Harry Fultz Robotics 2021-2022
Club: Robotics 3-6 (Ad Astra)
S.C.O.T.T.
Stationary Controlled Omnidirectional Turnable Talon

Introduction

Every day, the automation of the world and mass production require machines that become more and more efficient at the work they perform. Robotic arms technology is commonly used in the industry where they are automated to do specific jobs around the factory. We also find robotic arms in research laboratories where scientists use these devices to experiment in a controlled environment without being present inside it. These robots should be cost-effective and as durable as possible to ensure longevity and productivity in the field where they fit. S.C.O.T.T. is our take on building an industrial robotic arm remotely controlled.

1. Name of the project and typology

Project Name: Stationary Controlled Omnidirectional Turnable Talon

Themes: Scientific, Industrial, Cost-effective, Remotely controlled,

Format: Robotics 2021-2022

2. General Description

S.C.O.T.T. is similar to a human arm, but instead of a hand, it uses a hook to transport and move objects. The robotic arm will use servos to move its joints and a stepper motor in the bottom to rotate the whole body, ensuring 360° coverage. Project uses a glove containing flex sensors and a gyroscope to control the arm. The connection between the robot and the glove will be utilized via Bluetooth. Connecting this robot to the grid and not using batteries because of the high power the servos and stepper will require is a must. The body is 3D printed, along with its glove, making the design durable and cost-effective.

3. Detailed description of the project

3.1 Project Background

The robotic arm project consists of two primary circuits: the robotic arm circuit and the glove circuit.

The glove circuit contains a microcontroller (Arduino Nano) that transmits the information received from the sensors of the scheme. Several flex sensors are used to monitor the robot's movement, which, based on bending, emit an analog signal through the fluctuation of the internal resistance. To monitor the 3D movement of the project, a gyroscope is used, a component that records the movement of the hand in three dimensions. The information received from the sensors is passed to the Arduino Nano and transmitted through a Bluetooth transmitter.

The robotic arm circuit is the core circuit of the project. It contains the main microcontroller (Arduino Uno), the stepper and servo motors, the voltage distributor, and a Bluetooth receiver. Arduino Uno serves as the “brain” of the project, which manages all the robot's actions. The user input detected by the sensors in the aforementioned circuit is received by the Bluetooth receiver and transmitted to the Arduino. The Servo motors rotate based on the information received by the Arduino. The whole scheme is powered by the power grid, which, after passing through the voltage distributor, is transformed into 5V, 8V, and 9V to be used by the respective elements.

The 3D design is projected to approximate a human arm with a hook instead of a hand. As we had two circuits for the robot, we also have two designs for the project. The handle portion is designed to fit the size of an average hand. Through the movement of the fingers and the wrist, the robot's movement will be realized.

The programming of this project is quite complicated as it uses strict and concise variable ranges to stabilize and control the movement of the arm. Based on some flag values, the direction of movement and adjustment of rotation angles will be controllable by these flag variables. Stabilizing the project and calibrating the flex sensors is the most difficult part of this project.

3.2 The purpose and objective of the project

The goal of the project is the realization of an industrial robot that can perform movements and work based on human mechanical input. Building such a robot at such a low cost would be very fruitful for both a user of such a robot and humanity. This project will be called successful after a test that will be carried out during the presentation before an audience. The objectives of the project are as follows:

- The creation of a cost-effective robotic arm.
- Cooperation between two independent electronic circuits.
- Building complicated circuits.
- Cooperation of two microcontrollers.
- The creation of an efficient and durable 3D design

3.3 Requirements and results

Requirements:

- Building a voltage distributor powerful enough to power the motors in the robotic arm.
- Building a control circuit that will enable the user to direct the arm.
- The creation of a program that enables the connection of the signals received from the controller with the arm.
- Building a stable design using a 3D printer.

Results:

- Constructed a voltage distributor which not only provides energy for each element in the circuit but also supplies additional elements added during the elaboration of the scheme.
- Built and improving the control circuit making it clearer and more efficient.
- Created a program that enables the connection of the signals received from the controller with the arm and is capable of distinguishing the sensitivity of the commands.
- Built a durable design using a 3D printer, a control "room" and painting the robot with representative colors (orange and black).

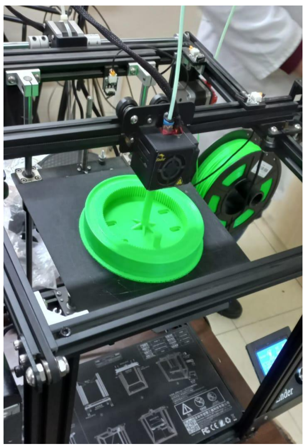
4. Development

4.1 Work plan

Preparation phase:

October 2021:

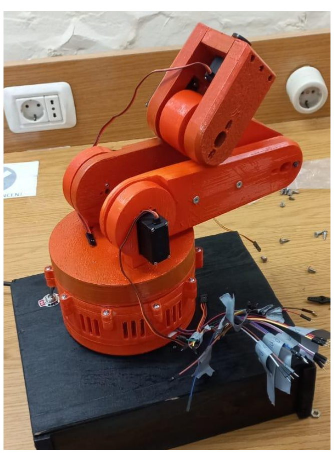
The work begins with the design of the two schemes that will be used. The design is carried out through programs such as EasyEDA and Fritzing. In parallel with this, the 3D design of the robot is built. The latter will be realized with the help of programs such as AutoCAD, Creality, TinkerCAD, etc. After these designs, the budget list of electronic elements will be carried out. The work will be divided into groups and we will start immediately from work.

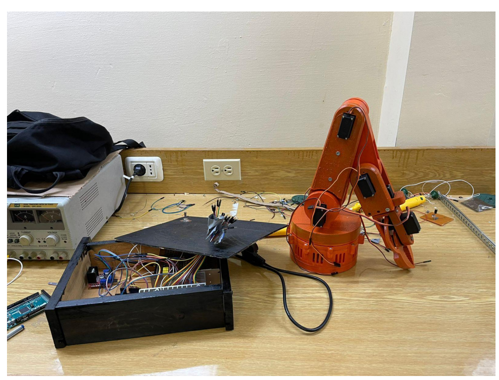


Development phase:

October - November 2021:

During the implementation phase, we build schemes based on the designs created during the first phase. In parallel, the scheme of the hand and that of the voltage distributor is built. Meanwhile, the 3D parts are printed by the printer. The programmer starts by testing the sensors and Bluetooth transmitter. As soon as the construction of the schematics and the 3D printing of the parts is finished, the assembly of the arm begins. The assembly is divided into two groups where one will deal with the construction of the base of the wing while the other with the wing. The base will be built with wooden materials.



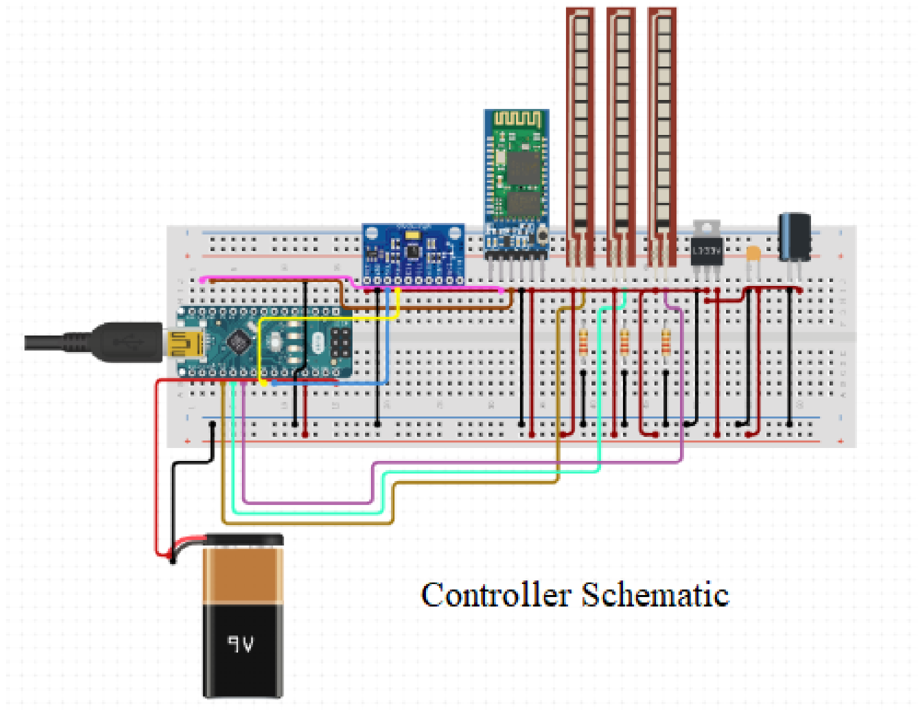


Final phase:

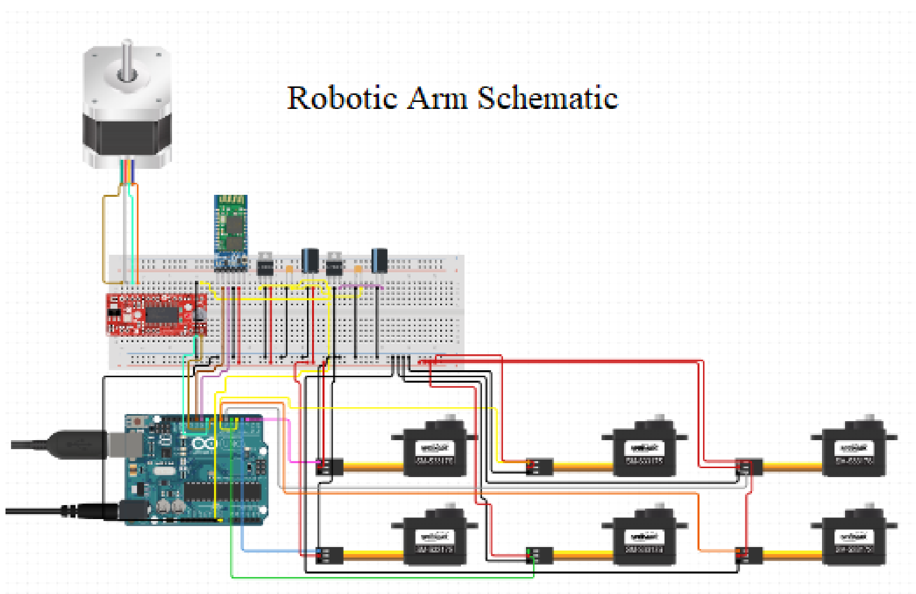
December 2021 - January 2022:

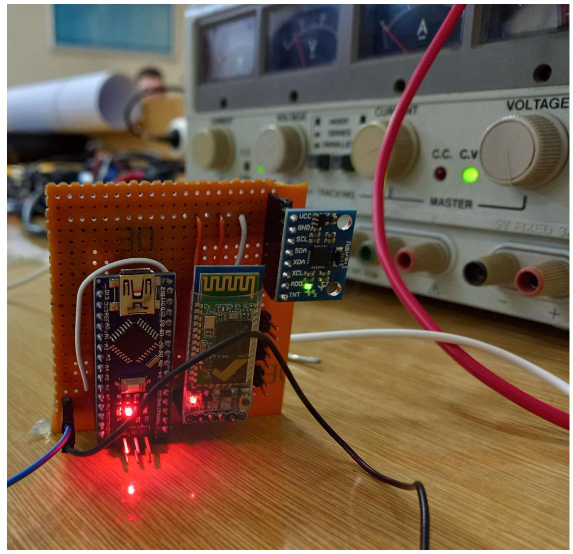
The programmer connects the two circuits to each other using the microcontroller and the inverse relationship between them to bring the arm to life. He also creates a way for the robotic arm to be controlled by an RC remote, in case the glove control proves to be not efficient. After the connection between the controller and arm is established, tests are run to mark the project as complete!

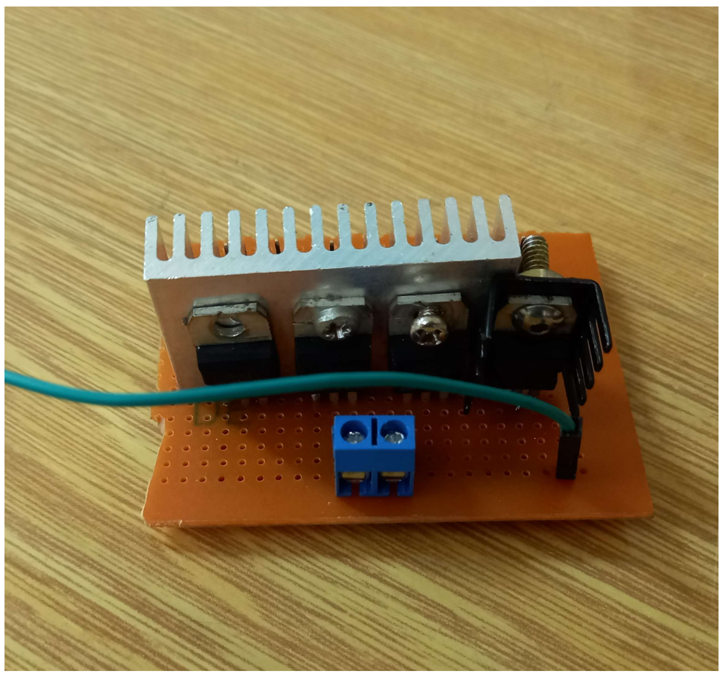
4.2 Electronic Schematics



Controller Schematic


Robotic Arm Schematic





4.3 Problems throughout development

There were three issues that we encountered during the project development:

1. Weight:

   After the 3D design was finished, we noticed that the parts were heavier than expected. Durability comes with a cost, heavier parts, which ment we had to use two 60kg servos for the base and four normal servos. Making this change would lead us to our second problem.

2. Power Distribution:

   Powerful servos require more power, which we had accounted for of course. One small issue stood in our way in power distribution. Thermal energy. After we figured out the problem, we rebuild the power distribution circuits to accommodate more amperage intake.

3. Sensor Problems:

   The sensors we were using were very sensitive to movement, a huge problem that would cause to delay in the project completion to calibrate them correctly. To add salt to injury, we didn't have time to calibrate the sensors in time because of a deadline. We decided it was best to connect the arm with an RC controller, one that would work as intended.

5. Budget

No.	Name	Unit	Amount	Price per unit	Price
1	Arduino UNO	piece	1	$20	$20
2	Arduino Nano	piece	1	$12	$12
3	Flex Sensors	piece	3	$7	$21
4	Gyroscope	piece	1	$6	$6
5	Bluetooth transmitter	piece	1	$12	$12
6	Servo Motor	piece	4	$18	$72
7	Stepper Motor	piece	1	$70	$70
8	Servo Motor 60kg	piece	2	$60	$120
9	Bluetooth receiver	piece	1	$12	$12
10	3D printer filament	coil	2	$20	$40
				Total	**$385**

* Price of the power block isnt included since the IC were provided by the school laboratory and the price was not mentioned.

6.Work Group

Project developers:

- Albion Spaho – 3D Design and Electronics
- Darti Lila – Electronics and Programming

Project Supervisor:

- Msc. Eugen Hoxha

7.Photo of Final Product:

Club Supervisor: Eng. Eugen Hoxha, Eng. Klarens Hoxha

Head of Electronic Department: Eng. Eneida Allkoci