ROBORREGOS

LEAGUE: SOCCER OPEN

COUNTRY: MEXICO

INSTAGRAM

CHECK OUR WORK!

POWERED BY: Mitutoyo diram AcuityBrands dipoleDIGITAL The Oilfield Software Company

ABSTRACT

We are RoBorregos Soccer Open, this poster details the design and development of autonomous soccer robots by a Mexican robotics team, RoBorregos. The team, comprising electronics, software, and mechanical specialists, uses advanced technologies including hyperbolic mirrors, vision systems, and precision mechanical components. Key innovations include a custom-designed Teensy 4.1 microcontroller integration for enhanced processin and new dribbler and kicker designs for improved gameplay of the robots.We highlight the mechanical, electrical, and software advancements made for the competition, emphasizing our methodology: first simulate, then test.

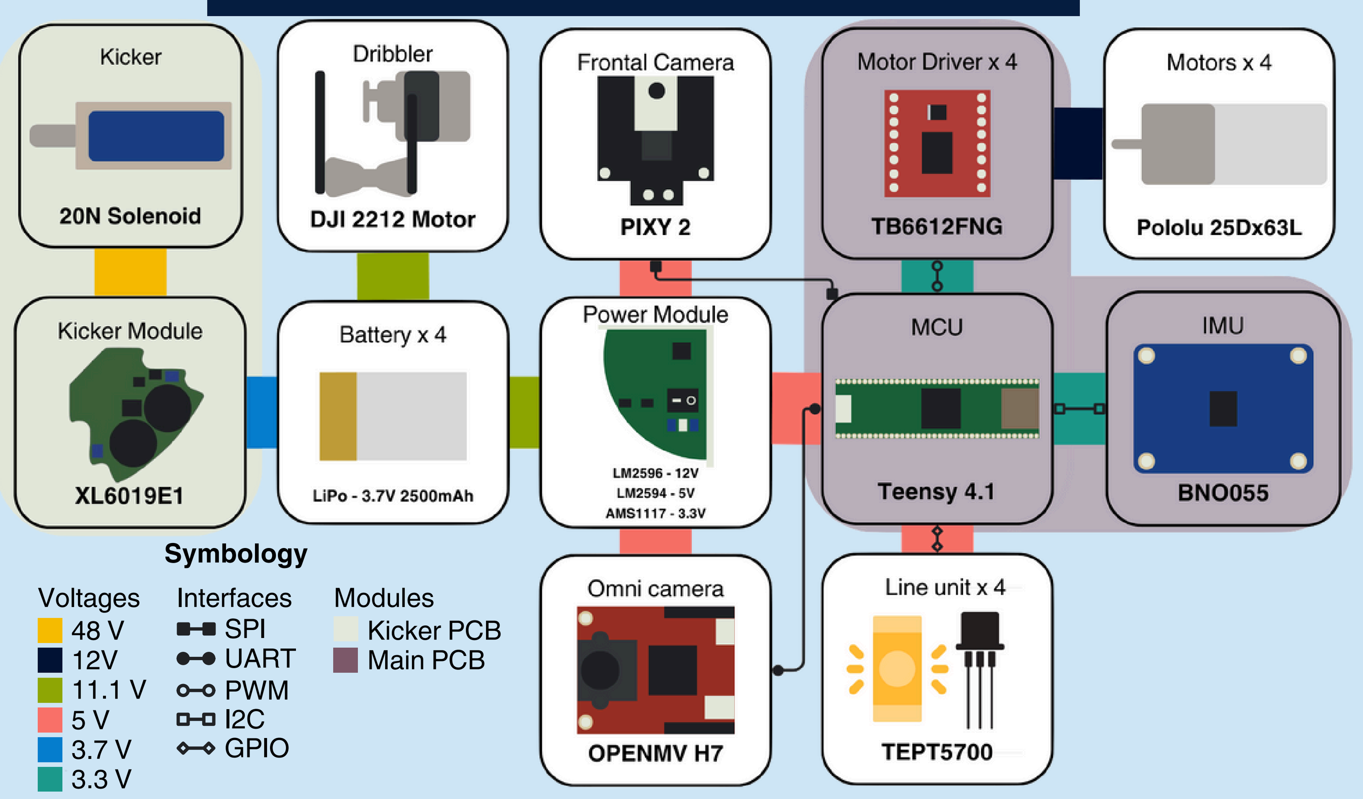
ROBORREGOS

YAÍR REYES

MAURICIO DEGOLLADO

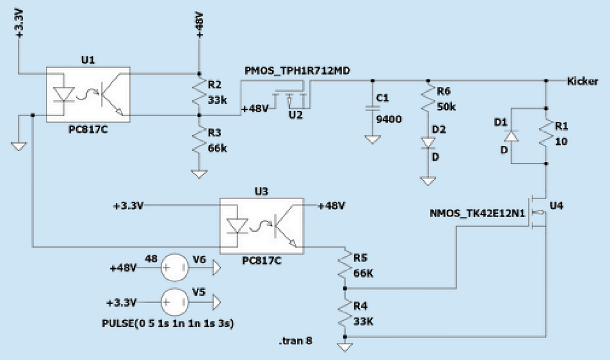
JOCELYN VELARDE

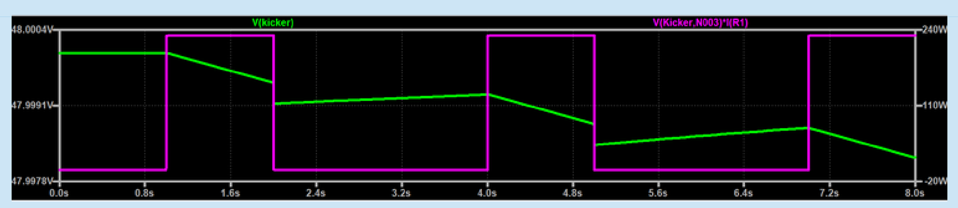
SYSTEM DIAGRAM



KICKER MODULE

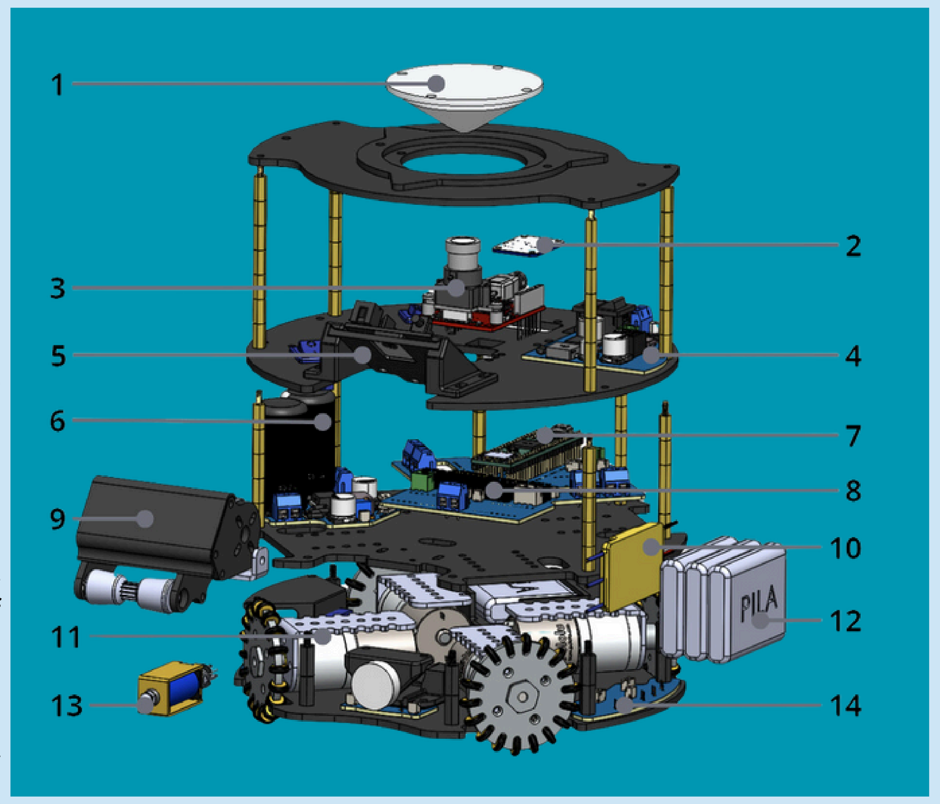
As we were working with higher voltages with this module to ensure safety we first simulate it in LTspice for the proof of concept, with this done we can also have a safest and better choice of the electronic devices that we will use. Our kicker can achieve a power output of approximately 240 W. By reducing the internal resistance of the solenoid, we can further enhance its strenght!





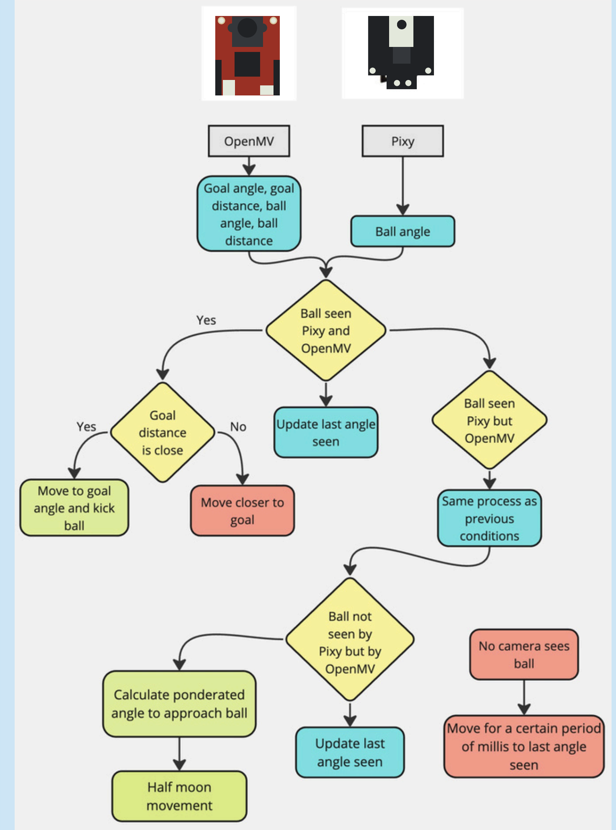
COMPONENTS

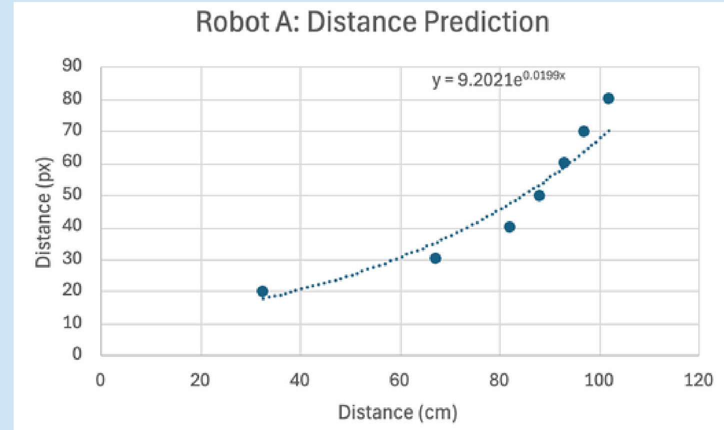
1. **Hyperbolic Mirror:** A custom hyperbolic mirror, supported by four brass spacer bars and chromed for optimal reflectivity, captures a full-field view.
2. **BNO055 Gyroscope** Our main IMU, using the yaw for the angle correction
3. **Open MV:** Selected for its MicroPython processing capabilities, is oriented upwards towards the mirror to accurately calculate distances and angles.
4. **Power PCB:** Designed module with switching regulators for the administration of all the voltage sources
5. **Pixy 2 camera:** Used as our frontal camera for better control and detection of the ball
6. **Kicker PCB** Circuit created for the safe voltage boost to 48 V, based of NMOS for the trigger circuit and PMOS for voltage protection
7. **Teensy 4.1**: Our main MCU, deciding to use it for the international competition due to its size and capabilities. At the national competition, we used the DualMCU, but we are not using it this year because of its instability.
8. **Main PCB** PCB that encapsulates our MCU, drivers and connectors for all of our sensors and actuators
9. **Dribbler:** Made from laser-cut acrylic, the dribbler features a DJI brushless motor, a precision 3D-printed pulley, and molded high-grip textured silicone.
10. **ESC** Driver for the DJI 2212 Brushless motor
11. **4.4 HP 12V Polulu Motor** 4 High Power motors as our main drive with omniwheels
12. **LiPo Batteries** Using 3 3.7V 2500 mAh LiPo batteries for our main robot, as well as one for the kicker system
13. **Kicker:** Robot A uses a 20N solenoid with a silicone tip for better grip. Robot B features a 5N solenoid with a removable silicone tip for strategic flexibility.
14. **Line Detection PCB:** PCBs with TEPT5700 Phototransistors as well as leds. All organized around the robot in order to detect the lines.

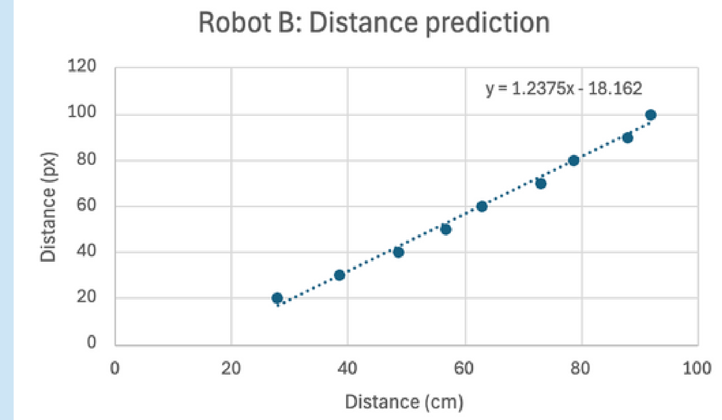


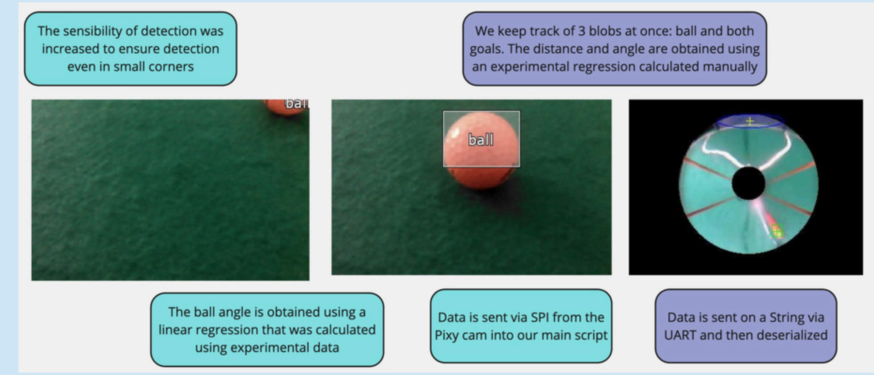
VISION DESIGN

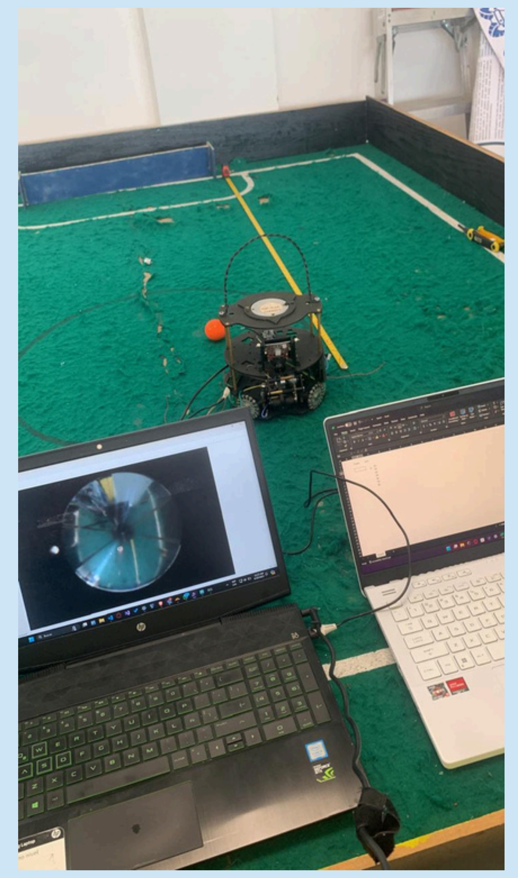
We developed our vision algorithm using an OpenMV and now a Pixy cam, considering that during the national competition we where not able to determine securely if the ball was in front of the robot. We also limited our range of vision applying some additional filters. Note that by gathering information from two sources we must keep all of our data updated











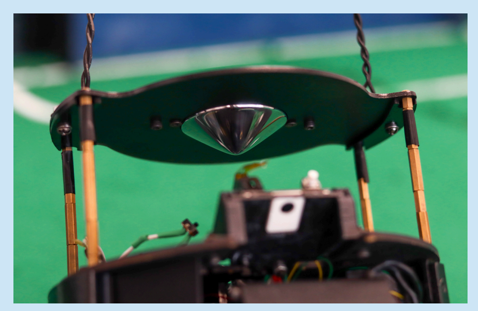
To obtain the distance towards the ball and goals it was necessary to perform an experimental procedure. That consisted on placing a flexometer on the center of the robot, then placing the ball on different positions. With that we recorded the actual distance compared to the distanced measured in pixels. We obtained two regression models. The first one was linear, while the second one was exponential. We took 10 measurements and then obtained an average, we also calculated the error for each regression obtaining +- 3 centimeters.

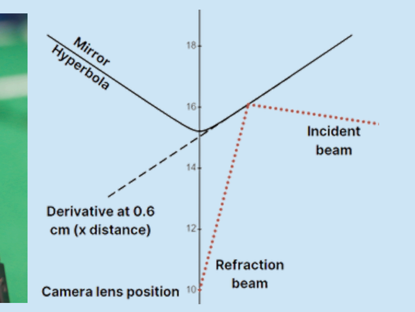
$y = 9.2021e^{0.0199x}$ $y = 1.2375x - 18.162$

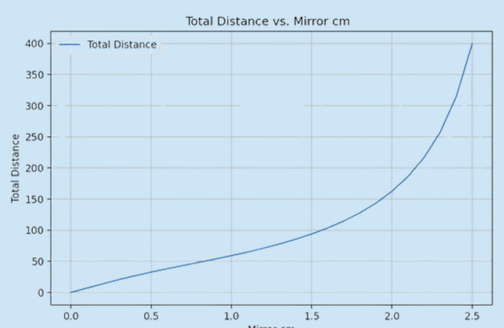
MIRROR DESIGN

Initially, we attempted to thermoform our mirror shape but had to abandon this approach due to the unavailability of a suitable material supplier. In our eagerness to commence testing, we experimented with folding mirror sheets into conical shapes, which yielded unsatisfactory results. Ultimately, we designed a precise model in SolidWorks and collaborated with METALWORK AND STAMPING to access advanced manufacturing machinery. This partnership enabled us to fabricate the mirror from steel and achieve a high-quality chrome finish.

To create a high-quality chromed mirror with an accurate visual field. We defined the mirror's shape using the equation $y = \sqrt{0.045 + 0.45x^2}$. By calculating the derivative of this shape, we determined the visible distance at every 0.1 cm increment. Additionally, we employed a linear regression model to refine accuracy beyond theoretical calculations. This combined approach leveraged both geometry and empirical adjustments, resulting in a more reliable estimation of the mirror's visual range.

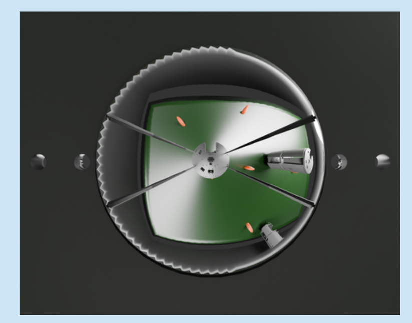




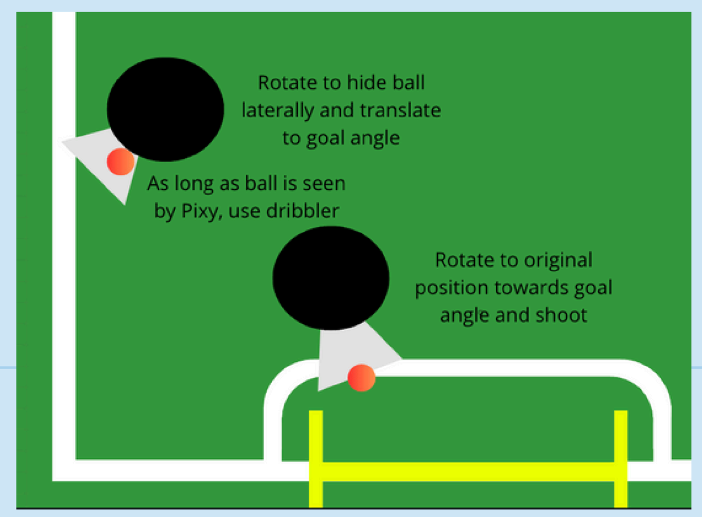


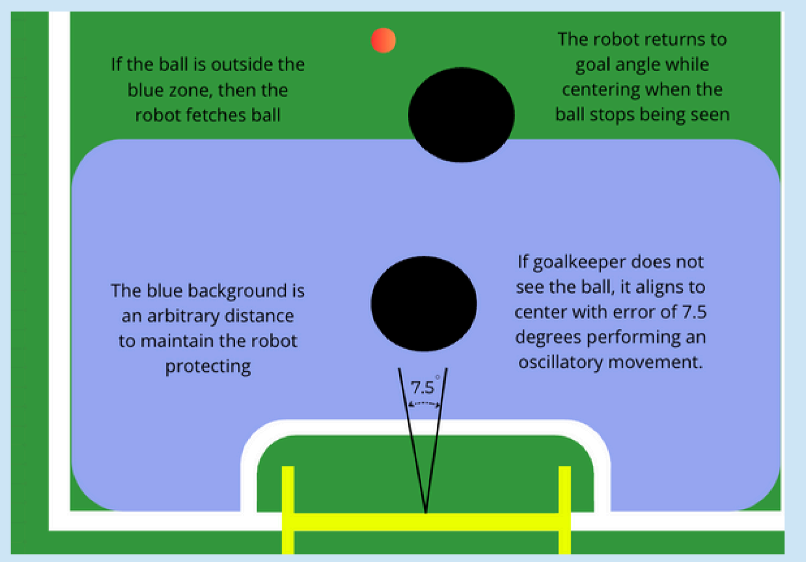
The code for these calculations was implemented in Python and confirmed through desmos, the graph on top visually compares centimeters of visibility to meters on the mirror's hyperbolic curve:

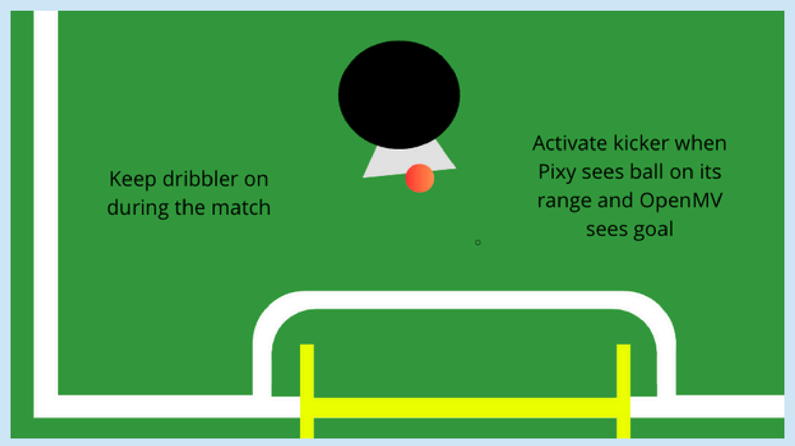
To confirm our theories and ensure the results met our expectations, we processed a simulation image through Blender. The detailed render provided reassuring validation.



STRATEGIES







DEVELOPMENT

Software

Hardware

Tools

PIXY

OpenMV

ARDUINO

EasyEDA

LTspice