UNIVERSITY OF SÃO PAULO

School of Engineering of São Carlos

FINAL REPORT - Grasp-e

Projects II

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São Carlos

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1. CAD drawings and photos of the prototype.

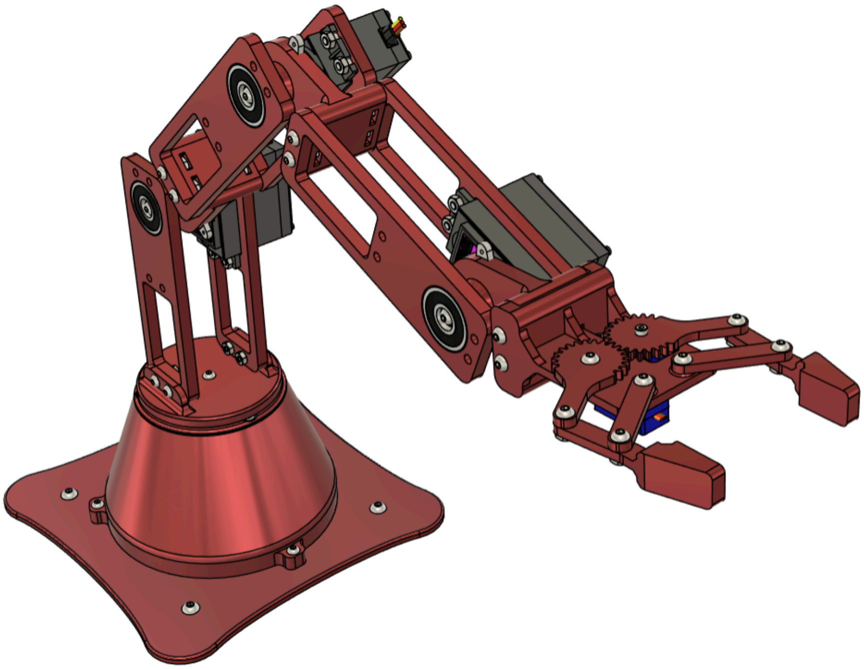

Figura 1: CAD of the manipulator

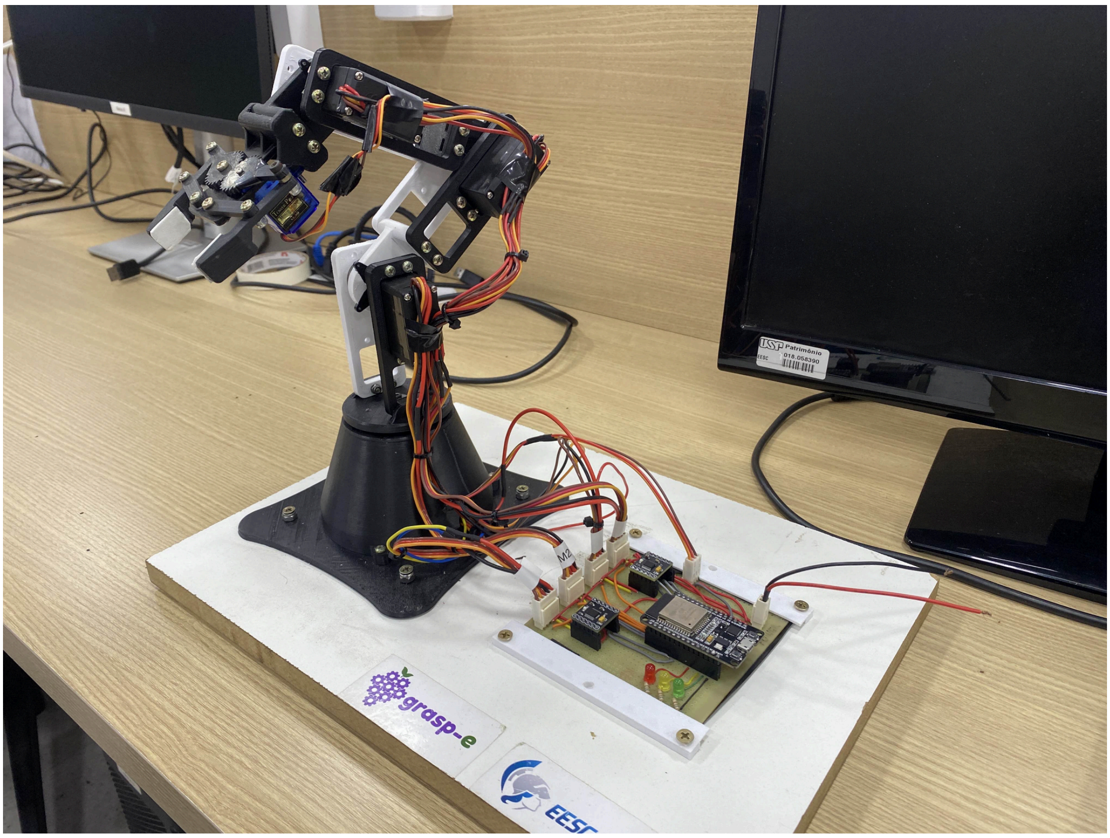

Figura 2: Manipulator prototype

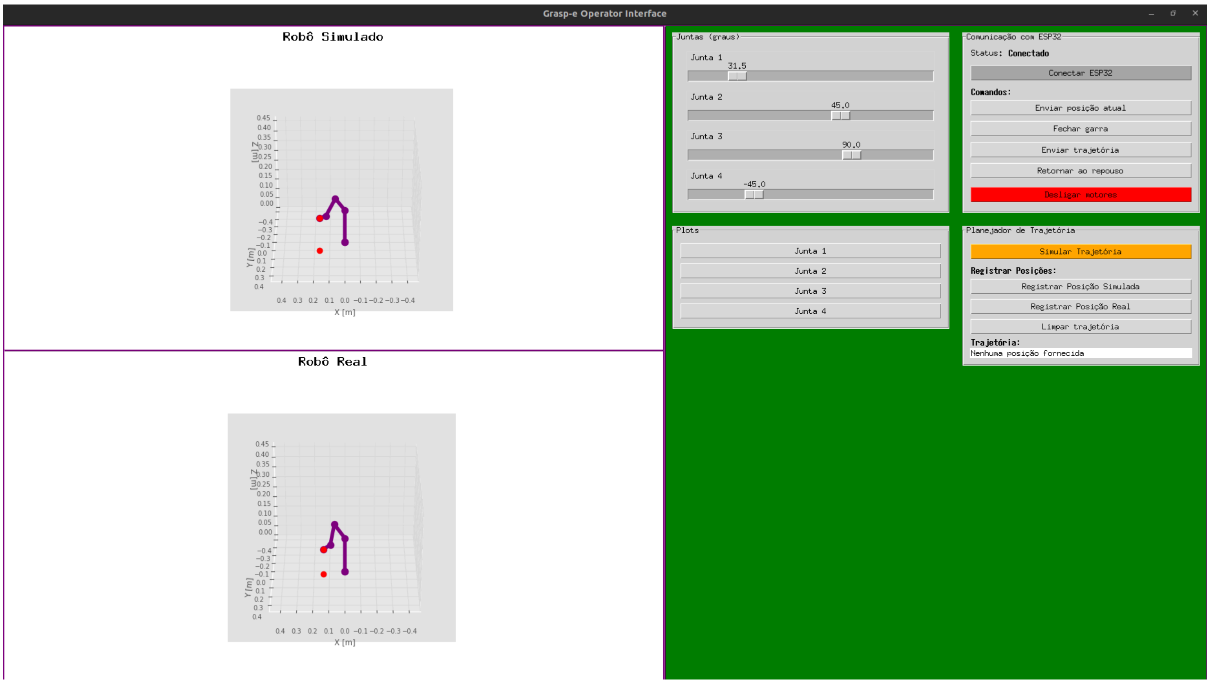

Figura 3: Graphical interface

2. Description of materials used

Mechanical components:

- 3D printed parts made with ABS and PLA plastics
- Screws and nuts of various sizes
- Wooden base

Electronics:

- ESP32 Microcontroller
- MG996R and SG90 Servomotors
- DRV8833 H-bridge
- Universal circuit board
- Connectors
- LEDs and resistors

It is also necessary to use a computer and a regulated power supply with 6 V and at least 2 A of output capacity.

3. Electronic and control diagram

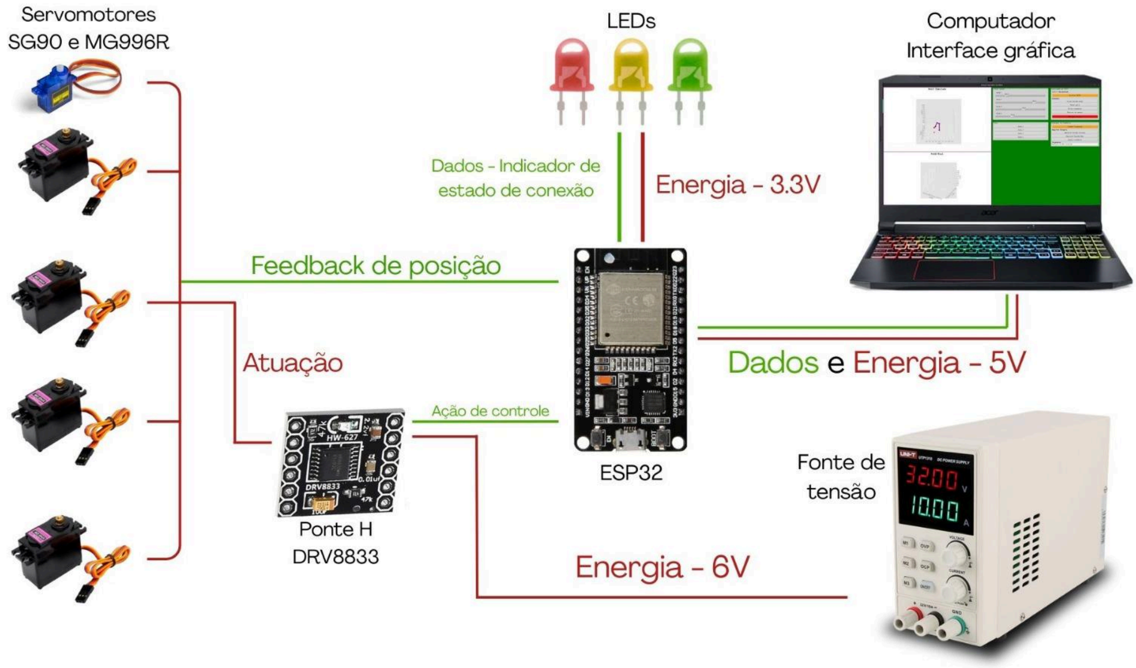

Figura 3: Electronic diagram

Above we can see the electrical diagram of the manipulator. The MG996R servo motors were modified by removing the factory control boards and soldering 5 new cables. Of these new cables, three are for the transducer, the resistive encoder (potentiometer), and two for the motor terminals.

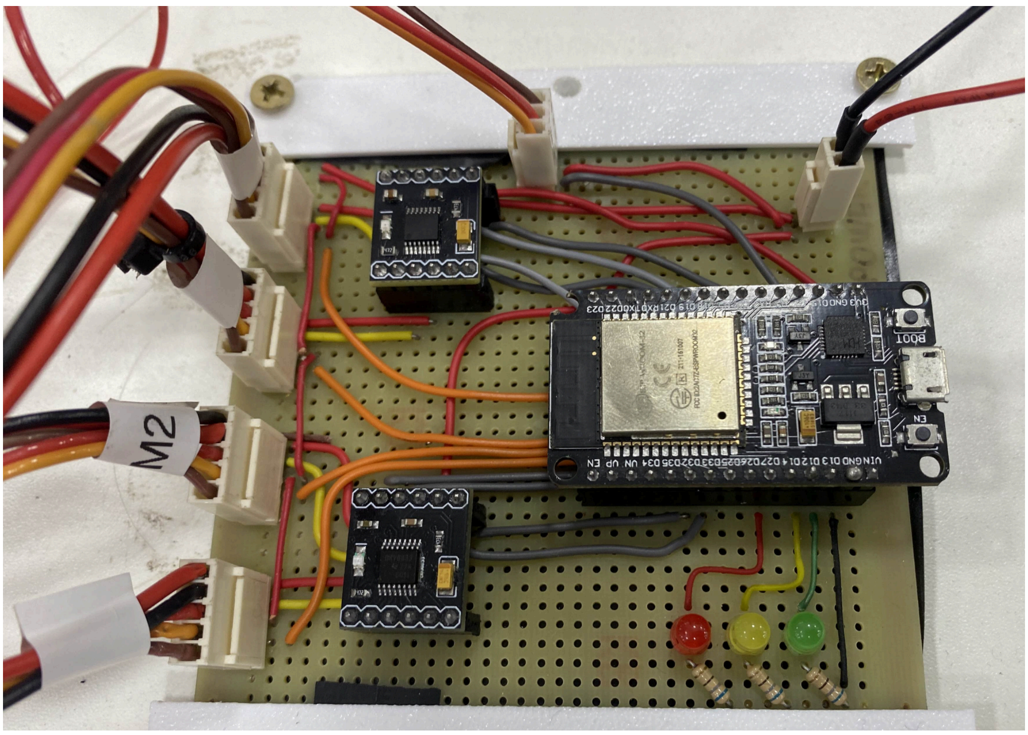

Figura 4: Circuit board design

In the photo above, we can see the circuit board made for the project. It was made using a perforated board and with manual routing of the wires, connecting the ESP32 to the two H-bridges, the SG90 servo, and the status LEDs. We can also see the power input for the motors, which is separate from the ESP32's power supply, which is via USB.

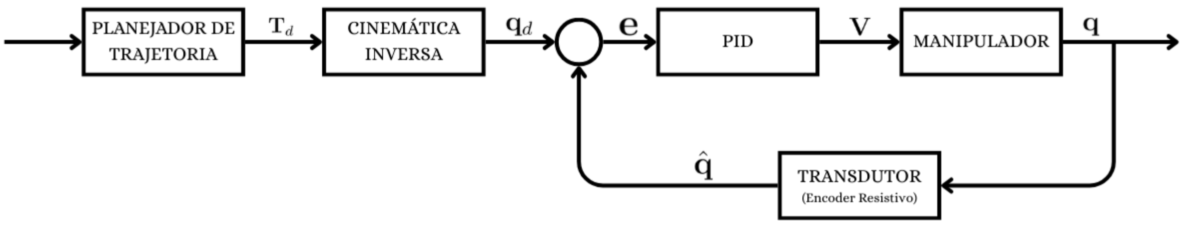

Figura 5: Control diagram

Figure 5 shows the system's control loop. In it, T_d and q_d represent, respectively, the desired positions in the workspace and in the joint space; V corresponds to the voltage applied to the actuator, which can also be interpreted as the control action; and q and $\hat{q}$ are, respectively, the actual position and the estimated position of the joints.

In the project, we chose to implement a PID control directly in the joint space. In this scheme, a trajectory planner provides positions in the workspace and, through inverse kinematics, the desired positions of the joints are obtained, which in turn serve as a reference for the PID controller.

Complementing the two diagrams, the code diagram (Figure 6) illustrates how the information and modules of the microcontroller and the computer communicate with each other.

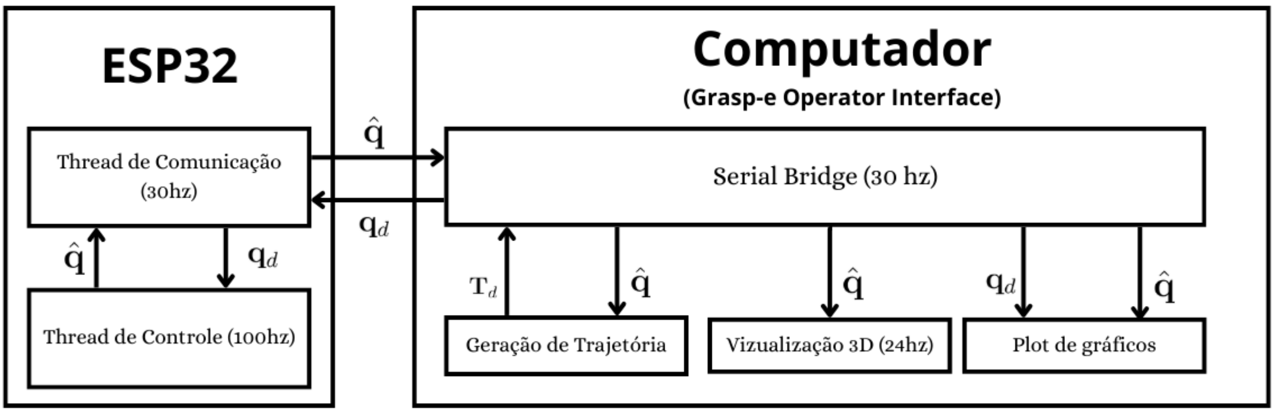

Figura 6: Diagram of the code and communication.

4. **Link to the videos and the code.**

Codes:

https://github.com/JPBG-USP/graspe-v3

Videos and pictures:

Multimidia