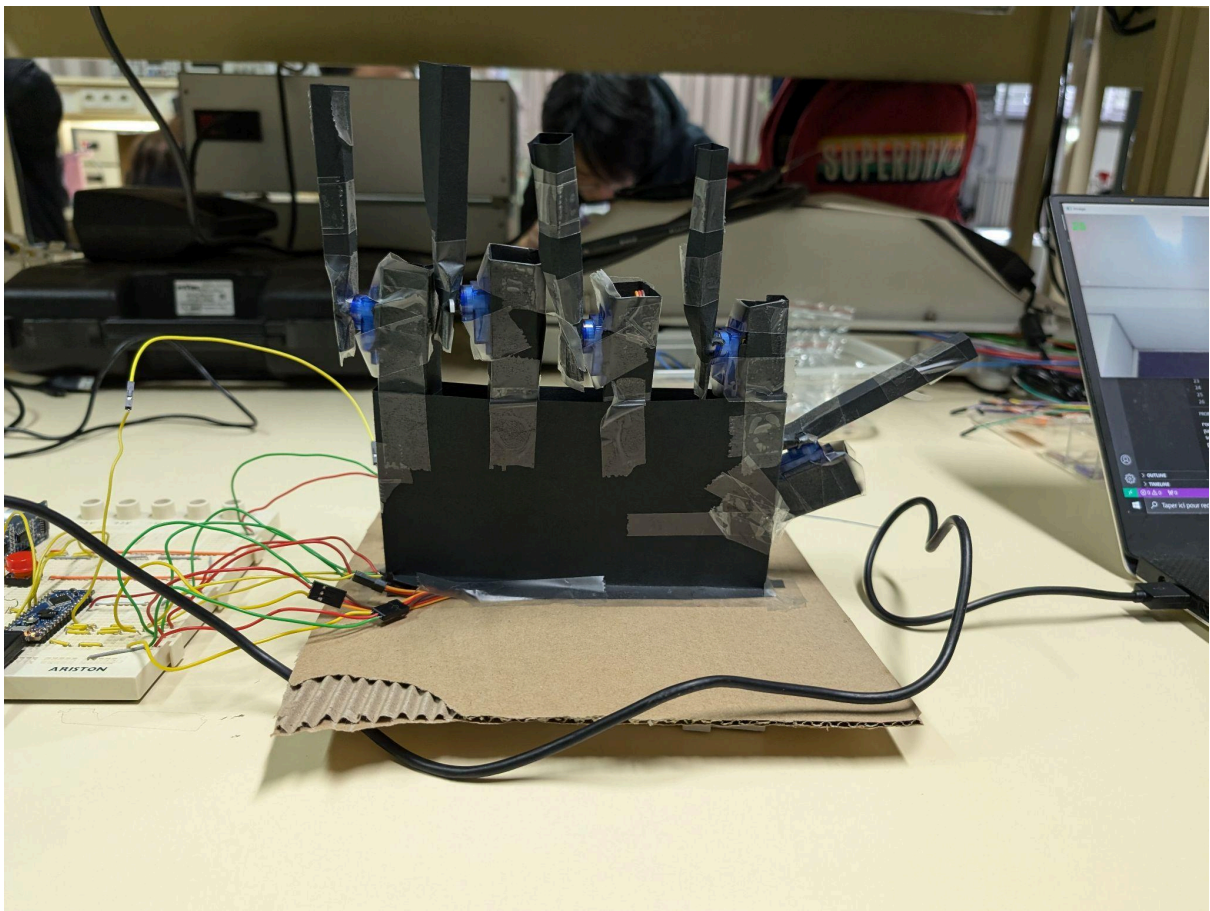Sam Hanot
Killian Pigot

UPM115
Physical Computing based on Open Software and Hardware Platforms
# Athens Programme 2024

Project description

For this project, we built a worthy opponent in the game rock-paper-scissors. Using 5 servo motors, we built a hand out of cardboard where the fingers can move into 3 different positions: rock (fist is closed), paper (all fingers are straight, fist is open) and scissors (only the index and middle finger are straight). To determine the position of the hand, we used an Arduino Nano Every, the central part of our project. We implemented 2 game modes to play, random mode and vision mode. Using a button a player can switch between the 2 modes.

For random mode, we use an ultrasonic sensor. A player simply holds one of their hands in front of the sensor. Once the game starts, 3 LEDs will light up one by one over a time span of 3 seconds. After 3 seconds, the hand will move to either the rock, paper or scissors position. The position is determined randomly by the Arduino.

Once the button is pressed, the game will switch to vision mode. For this game mode we connected a laptop to the arduino using the Serial connection. On the laptop a python script is running that uses the webcam in combination with computer vision to determine if the player is holding their hand either in the rock, paper or scissors position. The script will then send this information to the Arduino. The robot hand will then move into the position that counters the player, successfully winning every time.

Electronics:

fritzing
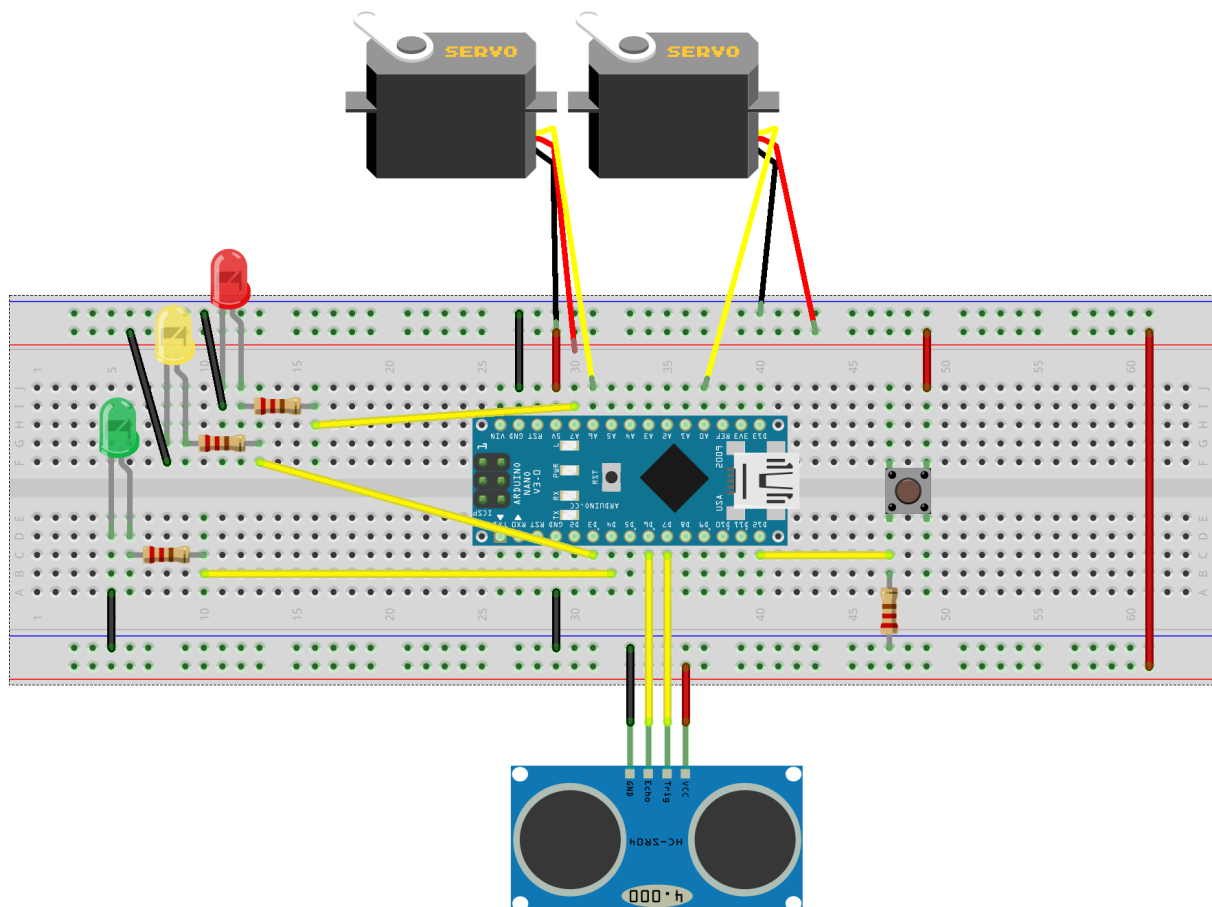
The electronics can be broken down into 4 parts:

- **Servo motors**: connected to the arduino, these 5 servos (2 on the diagram) are used to move the hand to perform the chosen action (randomly or in response to the player).
- **Leds**: a series of three LEDs that count down before the robot moves.
- **Sensor:** detects the presence of a player
- **Button**: used to switch from one game mode to another
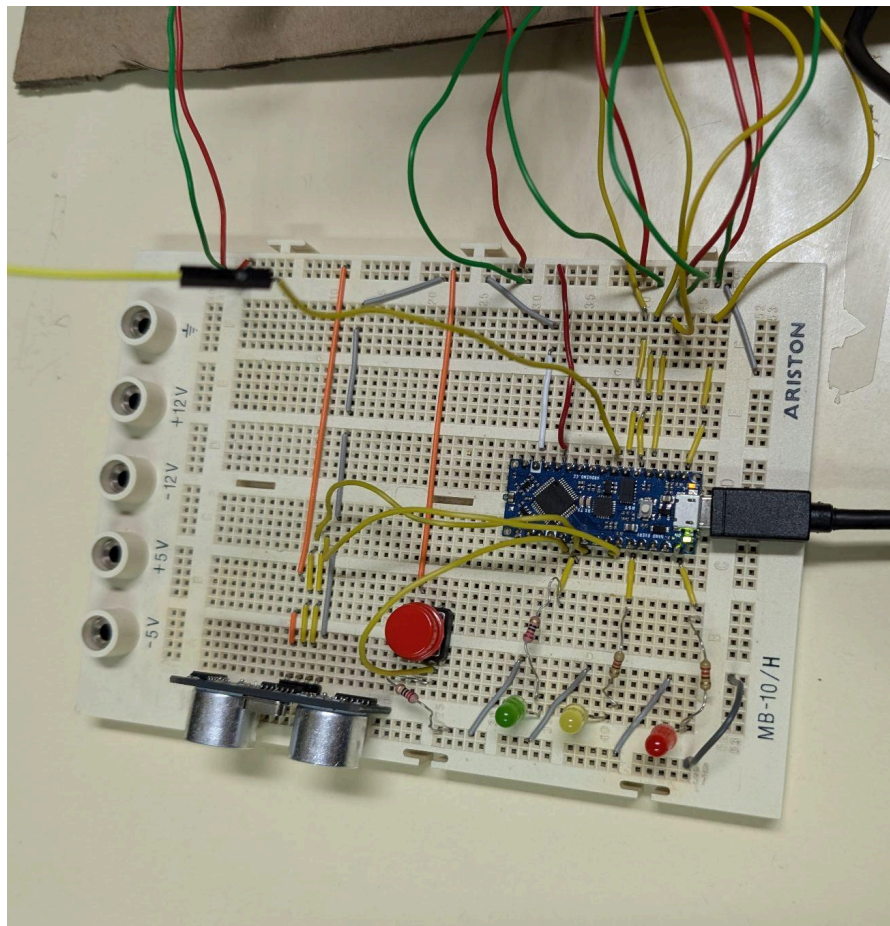
Arduino Code:

Our code includes 7 functions that are called in the loop;
- **rock(), paper()** and **scissors()**: functions used to send the movements to be made for each option to the servos.
- **launchGame():** function used to select the game mode (random or vision game). In random mode, this function uses the sensor to detect the presence of a player and launch the game, calling the round() function. Otherwise, a game is launched using the serial port and detecting a player's movements, calling the visionGame() function.
- **round()**: randomly chooses which move the hand will make
- **visionGame()** : listens to messages sent by the python script in order to know the movement detected by the player.
- **changeState()** : an interrupt function used to improve the precision of the button and change game mode

Python Code

For the Python script, we use the library *opencv.* Using the code example given by this library we can easily detect a hand in front of the image. Almost all code in the main function is from this example, greatly simplifying the process. The output is a hand with 20 different key points on different positions of the hand (e.g. keypoint one is the tip of the thumb, keypoint 6 is the palm of the hand, …). We used these key points to implement a logic system that can determine in which position the player's hand is. For example if all tips of the fingers are between the knuckles of the hand and the palm of the hand, then we know that the player is making a fist. This is how 3 functions that check if the hand is in a rock, paper or scissors position. We then use the functions from the Serial library to set up a connection between the Arduino and the laptop and send the position of the player to the Arduino. We only send the position if it changes and do not continuously send the found position to avoid overflowing the receive buffer in the Arduino.