GUJARAT COUNCIL ON SCIENCE AND TECHNOLOGY
Dept. of Science and Technology, Govt. of Gujarat
IDEATION STAGE FOR ROBOT MAKING COMPETITION
ROBOFEST GUJARAT-5.0

Application No.:

TECHNICAL DETAILS FOR PROPOSED ROBOT

(Wherever necessary separate sheet/page is allowed to attach; Institute may submit extra details if find necessary)

1. **Type of Robot**: Robotic mobile manipulator

2. **Robot Assembly Design (Proposed Diagram): Drawings each part of the robot is preferred as an attachment. (CAD drawings are preferred) (400 words)**

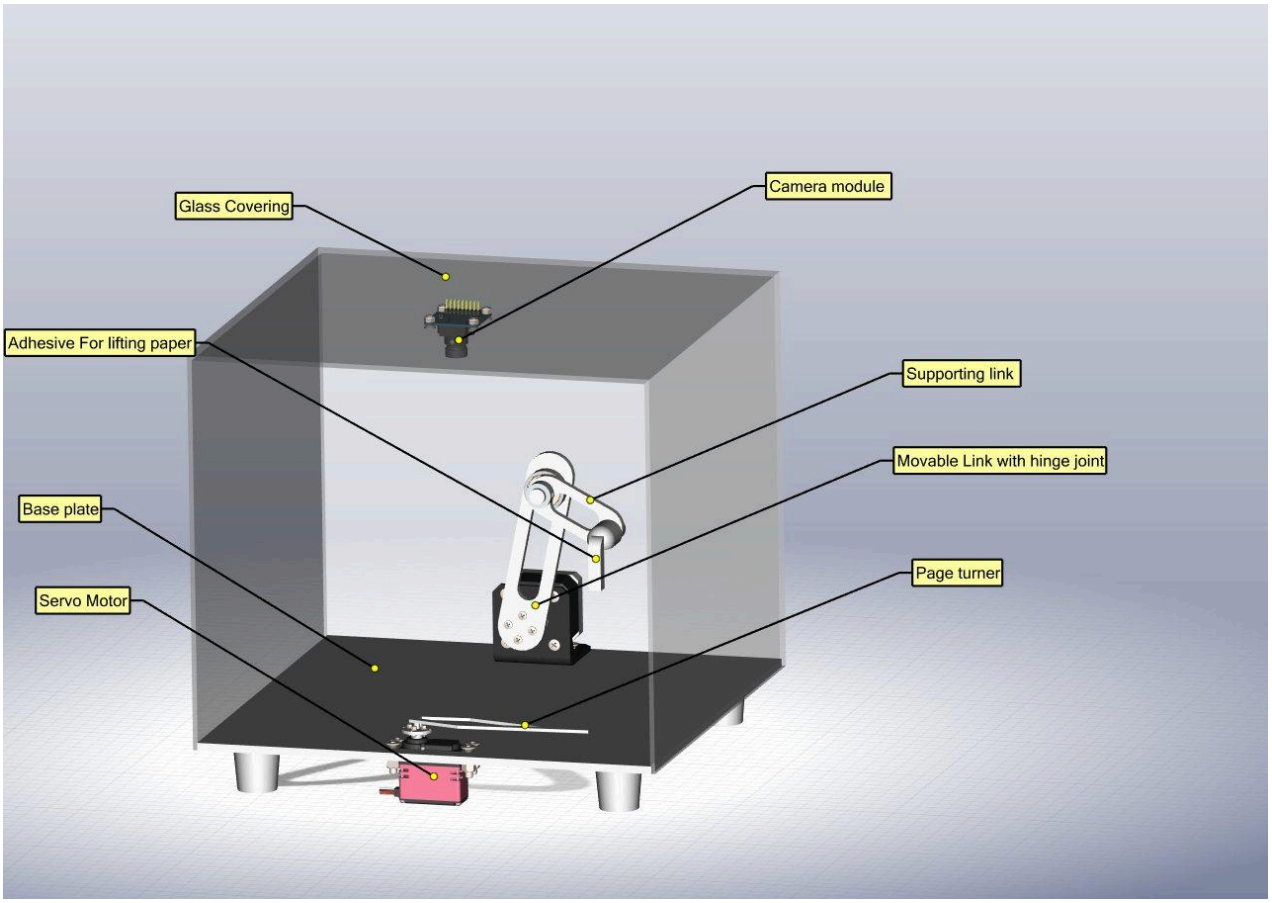


Fig:This robotic system is engineered for automated answer sheet evaluation, following a logical progression from power input to the final graded output.

1.Power Supply:

The system is powered by AC mains electricity, which is converted to DC via an integrated AC-to-DC converter. This regulated power is distributed to all core components, including the Raspberry Pi controller, stepper motor, servo motor, and camera module.

2.Control Electronics (Raspberry Pi):

The Raspberry Pi serves as the main processing hub, orchestrating all motor operations and overseeing image acquisition. It receives input power and issues precise control signals to both the motors and camera.

3.Base Plate:

Documents are placed on the stable base plate, which supports the entire mechanical assembly and ensures a consistent scanning surface.

4.Stepper Motor & Movable Link with Hinge Joint:

The stepper motor drives the articulated movable link, providing incremental and precise movement. The hinge joint allows the arm to lift and position each sheet accurately. At the tip of the link, an adhesive pad securely grips individual pages, facilitating effective page separation.

5.Supporting Link:

A rigid page-turning link connected to an articulated arm. The link is equipped with a tacky, non-damaging adhesive pad and is engineered to constantly face the page, ensuring a reliable grip for every turn.

6.Servo Motor & Page Turner:

The servo motor manipulates the page turner mechanism, enabling quick and controlled flipping of lifted pages after separation by the movable link and adhesive pad.

7.Glass Covering:

All components are housed within a chamber equipped with a glass cover, protecting the mechanism and ensuring a clear, dust-free environment for imaging.

8.Camera Module:

Positioned overhead and powered via the main supply, the camera module captures high-resolution images of each answer sheet immediately after page turning.

9.Image Processing & Cloud Workflow:

Captured images are sent from the Raspberry Pi to the cloud, where advanced OCR and NLP algorithms extract student responses. Each answer is automatically matched, using cosine similarity, against reference keys for objective grading. For

teacher-assisted checking, summaries and key points are provided via a user-friendly interface, allowing educators to verify scores efficiently and with minimal fatigue.

10.Final Output:

The system delivers a fully evaluated answer sheet, complete with marks and feedback, either automatically or with rapid teacher verification—streamlining the entire assessment workflow.

3. Components to be used: (Enlist all the components with their make/company in four groups as enlisted in the following table:

a. List of Structure components: like beams, bushes, shafts, belts, plates, pins, pulleys, wheels, connectors, batteries, motors, etc.

1.3D Printed PLA Plates

2.Custom Adhesive finger like structure

3.Aluminum connecting rods

4.Servo motor:Stall torque @4.8V : 1.2kg-cmStall torque and @6.6V : 1.6kg-cm/ Hiwonder HPS-2027 20KG High Torque Digital Servo Motor

5.Stepper motor:Pro-Range NEMA17 PR42HS40-1504 4.2 kg-cm Stepper Motor

b. List of Motion Components: like Chain, sprockets, flaps, etc.

1. Connecting Links made of PLA
2. Bearings made of Aluminium

c. List of Electronics Components: like Smart ports, switches, joysticks, controllers, LED/LCD screen, power supply, programming components, etc.

1.Switch
2.Jumper wires.
3. Bread board
4. Power supply direct AC Socket
5.Raspberry Pi 4 Model B
6.Stepper Driver
7.Servo Driver
8.OV5647 Camera module

d. List of Other Accessories: Clothes, plastic eyes/ear/feeling like real all external components which are for the look.

Not Applicable

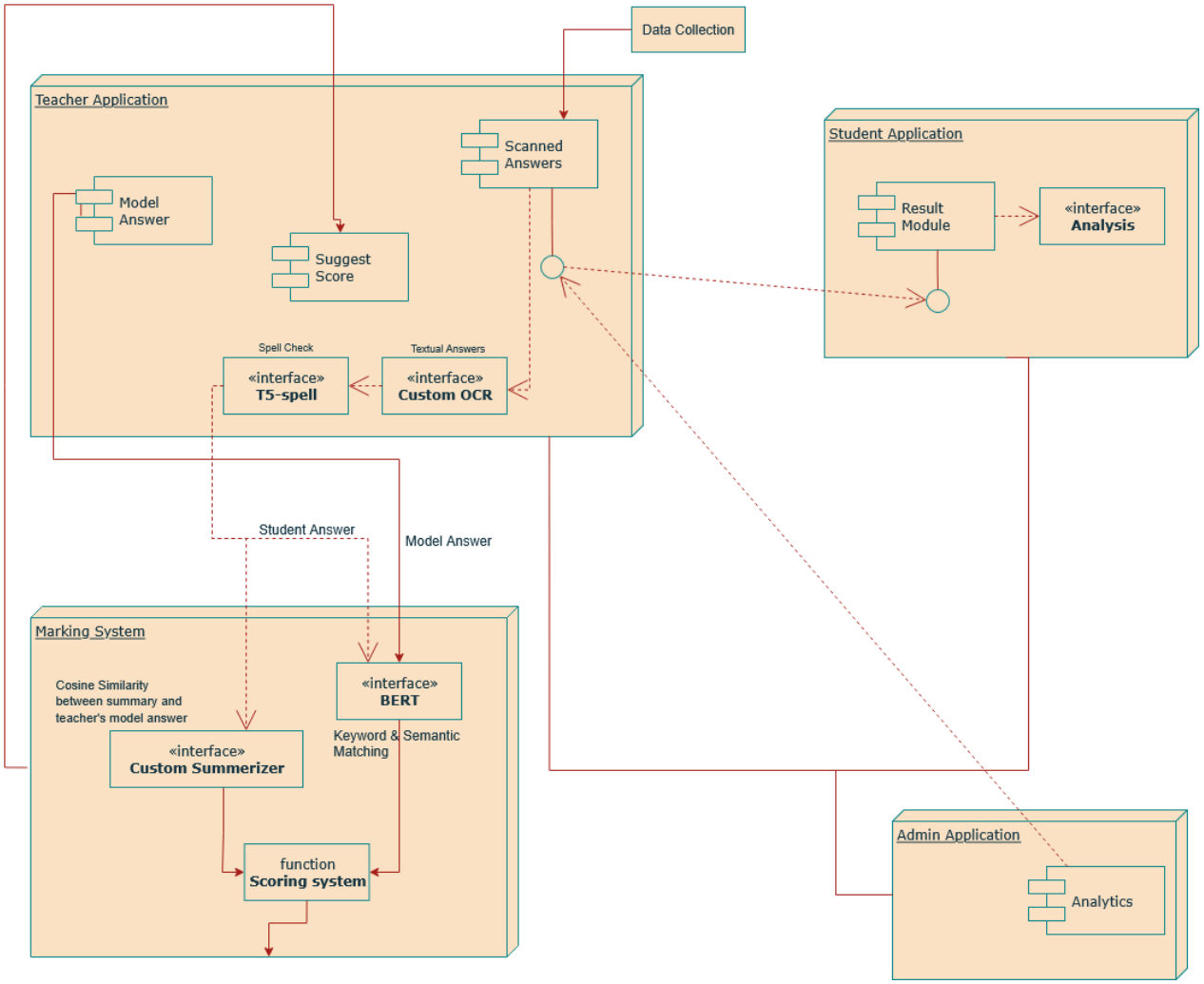
4. The methodology of Making Robot: (Please write Entire Technical Specifications of Proposed Robot with brief notes and diagrams) (400 words)

This robotic system features a page-turning mechanism that precisely flips pages of a document or book, allowing for continuous, hands-free operation. A stepper-controlled hinged arm with a finger-like adhesive pad selectively lifts the topmost page of the answer sheet, positioning it above a servo-driven flipping mechanism. The adhesive isolates a single page, after which the servo motor, combined with a rotating arm precisely flips the page to the other side. The process is coordinated by a microprocessor, supporting both forward and backward turning, and is compatible with different book sizes using adjustable clamps on a secure base.

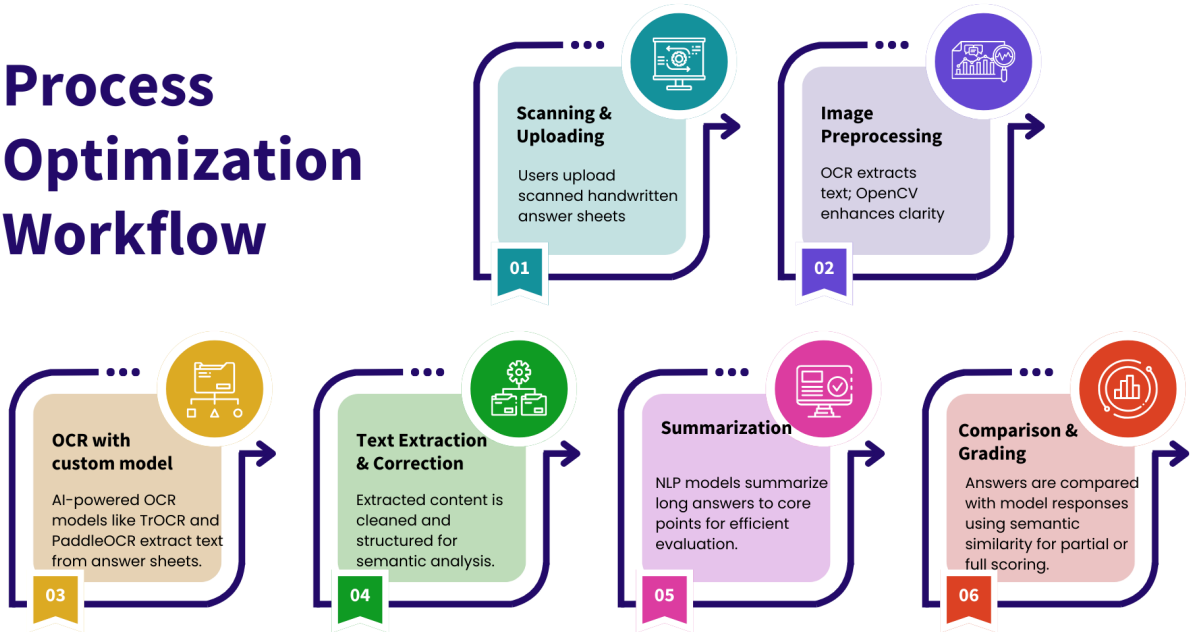
The system presents a modular AI system for automated answer sheet evaluation. The workflow begins by preprocessing and uploading answer images, followed by line-by-line pattern/text detection using basic image processing (OpenCV). Image processing is responsible for splitting the page's content into different lines. Then, our custom Optical Character Recognition (OCR) model extracts text from each line, measures could be taken to correct spelling mistakes caused by the OCR model. Answers are summarized with a fine-tuned Mistral-7B model, ensuring concise and meaningful output.

The first step of the evaluation process requires the teacher to provide the official answer key, these will be split into points referred to as *"ground truths"* henceforth. The system uses sentence embeddings and cosine similarity to compare extracted answers with such ground truths, providing a quantitative score. Final marks are suggested based on similarity scores. This system is capable of evaluating a wide variety of subjects such as Mathematics, Science, English and multiple local languages if properly trained.

An overhead camera captures high-resolution images of each page, which are then processed by a computer vision model that functions as the "brain" of the system. This model performs OCR to digitize the text and integrates automated evaluation to check for specific keywords, formatting, or other grading and analysis criteria. Overall, this compact, self-contained unit is ideal for tasks requiring rapid scanning, digitization, and intelligent evaluation of physical documents or exam papers.



Software Architecture



5. Application of proposed Robot in a societal context: (Not more than 100 words)

A new robotic system has been developed to fully automate exam paper evaluation. By reducing human effort in grading, it eliminates fatigue and personal bias, ensuring fair and consistent grading.

This system allows them to focus more on teaching, mentoring, and guiding students. The feedback system allows students to get more insights on their mistakes, enhancing their understanding and overall academic performance.

The addition of hardware implementation enables usage over areas with poor internet connections, as papers can be stored and submitted whenever connection is established.

6. Size of robot proposed for Proof of concept (Small version):

a. Length in cm 30 **b. Width in cm** 30
c. Height in cm 30

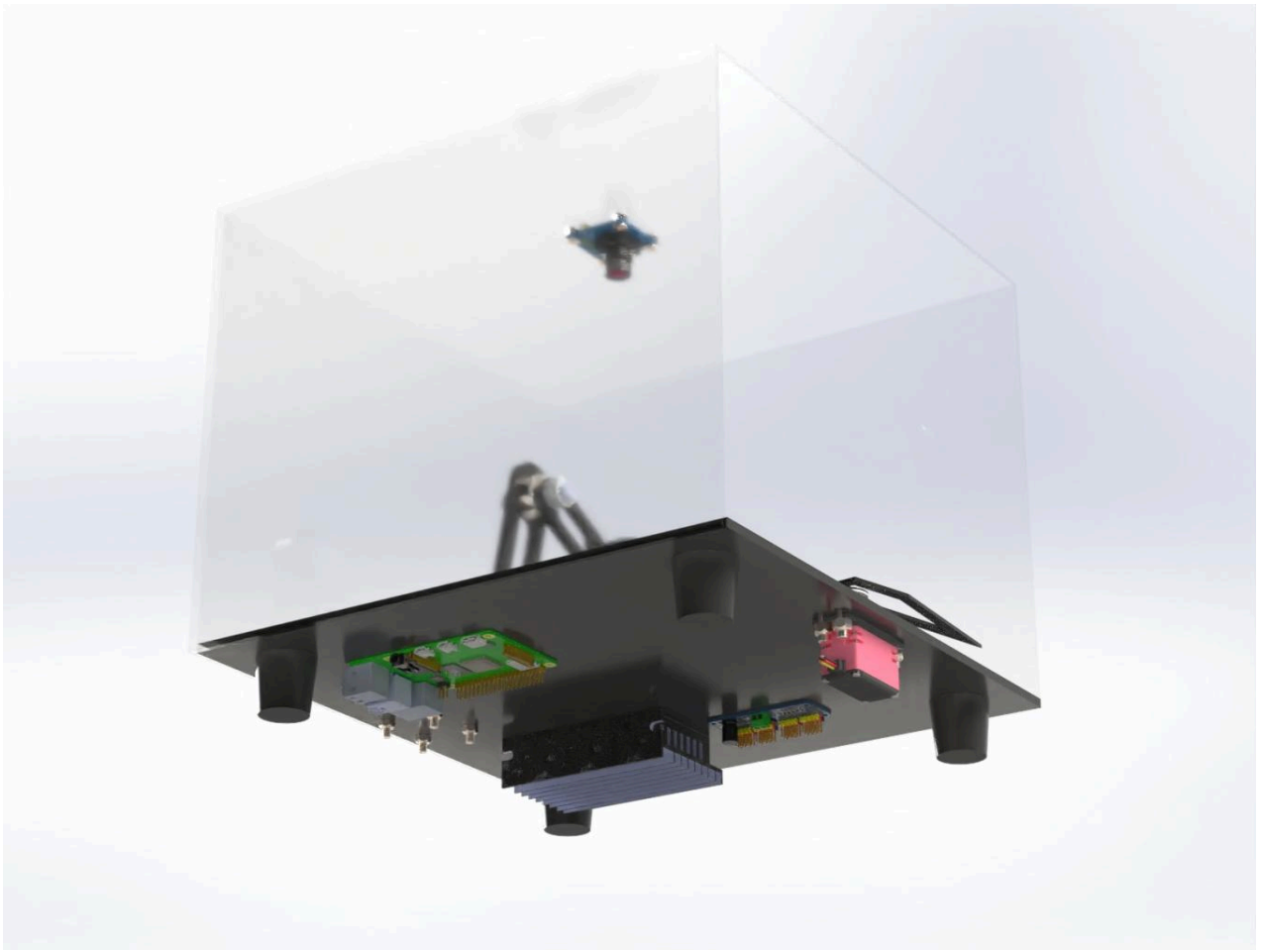
7. Size of robot proposed as Proto type (Actual Version)

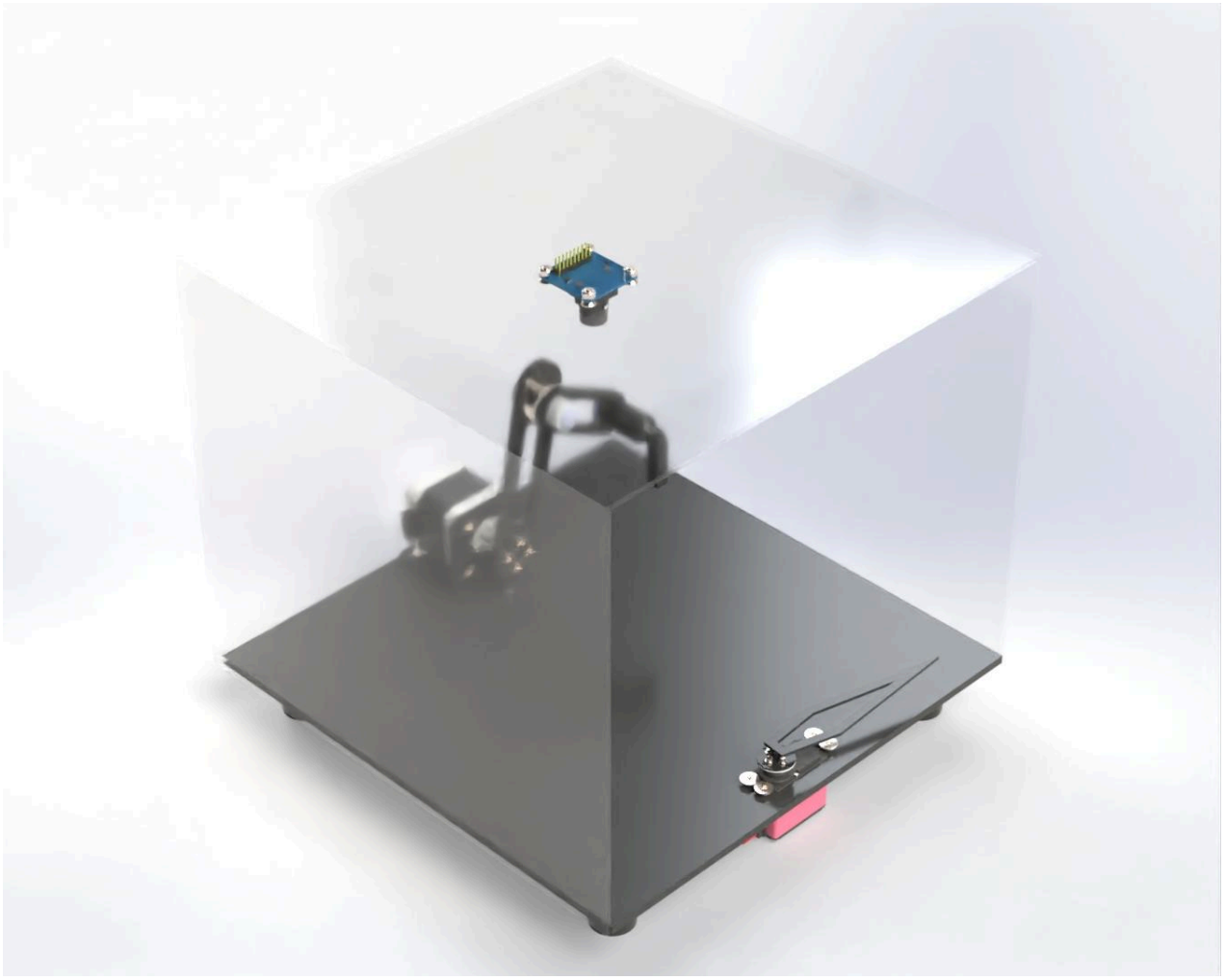
a. Length in cm 30 **b. Width in cm** 30
c. Height in cm 30

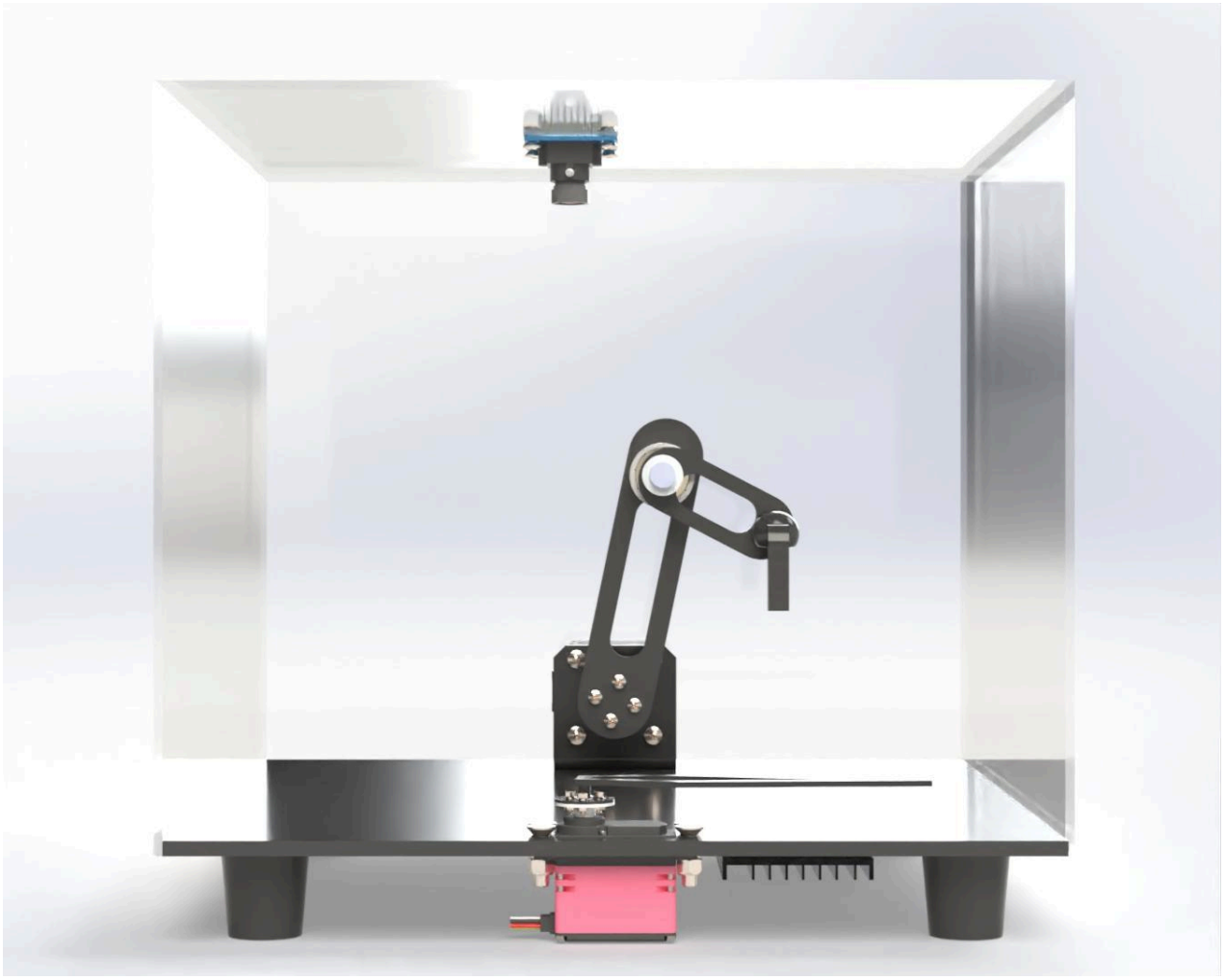
8. **Timeline for Robot making with milestones. (Divided in activities vs. no. of days)**

Objectives	Month 1				Month 2			
	Week 1	Week 2	Week 3	Week 4.	Week 1.	Week 2	Week 3	Week 4
Resourcing and ordering components online								
3D printing parts for proof of concept								
Gathering all components and inventory management								
Model training for handwritten text recognition								
Assembling the components								
Model testing								
Revisions in the model								
Final model testing								

9.Please attach the proposed outline (photograph) for understanding of the evaluation committee.







9. ☐ I agree to file a patent of the proposed robot in ROBOFEST-GUJARAT 5.0 from the PIC Cell of GUJCOST.

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