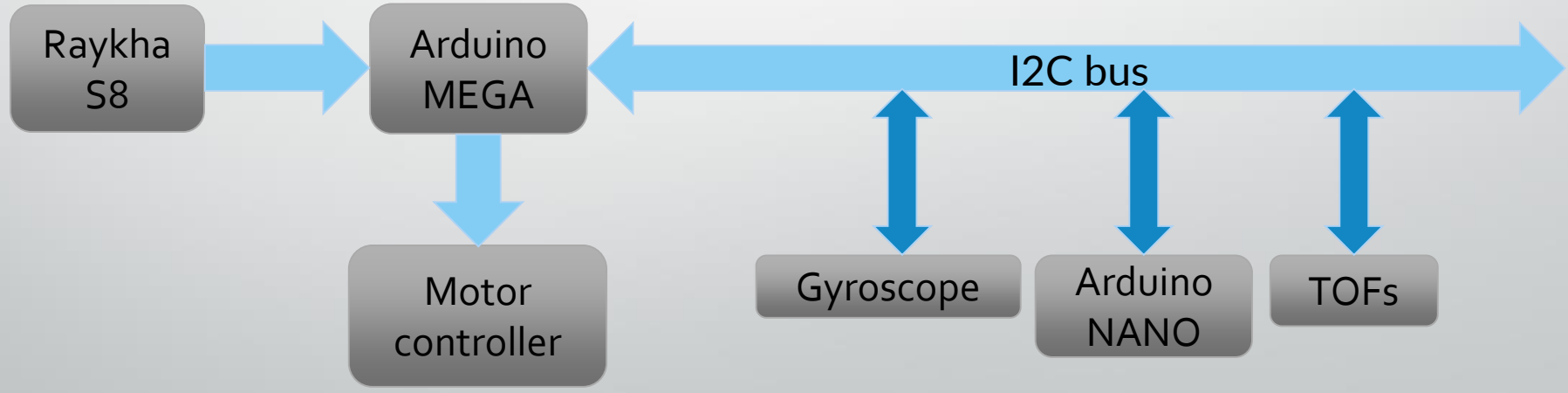
2 sensors on either side for pillar and wall detection

1 sensor in front for the box detection

MPU 6050 Gyroscope

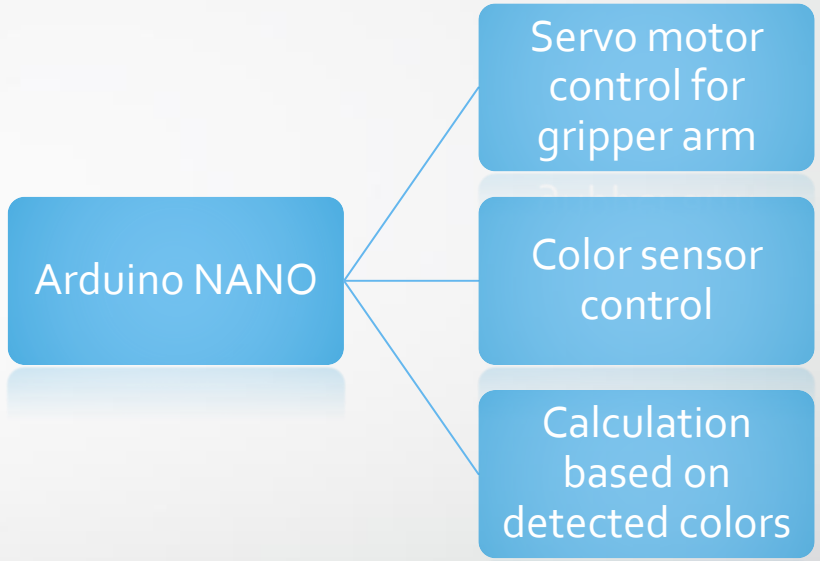
The Processing Unit

- **Arduino MEGA2560**
  - Arduino modules have a wide range of libraries.
  - The clock speed, flash memory, RAM and Interrupt count is higher than UNO/NANO



The Processing Unit

- **Arduino NANO**
  - For better modularity and debugging, use a separate controller for the box handling mechanism.



- A debugging interface, indicator LEDs are also connected to the main processor.

Actuators – Gear motors

According to our calculations for the worst-case scenario in previous assignment (4)

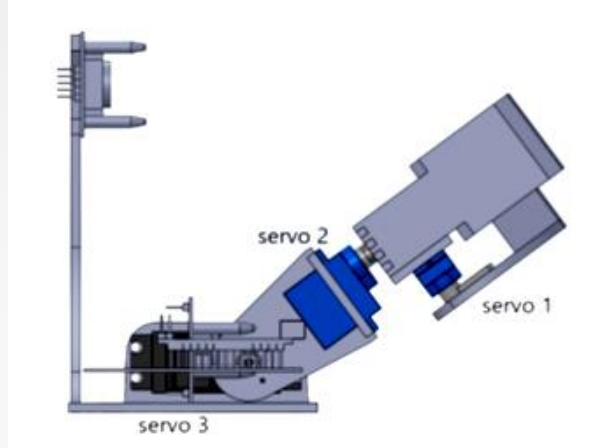
- Total weight – 1.5 kg
- Torque require for a wheel – 0.78 kgcm
- Maximum stall torque - 1.036 kgcm
- Maximum power output – 0.144W
- Power require in climb down the ramp – 0.11W
- Maximum speed need in flat ground – 26.52 rpm

For the above requirements we chose a motor which was **Pololu 25D 12V high power 47:1 gear motor with encoders**

Main specifications

- No load speed & current – 210 rpm, 300 mA
- Stall torque & current – 12 kgcm, 5.6A@12V

Actuators – Servo motors



According to our previous calculations on servo motors,

Servo1 maximum torque = 0.115 kgcm
Therefore we chose **Tower pro SG90** servo for the servo1 & servo2.

Main specifications

- Torque – 2.5 kgcm
- Speed – 600 dps

Servo3 maximum torque = 2.047 kgcm

Therefore we chose **Tower pro SG5010** servo motor for servo3

Main specifications

- Stall torque – 5.5 kgcm (4.8V)
- Speed – 5.26 dps

Line Following

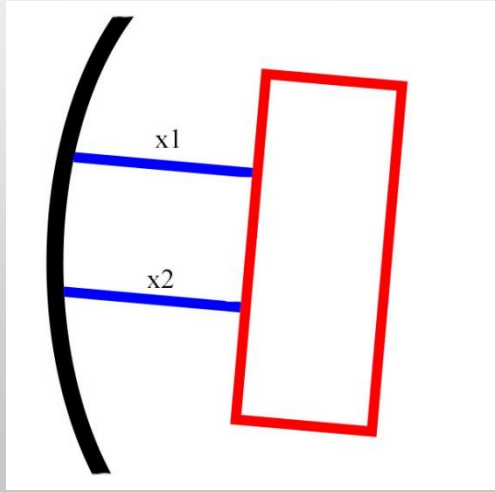
PID algorithm will be used
Outputs of sensor readings will be used to calculate the robot's position on the line.

Formula: $\frac{s_1 \times d_1 + s_2 \times d_2 + \cdots + s_8 \times d_8}{s_1 + s_2 + \cdots + s_8}$

here, s_i will be either 1(white) or 0(black)
d_i will be values of each sensor

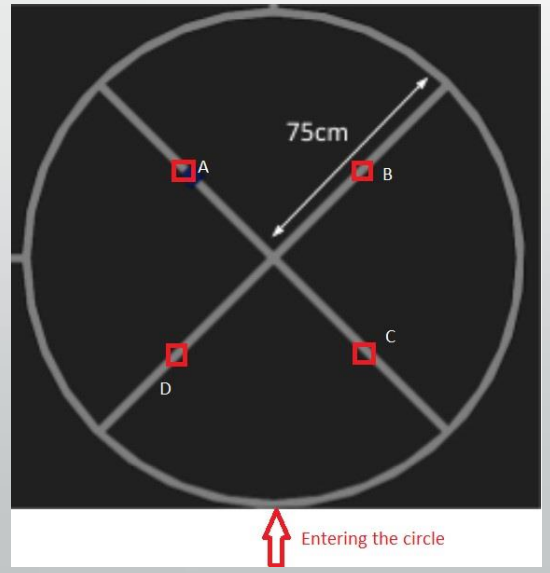
Wall Following

Readings from four VL530LX TOF sensors will be used
PID algorithm will be used



Circle Navigation

Detect the Circle
Navigate along the circumference until finding a radius and enter the radius.
Look for box with front TOF
If found in close proximity, come from other side and manipulate
If found in opposite radius, reach the box and manipulate
Else reach the center, check the side of the box, reach and manipulate
Take color sensor readings and calculate path
Drop the box and exit the circle in the shortest path



Dotted Line Following

Detect end of a segment
Select the tangent direction and move given distance
Detect next segment
Adjust direction

Ramp Navigation

Detect the ramp, using front TOF sensor and Gyro.
Increase motor power for uphill motion
Adjust speed with response from gyro at the top of the ramp
Turn
Control speed while climbing down

Pillar Detection

Side TOF sensors will be used to count the pillars
Adjust the course if needed
Proceed otherwise

Gate Passing

Use front TOFs to identify closed gates
Distance to cover = 120 cm
10s time to cross in the worst case, therefore required base speed 12cm/s
Maximum waiting time will be 17s
Three possible scenarios

1. Gate 1 is Closed: Wait until it is opened, pass through both gates.
2. Gate 2 is closed (G1 open) : Pass G1, then G2 will open.
3. Both gates are open: Wait until a gate is closed, choose scenario 1.

Power Plan

- The robot will be powered by two Li-Po batteries - dual battery setup
  - 7.4V 2200mAh 25C battery
  - 11.1V 2200mAh 25C battery
- Three voltage regulators – all **LM2596S**
  - 9V supply for drive motors, Arduino MEGA and OLED display
  - Two 5V supplies for sensors, servo motors and other components
- Battery level indicators will be used with both batteries to avoid over-drain of batteries
- Two PCBs would be used to minimize the wiring
- PCBs will be finalized after breadboard testing
- DIP switches will be used to control each component during testing
- Alternatives for 9V regulator: **XH-M401** module or **XL6009** module

Task Delegation

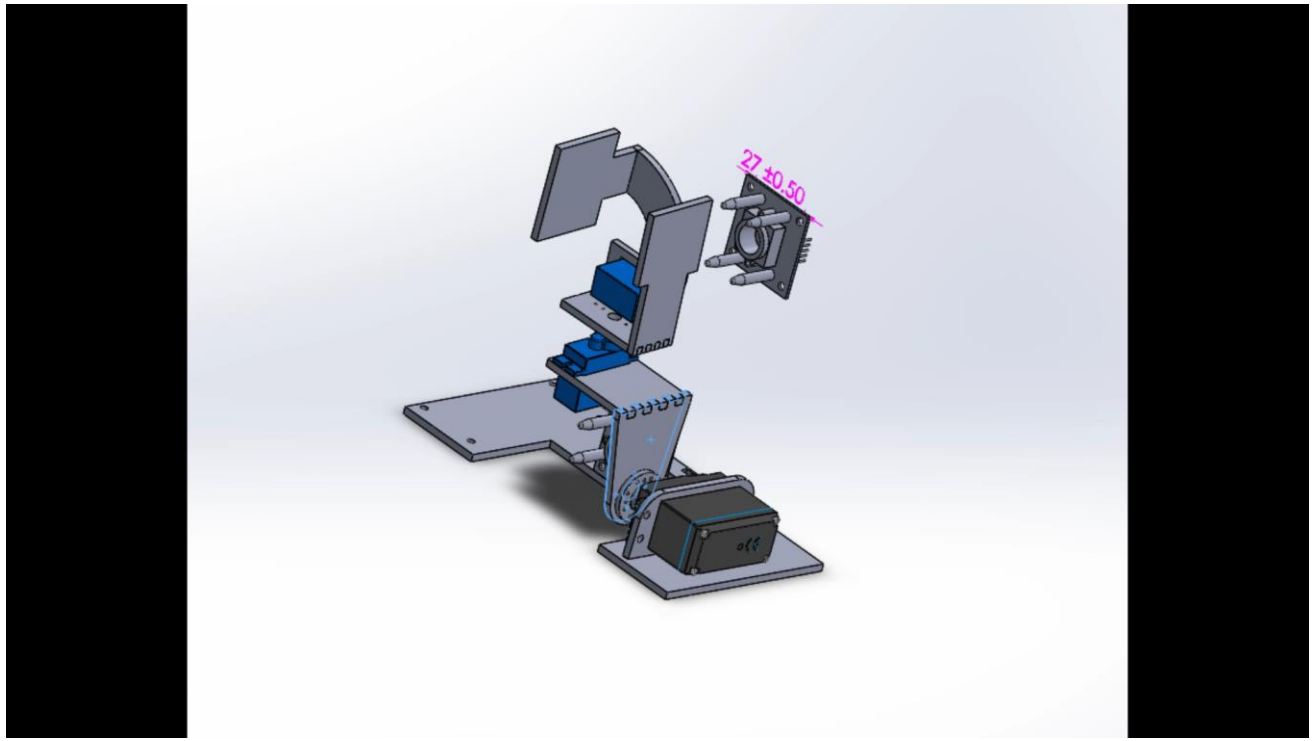
- **Phase 1:** Preliminary design
  - Pamuditha: peripheral components, robot body, coordination
  - Tharindu: box collection, color sensing
  - Yasod: circle navigation, ramp navigation
  - Vidura: gate area, (arena)
  - Thieshanthan: wall following, pillar detection
  - Yomali: line following, (arena)

Task Delegation

- **Phase 2a:** Virtual implementations
  - Schematic and PCB: Thieshanthan, Vidura
  - Coding: Pamuditha, Tharindu, Yomali
  - Mechanical design: Yasod
- **Phase 2b:** Actual implementation
- **Phase 3:** Testing and optimization

- We are currently in the phase 2a.
- Task delegation for phase 2b and phase 3 will be decided when the university starts.

Ramp Simulation



Arm Simulation