Harry Fultz Robotics 2021-2022
Club: Robotics 3-6 (Ad Astra)
T.A.B.C.A.
Temperature And Barometric Calculation Assistant

Introduction

Ever since the dawn of mankind, humans have tried to predict their futures and fate. Nature and weather were seen as something controlled by the gods, but the weather became predictable with the advancement of the understanding of the world. Today we have scientists and stations dedicated to these predictions, calculating every move of nature by measuring the different variables that affect weather. Sometimes scientists need to spend time in the field, especially geologists, in environments that might not have a connection to the magical tool of the internet. They need a self-reliant tool to do all these calculations, even giving inside into the factors surrounding them, like humidity or temperature. T.A.B.C.A. is the all-in-one solution.

1. Name of the project and typology

Project Name: Temperature And Barometric Calculation Assistant

Themes: Scientific, Meteorological, Self-efficient, Weather Station,

Format: Robotics 2021-2022

2. General Description

T.A.B.C.A. is a mobile weather station capable of being a companion to a scientist in the field by providing accurate meteorological data and predictions about different environments. The robot realizes this by using a microcontroller that computes the information gathered from the different sensors that are included in the scheme. The beauty of T.A.B.C.A is that it is self-reliant, meaning it provides energy for itself by using a solar panel and circuits to recharge its own battery. T.A.B.C.A. has a strong outer design that protects her circuits from outer shock and bad weather. The wheels that are used provide mobility in muddy terrains but with a disadvantage when traversing through harsh rocky terrain.

3. Detailed description of the project

3.1 Project Background

T.A.B.C.A. is a robot with multiple built-in circuits that interact with each other to create a marvelous mobile weather station.

The first circuit that we have to discuss is the “brains” of T.A.B.C.A. the microcontroller (Arduino Uno) that connects to every sensor that is provided inside the robot. Most of the sensors provide digital output, easy to compute and display for us. Here we can mention the humidity sensor, the raindrop sensor, and the temperature sensor. Things become hard when we have to deal with analog data that is provided by the multiple gas sensors that work together to check the levels of different compounds in the air, such as Methane, CO, CO2, Natural gas, etc. All the data is computed in a single algorithm that displays the information on the frontal LCD screen.

The second circuit is the power distribution circuit which consists of two Lithium Polymer batteries that power the entire robot. The power is split into two main voltages, 9V, 5V, and 3.3V to accommodate the microcontroller, the servos, and the sensors. The batteries are charged by a power-stabilizing circuit that doesn't allow voltage fluctuations that might cause the battery to burn in the process. This circuit is connected to the solar panel at the robot's top, providing half coverage of the robot's roof. Alongside the solar panel, we have implanted a system that tracks the sun, having as much efficiency as possible to charge the batteries of the robot.

The exterior of the robot is a mix of the old design and the new one. T.A.B.C.A. was originally a stationary weather station designed by Darti Lila and Erlis Ciko during the A.S.E.F 2021, which won them a silver medal in hardware control. This version of T.A.B.C.A contains the original 3D printed box, with the addition of the part where the wheels are located, a thin metal sheet. The design includes a small storage space in the back, where a scientist can store small tools such as screwdrivers or specimens gathered from the environment. It is not advised to put fragile objects because it might cause them to break from shock.

The code that makes the robot run is a combination of some algorithms that work together. The barometric sensor is mainly used in the weather prediction algorithm to determine how the weather will change in the near future. The screen is set to refresh every five seconds to provide other data like temperature, humidity, and the presence of dangerous gases in the environment. To indicate the high presence of dangerous gases, LEDs are used to signal danger. The algorithm to make the solar panel follow the sun uses two photoresistors and compares the resistances to know the side with the most sunlight. T.A.B.C.A. moves through an application created by us that allows us to control its movements.

3.2 The purpose and objective of the project

The project's goal is to realize a mobile weather station that provides useful data to scientists in the field. This data is also computed to predict the weather in the near future. Self-reliance is also a goal for us to be able to deploy a robot like that to the field. The project's objectives are as follows:

- The creation of a self-efficient project.
- Creating a stabilized charging circuit.
- Managing information to predict the weather.
- Controlling the robot with a smartphone application.
- The creation of a durable 3D design

3.3 Requirements and results

Requirements:

- Creating an organized circuit that manages multiple sensors and processes their data to do simple predictions.
- Building a control app that will enable the user to drive the robot.
- The creation of a self-sustaining system through the solar panel that followers the sun.
- Building a durable design using the old structure and thin metal sheets.

Results:

- Created a circuit that processes the information from all the sensors, displaying all data in the LCD and indicating danger with the LED lamp.
- Built an optimized application that controls the movement of the robot.
- Built the stabilized battery recharge system and optimized the solar panel's efficiency.
- Built a durable design using the old box and thin metal sheets to create a base where the wheels are placed and the project is rested upon.

4. Development

4.1 Work plan

Preparation phase:

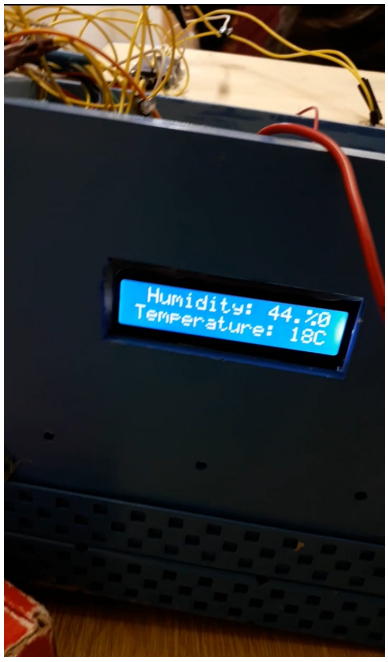
December 2021:

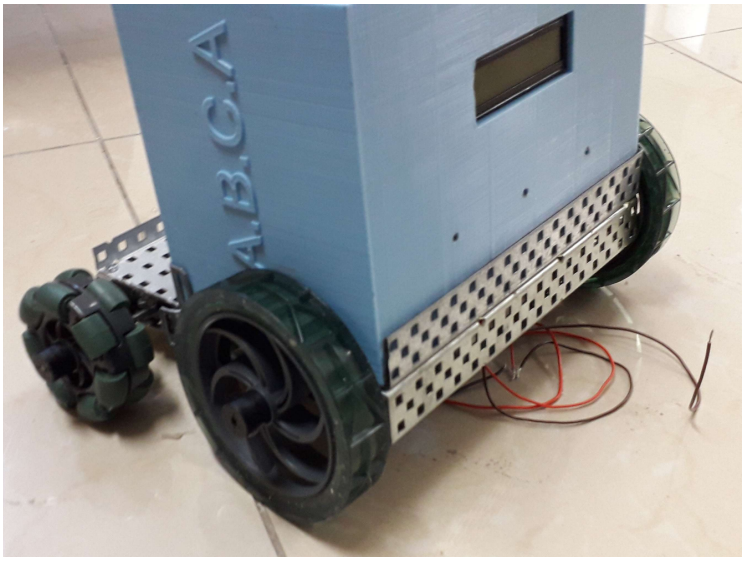
The preparation phase begun with the redesigning of the old circuit. This time we would add a variety of new sensors, so the used analog and digital ports of the Arduino were rethought. Programming was essencial to this phase since trying out every sensor individually was a must to understand its behaviours and how we can increase the optimisation of power and account for misscalculations.

Development phase:

January 2022:

During the development phase we designed and built the power control circuits. Along with the main structure with the wheels attached we had to account for another tiny scheme that would rotate the solar panel to follow the sun. Holes were created to the side so the gas sensors would detect certain gases in the environment and a raindrop module was implemented on the top to detect rain. The screen was attached, refreshing to show different information that it was gathering. A few tests were organised for the sensors to fix small issues in sensor cooperation.



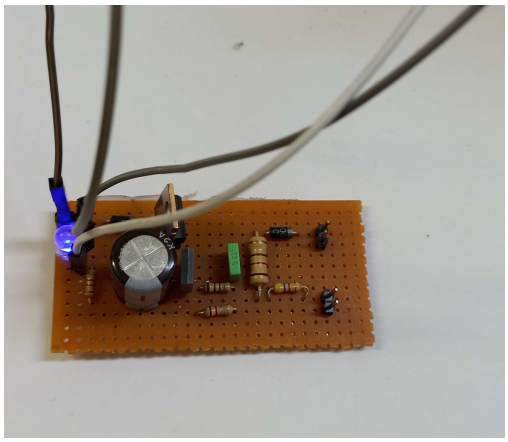


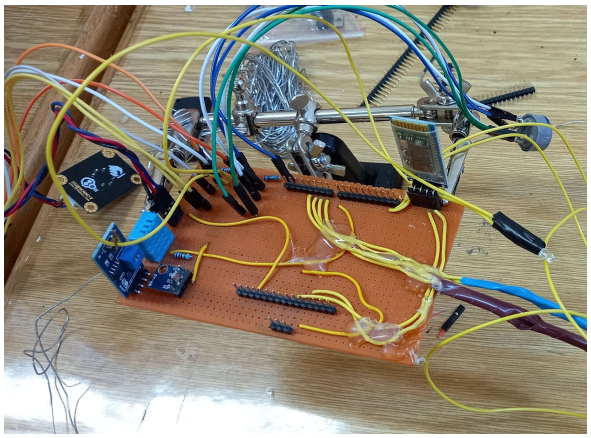
Final phase:

February 2022:

During the final phase tests were run to measure power usage, and optimise the efficiency of the circuits. A hole was installed for cooling down the circuits inside, avoiding overheating issues that might arise. Wires were shortened to save as much space as possible inside of the robot. The program was optimised by removing redundant variables and functions.

4.2 Electronic Schematics





4.3 Problems throughout development

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

1. Weak servos:

   Having a strong design for its body, T.A.B.C.A. is a heavy robot, which means that a lot of power is required to move it. The four servos in the bottom work together to realise movement; it is slow but steady.

2. Small space:

   Having thick walls and a small surface in the inside, it is difficult to fit all the circuits inside and wires become cluttered sometimes. This is a problem whenever T.A.B.C.A. needs to be repaired.

3. LCD glitch:

   During testing, the LCD screen was damaged, leading to glitches during the display of the environmental variables. This problem was not fixed due to time restrains, so the display only works about 70% of the time, the other being filled with glitchy screen.

5. Budget

No.	Name	Unit	Amount	Price per unit	Price
1	Arduino UNO	piece	1	$20	$20
2	Humididty and Temperature Sensor	piece	1	$10	$10
3	Barometric Sensor	piece	1	$9	$9
4	Methane Gas Sensor (MQ7)	piece	1	$5	$5
5	Oxygen Gas Sensor (MQ2)	piece	1	$5	$5
6	CO Sensor (MQ9)	piece	1	$5	$5

7	Servo Motor	piece	5	$18	$72
8	LED	piece	1	$0.1	$0.1
9	Raindrop Sensor	piece	1	$70	$70
10	Photoresistors	piece	2	$60	$120
11	Bluetooth receiver	piece	1	$12	$12
12	Solar panel	pieve	1	$15	$15
13	3D printer filament	coil	2	$20	$40
14	Wheels	piece	4	$5	$20
				Total	**$403**

* 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

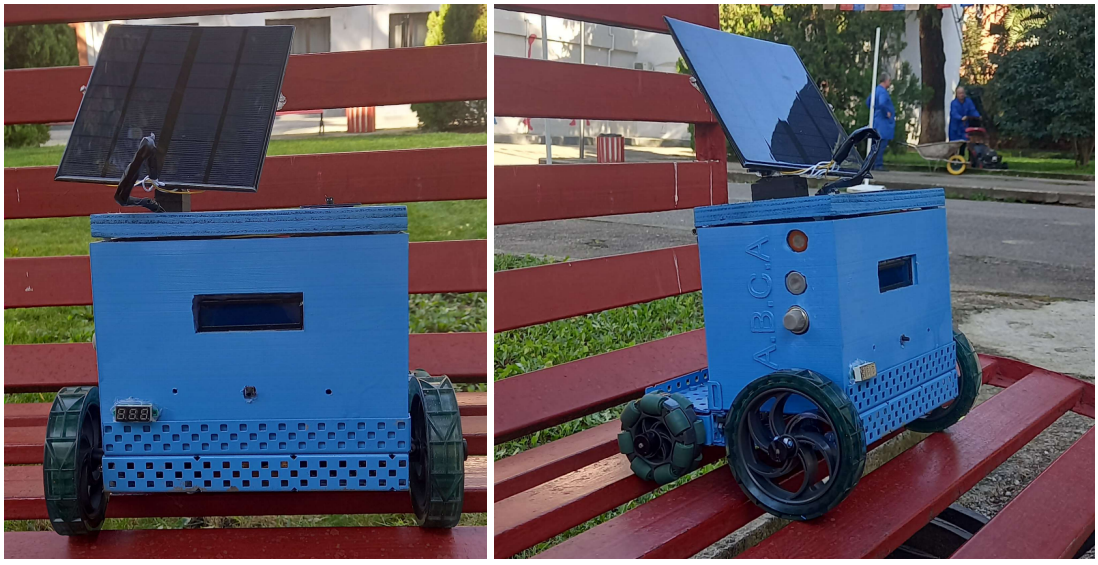
Project developers:

- Darti Lila – Electronics and 3D design
- Marvin Ruka - 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