

PRODUCT DESIGN PRACTICE

PROGRESS REPORT

**AUTOMATION IN HIGH RISE WINDOW
CLEANING**

GROUP NO : B2 - 43

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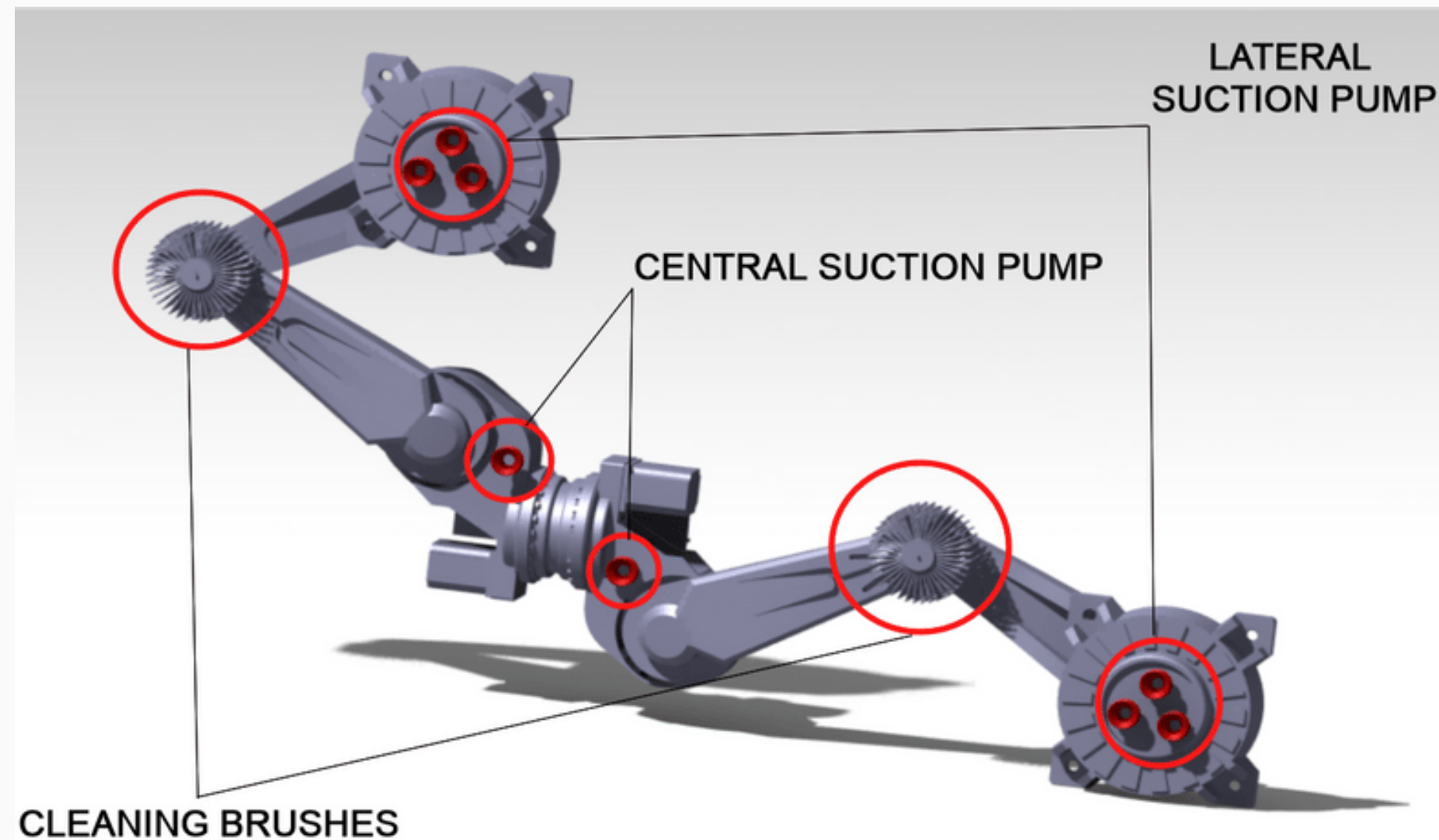


Snippet of existing customer



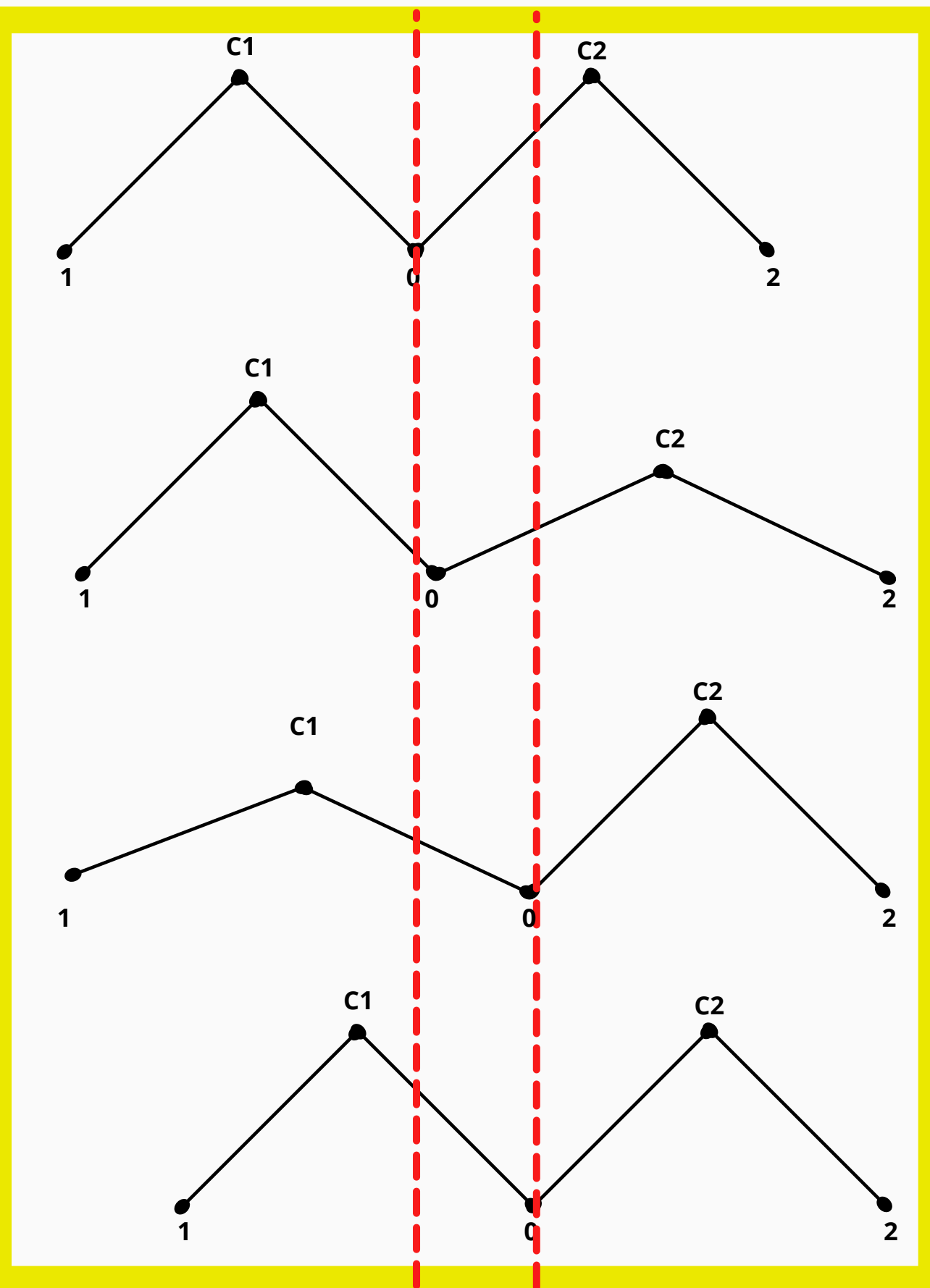
CONCEPTUAL MODEL

MINIMUM VIABLE PRODUCT

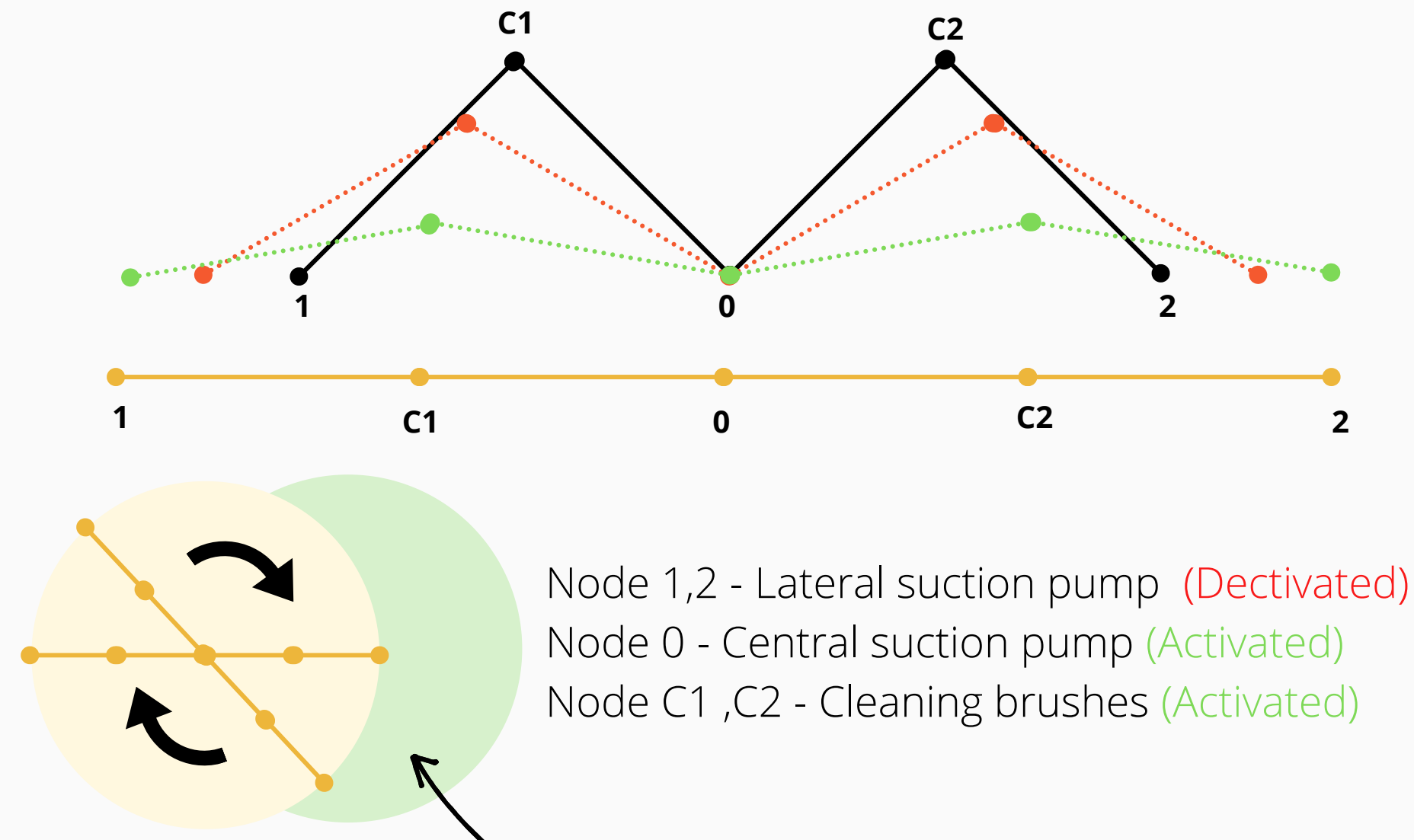


- Spider leg movement (Biomimicry) without suction plunger system
- Cleaning movement (360 degree cleaning)
- Dust Density Index Identification
- Obstacle detection and Rerouting
- Water flow via pipes for internal cooling system (Simulation)
- Window cleaning robotic system and other subsystems simulated using CAD modelling for showcasing entire feature of the conceptual model

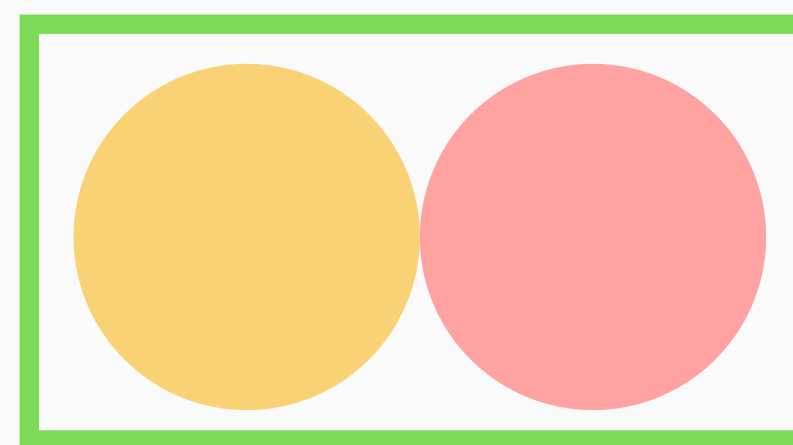
*The highlighted features are critical functionalities that are included in our MVP



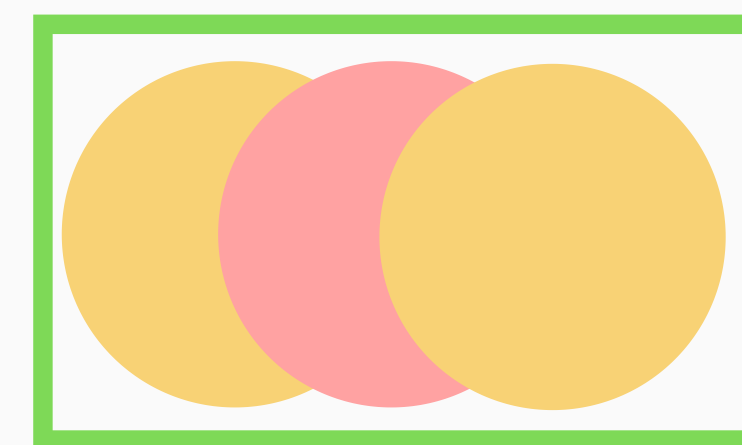
Spatial X movement - Only two out of three suction system is activated when the robot traverses in x direction



The distance between one cleaning area and the next successive cleaning are is reduced to reduce the amount of unclean area



More uncleaned area when step size is high decreasing the efficiency of cleaning process

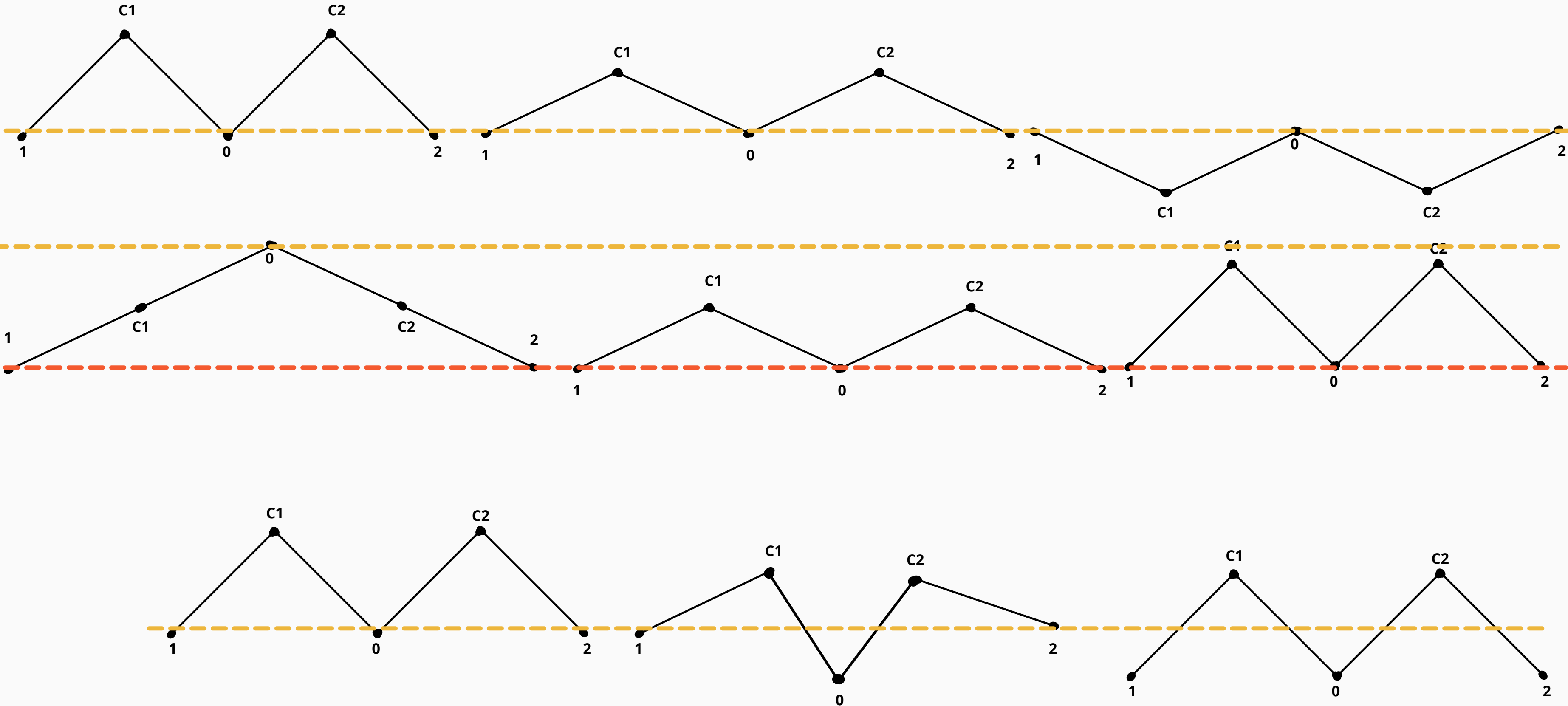


Less uncleaned area when step size is less increasing the efficiency of cleaning process

How does it work?!



EXPLAINED USING LINE DIAGRAMS



PREVIOUSLY ON HACKATHON 1

DUST DENSITY DETECTION



Image 1 - Reference image

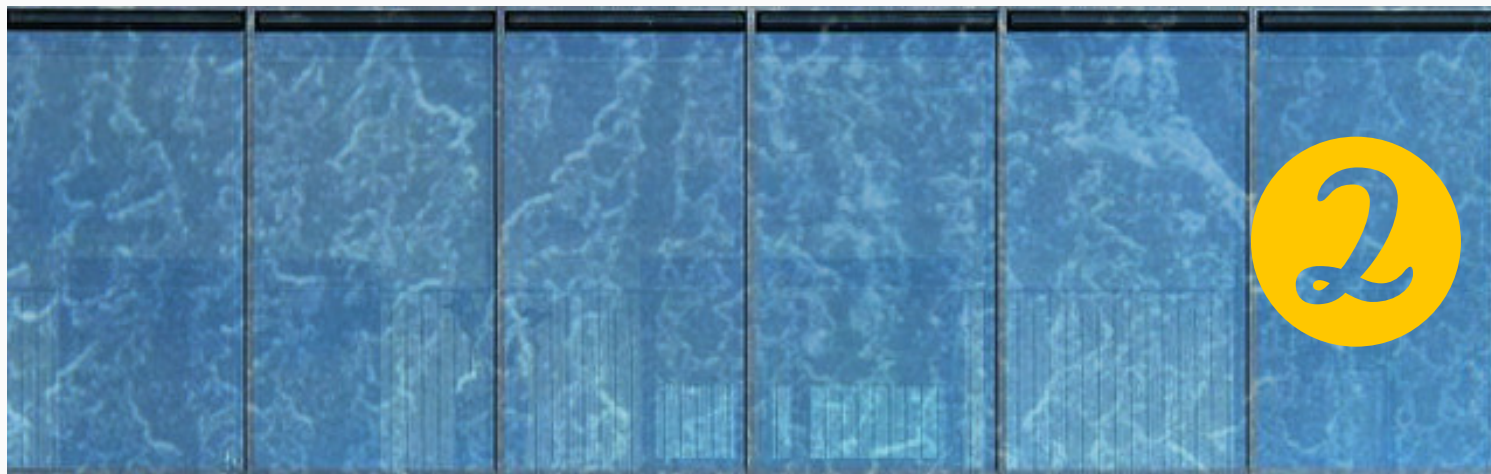


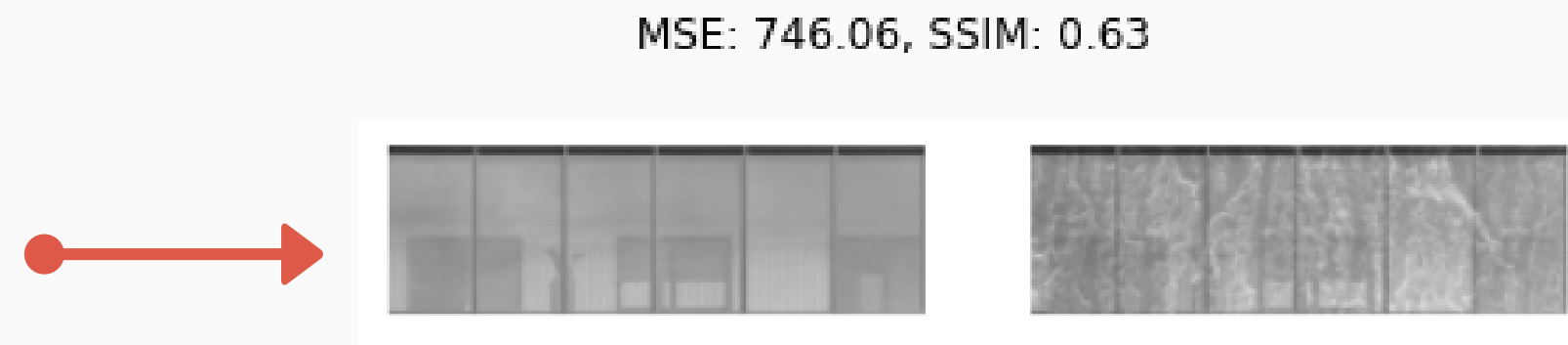
Image 2 - Image with higher percentage of dirt



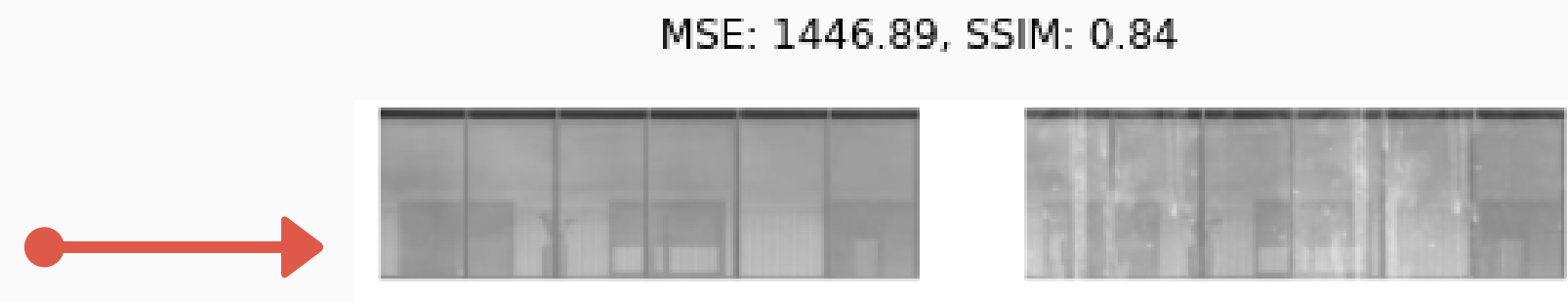
Image 3 - image with slightly lesser percentage of dirt



Reference image versus reference image



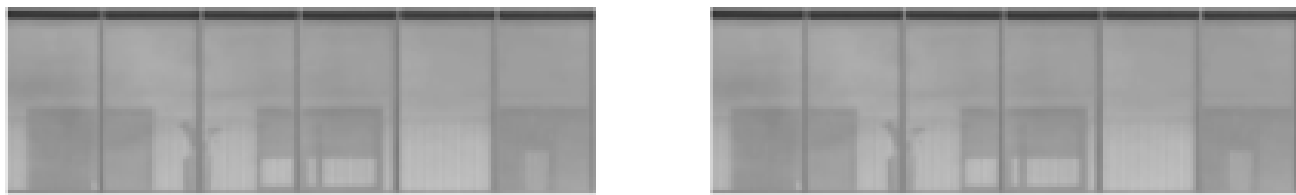
Reference image versus image 2



Reference image versus image 3

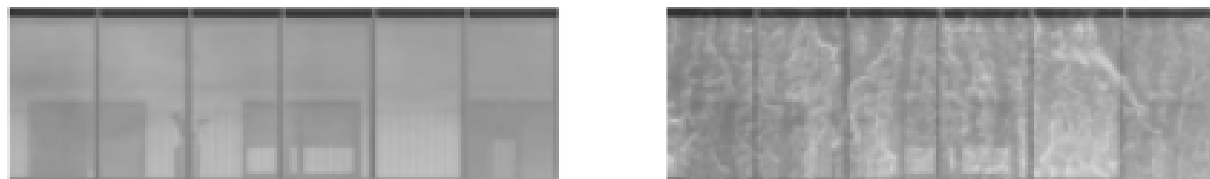
**Using python
programming
language**

MSE: 0.00, SSIM: 1.00



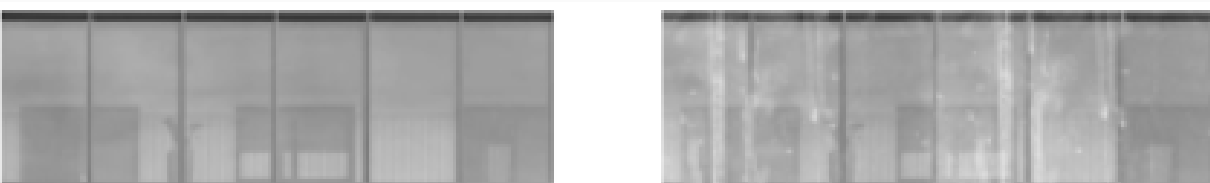
Reference image versus reference image

MSE: 746.06, SSIM: 0.63



Reference image versus image 2

MSE: 1446.89, SSIM: 0.84



Reference image versus image 3

SSIM ----- Structural similarity (Ex if $ssim = 0.5$ it means 50 % matches with reference image (Values ranges between 0 to 1))

MSE - Mean Square Error (Values generated does not have boundaries)

At first the reference image is compared with itself hence the $ssim$ generated is 1 it means the image matches 100 % with the reference image which is obvious

Second the image with higher dust density is compared with the reference image and the $ssim$ generated it 0.63 where it means 63% is clean as the reference image and remianing 37% is composed of dust and this value (0.37) is used to control the flow rate valve of the cleansing agent solution. Similiarly 16% dust is present in the third image when compared with the reference image

(1 - $ssim$ value) \longrightarrow Monitored flow control of cleansing agent

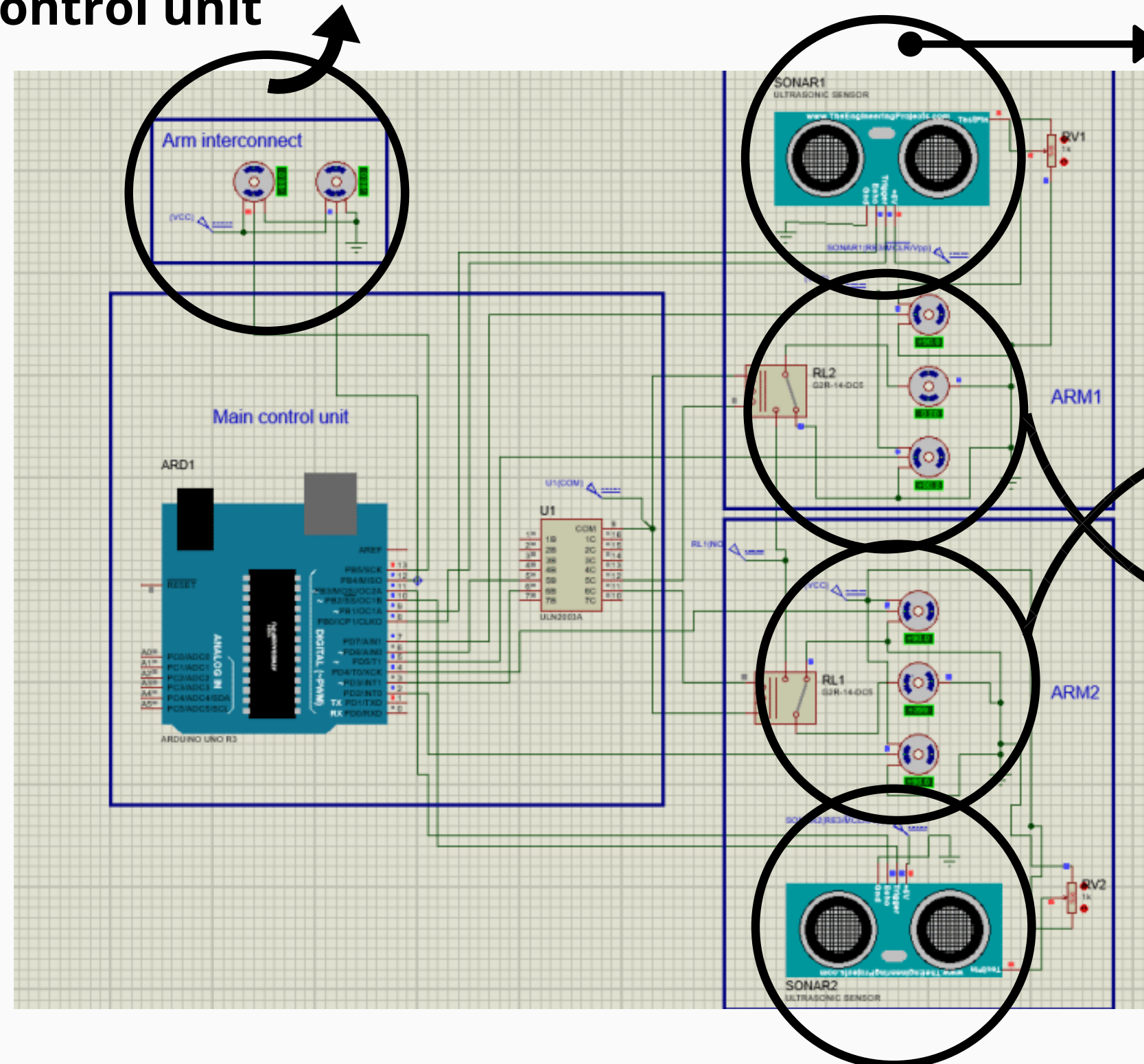
PREVIOUSLY ON HACKATHON 1

ELECTRONIC SIMULATION

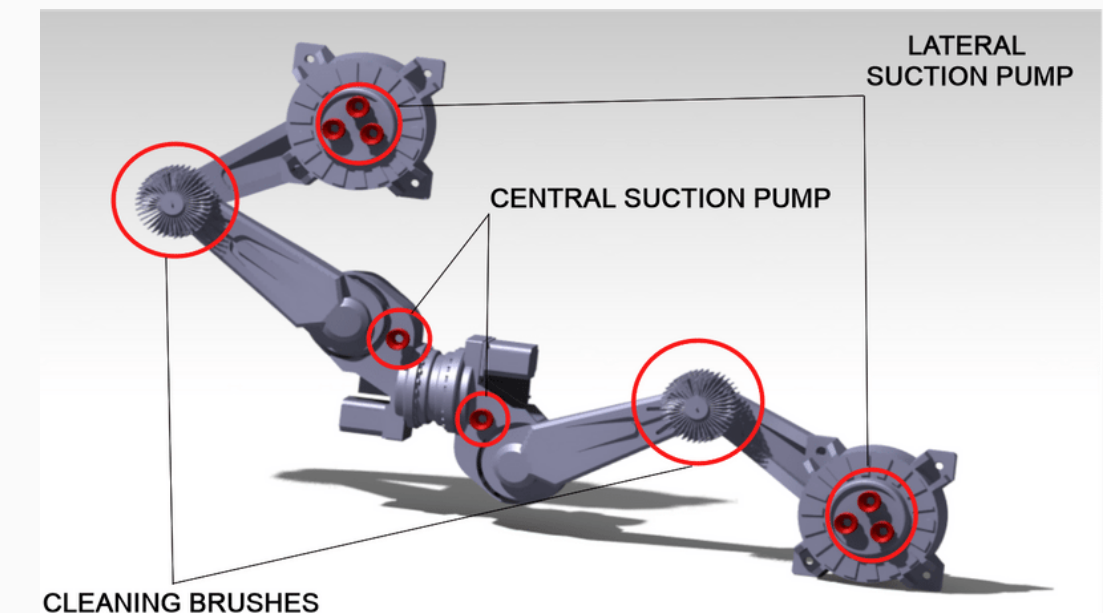
Servo motors which connect the arm to the control unit

Ultrasonic sensor

Arm 1 and 2 are used for movements. The brushes are attached to the elbow joint and the water outlet is located at the elbow joint. The arm interconnect circuit is used in connecting the arm to the main control unit of the robot.



Servo motors and Dc motor which help in cleaning and movement.



VIDEO OF WORKING OF ROBOT WITHOUT MECHANICAL STRUCTURE

The servo motors at the extreme nodes rotate in in opposite direction with small time lapse for the suction pump system to release and lock to perform **Spatial Y direction movement**

VIDEO OF WORKING OF ROBOT WITHOUT MECHANICAL STRUCTURE

The cleaning brushes rotates simultaneously about their axis as well about the central axis at higher speed to shred off the dust from the glass when cleaning motion is in progress

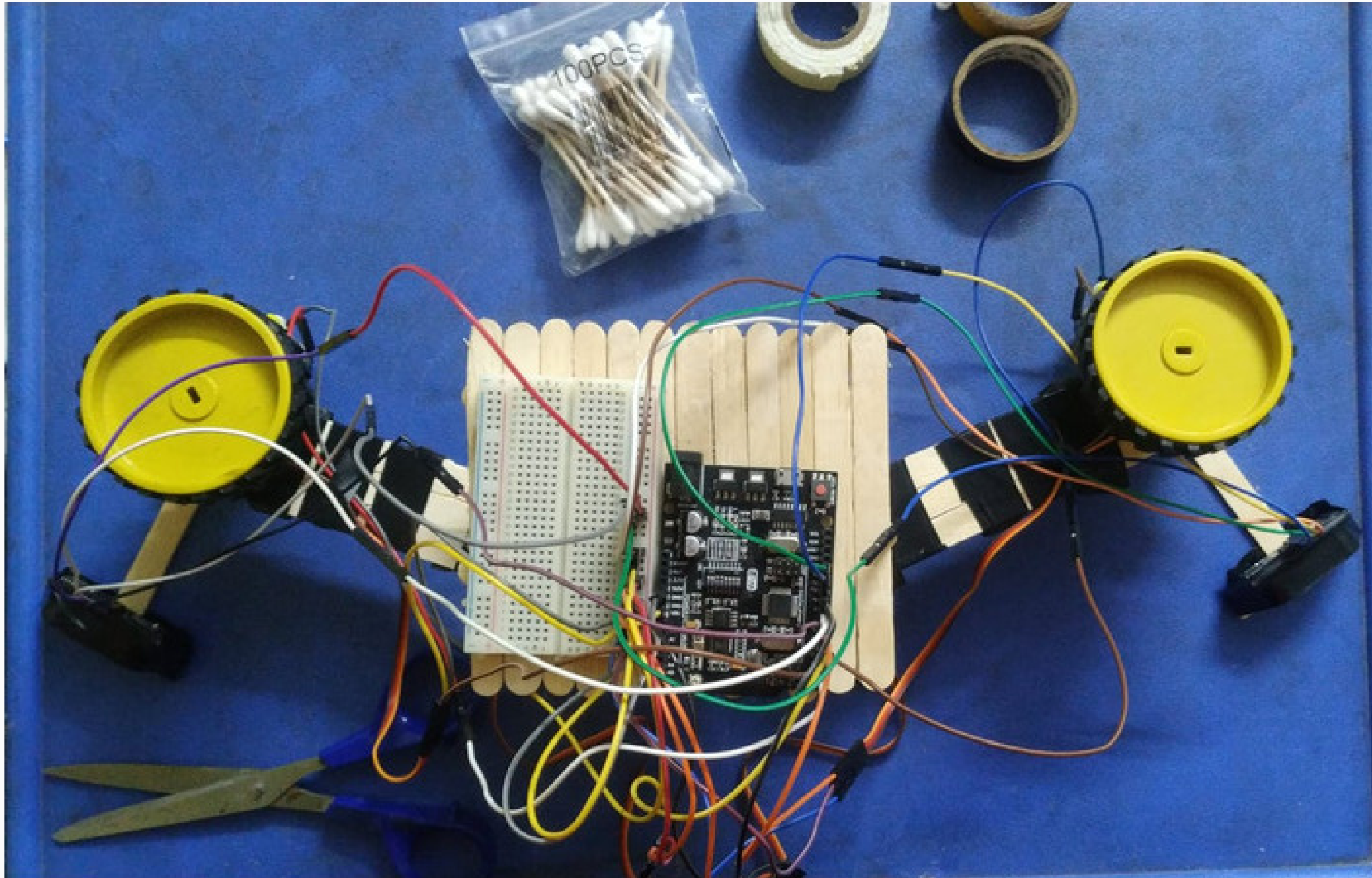
VIDEO OF WORKING OF ROBOT WITHOUT MECHANICAL STRUCTURE

The servo motors at the extreme nodes rotate in in same direction with small time lapse for the suction pump system to release and lock to perform **Spatial X direction movement**

CURRENT PROGRESS

PROTOTYPING

PROTOTYPING WITH MECHANICAL STRUCTURE



What can be observed?



The M shape equilibrium position that was explained in the Line diagram for the movement is achieved here. And the ice cream sticks are chosen to reduce the weight factor of the robot. And the wheels represents the cleaning brushes which will be coated with cotton material to ensure soft cleaning

CURRENT PROGRESS

PROTOTYPING

**VIDEO OF Y DIRECTION
MOVEMENT**

CURRENT PROGRESS

PROTOTYPING

**VIDEO OF 360 DEGREE
CLEANING MOTION
MOVEMENT**

CURRENT PROGRESS

PROTOTYPING

**VIDEO OF X DIRECTION
MOVEMENT**