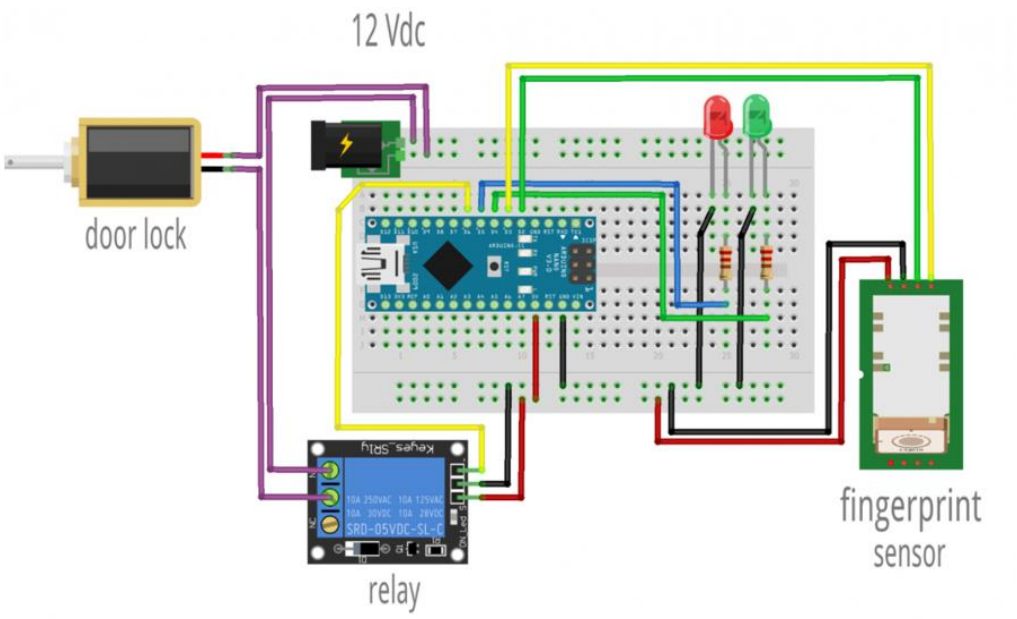
Fingerprint Lock with Arduino Nano



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Course: BEng Electrical and Electronic Engineering

Venue: University of South Wales Treforest Campus 2022-23

Introduction

Our group project is to design and physically produce a robust fingerprint recognition lock with LED indicators that can be used to lock a safe. There are possibilities that our lock could extend into other prototypes and uses such as doors, suitcases, gates, cars, properties etc.

This project is being undertaken as fingerprint technology is now in widespread practice, which means we should learn about how the technology functions and try to understand how to build a product that can put it into practice. This project requires some coding as we are planning to use an Arduino Nano as our prototyping platform which contains an ATmega 328 microcontroller. The Arduino is to be powered via Micro USB. During the design of our project, we will learn how to code our lock so that it performs the specific tasks our product is required to do. This will also give an opportunity for our group to expand our understanding of how coding for the microcontroller works.

We plan to use a solenoid device as the foundation of our lock, specifically looking at the MP001162 Multicomp Pro, SOLENOID LOCK as our starting point. It is a small 12V, 9W solenoid and as we hopefully create more prototypes (for different purposes) we may change the solenoid as various products will require different specifications for the appropriate solenoid. The design will use LEDs to represent and indicate different states that the lock is in. Another option would be to use a small LCD screen, but this is impractical for a few reasons. LEDs will be cheaper, much more compact and space saving, more robust, much easier to code than an LCD screen and consume less power.

We will need to use a fingerprint sensor to receive information from somebody's fingerprint then transmit the information to the microcontroller. As we will have stored the fingerprint of the user, which is stored in the flash memory of the microcontroller, the microcontroller checks if the scanned fingerprint matches the fingerprint in the flash memory.

The fingerprint is going to be hardcoded in as this is the most secure way, we can do it due to weak security from the Arduino. However, we may use a different platform for subsequent prototypes such as Raspberry PI Pico which is more secure.

As we start to construct our project, we will need to make sure the dimensions of our project all fit together and are all compatible. It should fit in a safe chassis however if not our backup plan is to reengineer our locking system into a portable fingerprint lock or adapt it to different items such as a door, suitcase/briefcase lock.

Another point to add is we will need to solder our components onto a PCB containing the Arduino. We need to take care not to bridge any tracks, spill solder or break any components and therefore will require a steady hand.

Summary/Background research of product

This section will talk about the background research which we have conducted for our idea and the justification of our chosen idea. Also, we will talk about the initial objections of our idea and how we dealt with these objections before finalising our idea.

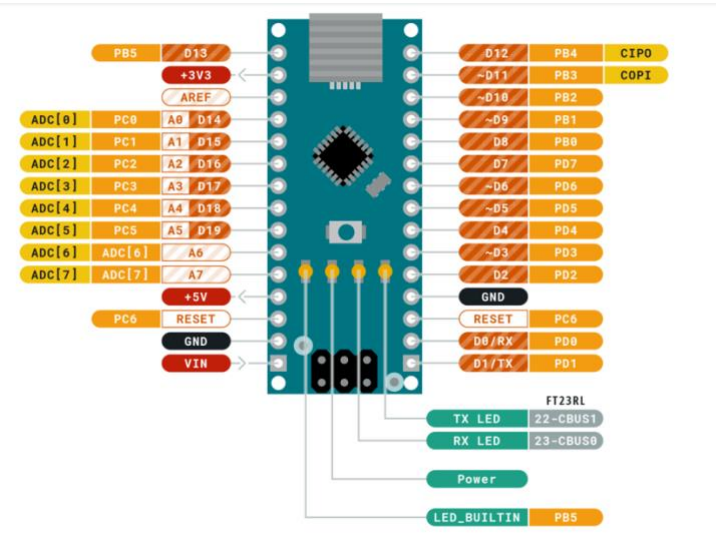
Firstly, when deciding on our project, we thought of using the Renesas boards given to us in embedded for our project. This would be a viable option but due to our lack of knowledge of the architecture of the board and our programming skills for the board not being up to par, we decided not to use the Renesas board and decided on an Arduino Nano. An Arduino Nano was a viable option for us to use as it was inexpensive and most importantly easy to use. We could adapt pre-existing code which would help towards our project instead of completing learning how to program an embedded system which is hard for us to understand as of now or understanding an embedded systems architecture which we are unfamiliar with so we decided on an Arduino as we could implements more aspects into the Arduino as material is more available for it.

Now after deciding on using an Arduino Nano on our project, we needed to decide what we wanted to do with the Arduino. After brainstorming ideas, we decided on creating a safe lock with a fingerprint sensor. For us to work on this project, we needed to look at other lock systems with a fingerprint sensor to grasp the basics of how to conduct out project for our situation. This website demonstrates the use of a fingerprint scanner on a door lock system.[1] We can use the configurations of the fingerprint sensor from this project and use it in our project. After this discovery, we had the thought of using an RFID reader in our project. This website demonstrates the use of an RFID in an electric door lock.[2] The reason we didn't decide to go forward with using an RFID due to the requirements of the user and to make the product as compact as possible. If we added the RFID, the size of the product which increase by at least 2 inches in dimensions.

Now, we have decided on the parts and have grasped the basic concepts of our project, now it's time to find and research the schematics and circuit diagrams for our project.

[1] Arduino Project Hub. (n.d.). *DiY Fingerprint Door Lock System*. [online] Available at: https://create.arduino.cc/projecthub/diyprojectslab/diy-fingerprint-door-lock-system-98dcea.

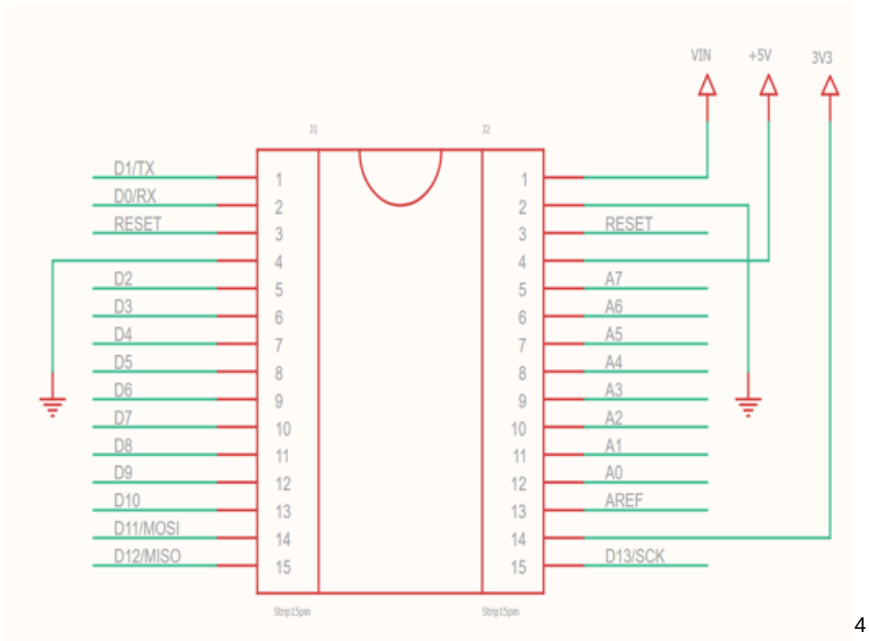
[2] *Electric Door Lock With Fingerprint Scanner and RFID Reader*. [online]. Available at: https://www.instructables.com/Electric-Door-Lock-With-Fingerprint-Scanner-and-RF/.



[3]

Figure 1.1: Pin-out diagram of Arduino Nano

This image shows the pin-out diagram of the Arduino Nano takes from the Arduino website. This will allow us to understand how the Arduino works and tells us the significant of each pin and it's use which will be useful for us.



[4]

Figure 1.2: Schematic of the Arduino Nano

[3] Arduino® Nano. (n.d.). [online] Available at:

https://docs.arduino.cc/static/e7d6ca34b88350545d67282788df0956/A000005-datasheet.pdf

[4] Figure 1.2, 1.3 and 1.4 : Arduino, n.d. *Arduino Datasheet.* [Online]
Avaliable at https://www.arduino.cc/en/uploads/Main/Arduino_Nano-Rev3.2-SCH.pdf

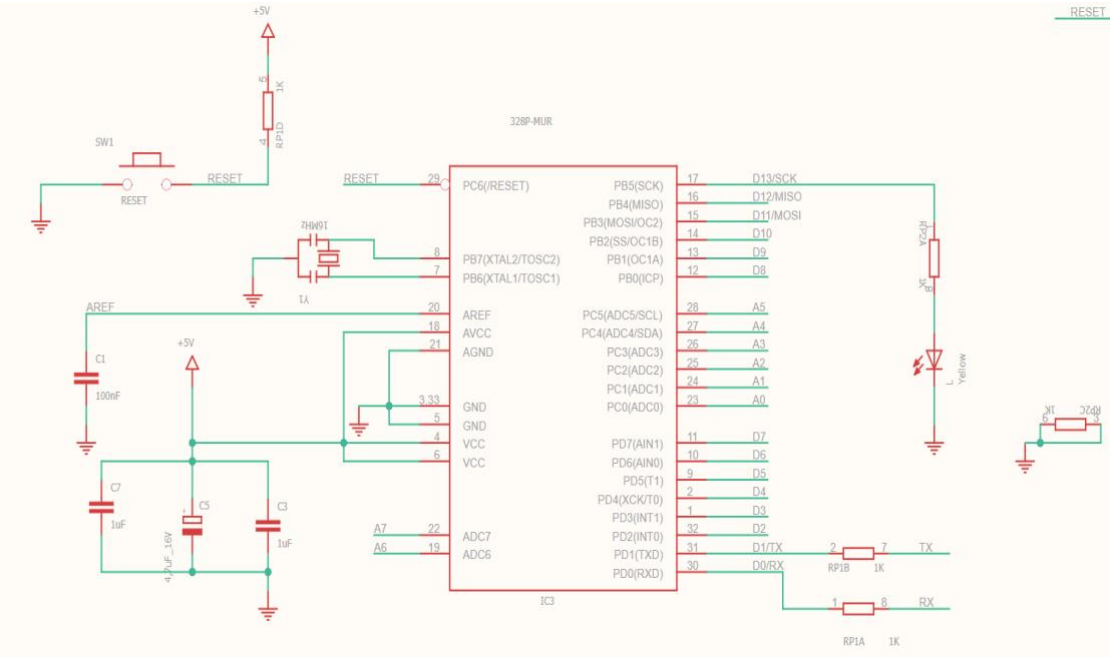


Figure 1.3: Schematic of the Microprocessor

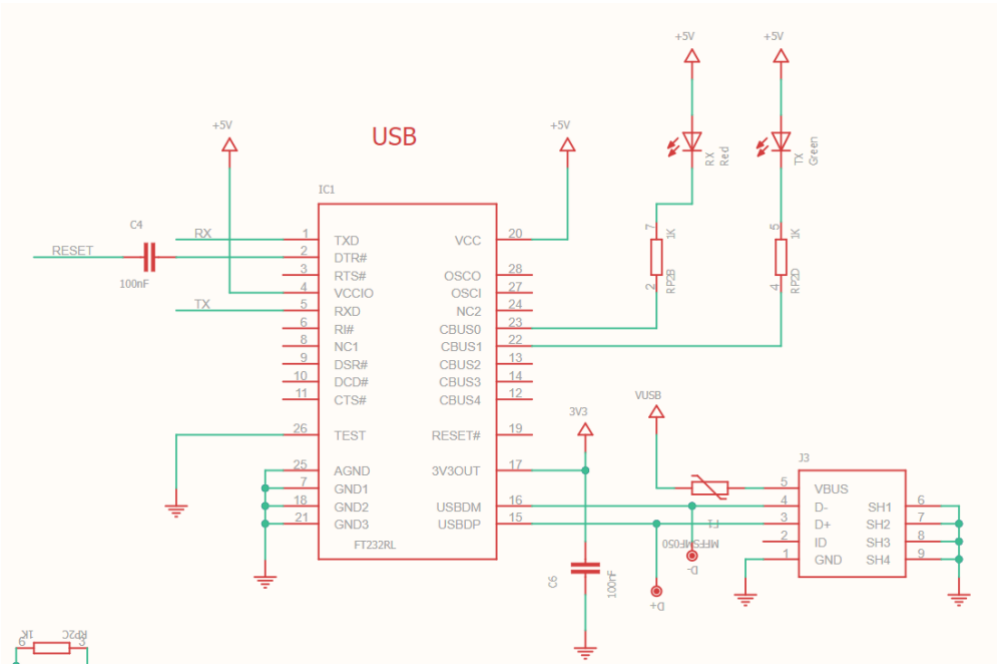
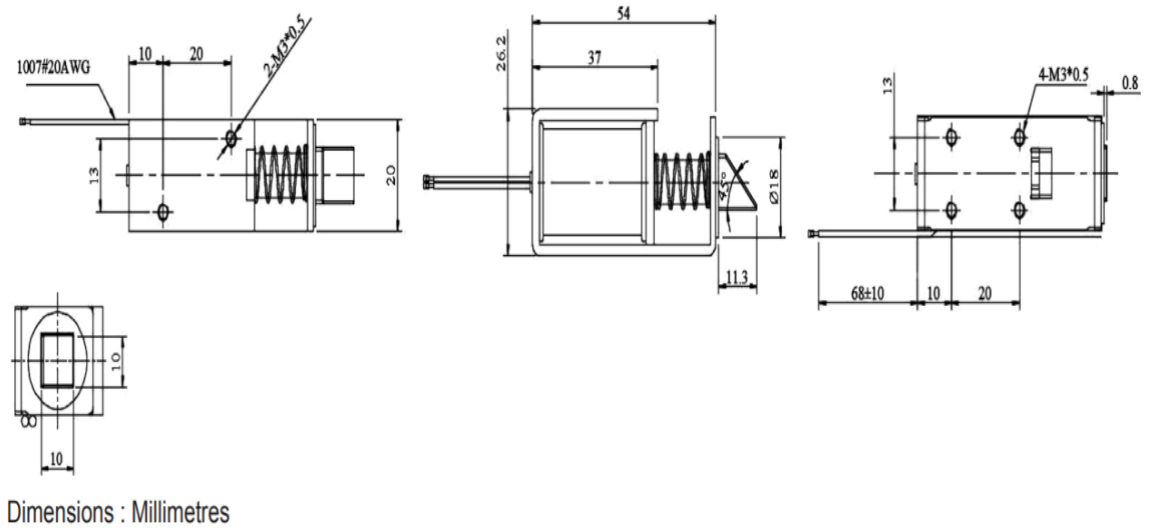


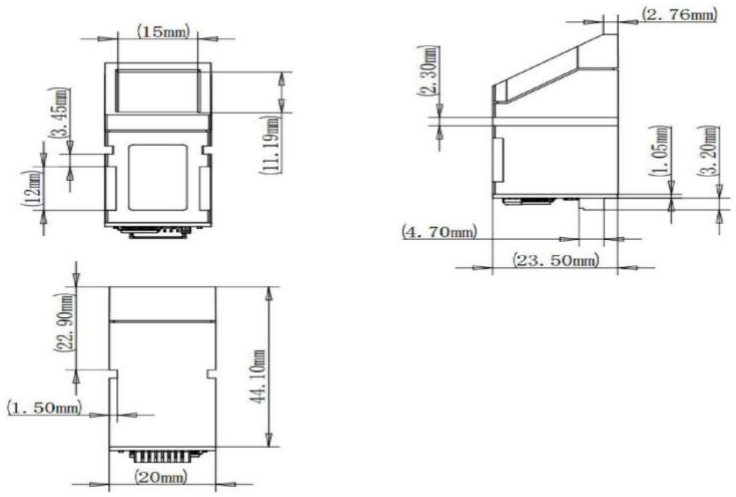
Figure 1.4: Schematic of the USB Input

This is the schematic diagrams of the Arduino Nano, the microprocessor and the USB input taken from the Arduino website which is crucial for us as it allows us to render a 3d model of the Arduino Nano which can be rendered in Proteus.



[5]

Figure 1.5: Dimensions of the solenoid lock



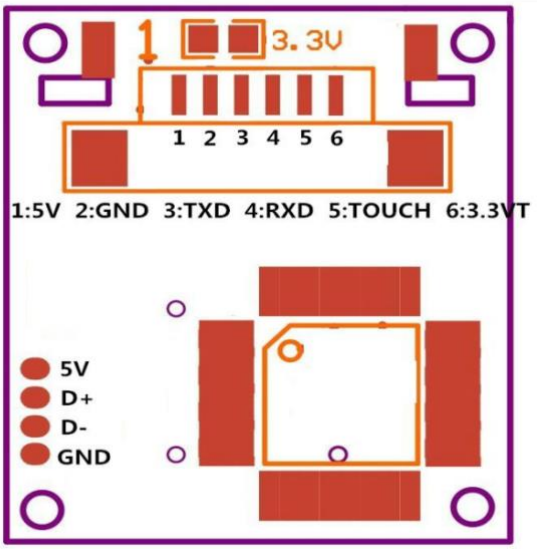
[6]

Figure 1.6: Dimensions of the fingerprint sensor

[5] Solenoid Lock Diagram Specifications Electrical Specifications. (n.d.). [online] Available at: https://www.farnell.com/datasheets/2865763.pdf

[6] Manual, U. (2011). *R307 Fingerprint Module*. [online] p.1. Available at: https://www.openhacks.com/uploadsproductos/r307_fingerprint_module_user_manual.pdf

These are the dimensions of the solenoid lock and fingerprint sensor taken from the Farnell website. This diagram will allow us to redesign the solenoid lock and fingerprint scanner into proteus with the correct measurements and to create the 3D model of these two parts with precision.

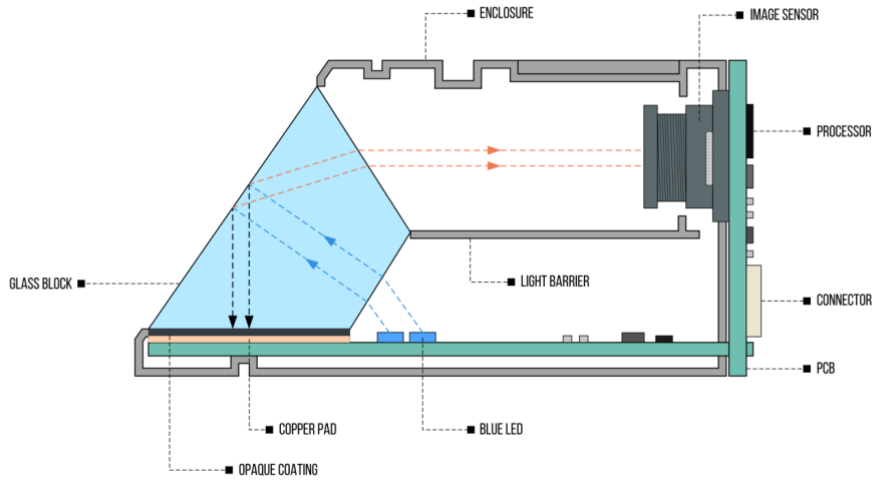


[6]

Figure 1.7: Circuit diagram of Fingerprint sensor

This is the circuit diagram of fingerprint sensor taken from a GROW industries pdf which will allow us to understand the circuitry of the fingerprint sensor and the alignment of the pins which will be useful to us when constructing of the product.

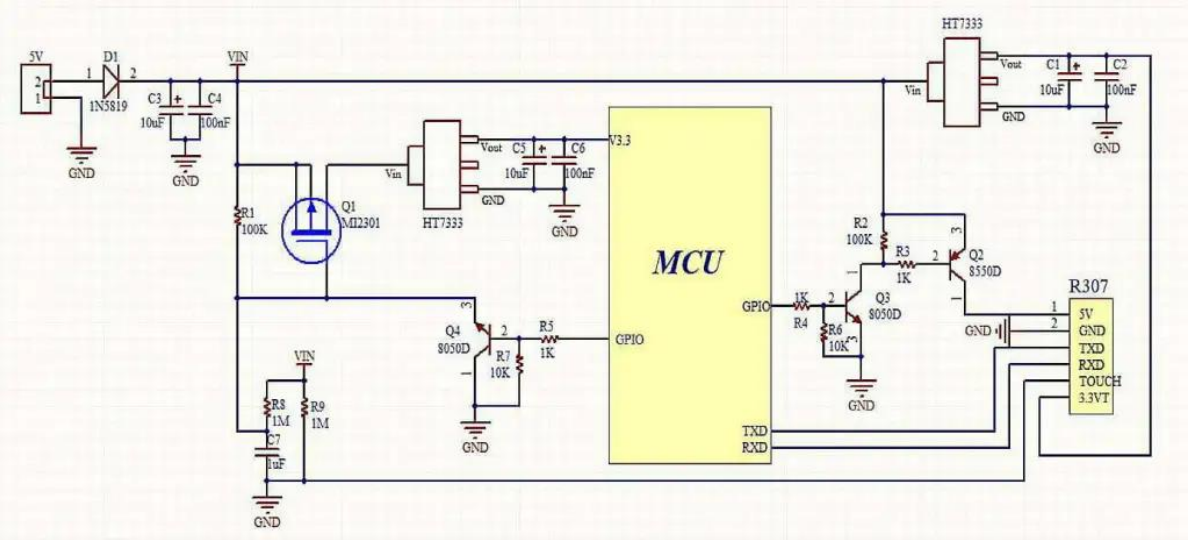
[6] Manual, U. (2011). *R307 Fingerprint Module*. [online] p.1. Available at: https://www.openhacks.com/uploadsproductos/r307_fingerprint_module_user_manual.pdf



[7]

Figure 1.8: Diagram of fingerprint scanner

This is a diagram which depicts how the fingerprint scanner works taken from the CircuitState website. This allows us to see what each of the scanner is and the purpose of each part of the scanner.



[6]

Figure 1.9: Schematic of fingerprint scanner

[7] circuitstate.com. (n.d.). *Interfacing R307 Optical Fingerprint Scanner with Arduino Boards for Biometric Authentication - CIRCUITSTATE Electronics*. [online] Available at: https://circuitstate.com/tutorials/interfacing-r307-optical-fingerprint-scanner-with-arduino-boards-for-biometric-authentication/

[6] Manual, U. (2011). *R307 Fingerprint Module*. [online] p.1. Available at: https://www.openhacks.com/uploadsproductos/r307_fingerprint_module_user_manual.pdf

This is the schematic of the fingerprint scanner taken from the GROW industries pdf. This will allow us to design of the fingerprint scanner in Proteus by helping us see where to wire each part with no complications. The schematic also allows us the render a 3D model of the sensor on Proteus so we can see a 3D model of the fingerprint scanner on Proteus.

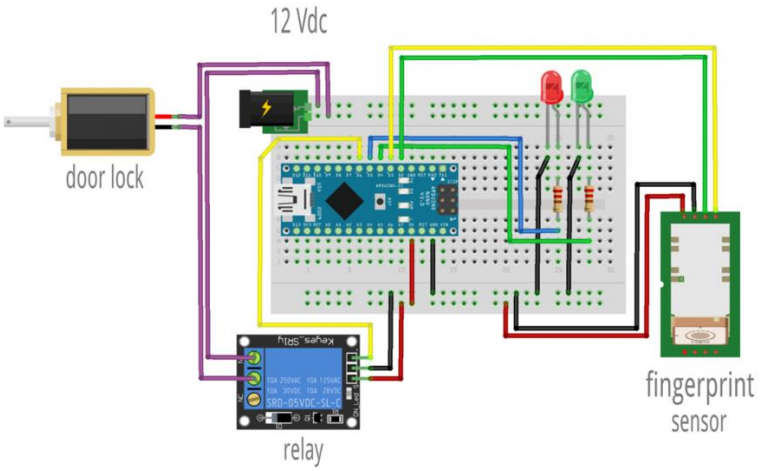


Figure 2.10: Circuit Diagram of the planned product

This is a circuit diagram of our planned circuit which we design with a use of a breadboard. In our final project, instead of a breadboard, we will use a copper board and solder each of the components onto the board. This design gave us an insight on how the circuity would look like before constructing it in real life.

Risk Assessment

- Generic risks

Generic Risks are risks that are generally there every day. Things like your surroundings and the scenario that you are in. For example, theft of materials, acts of God etc.

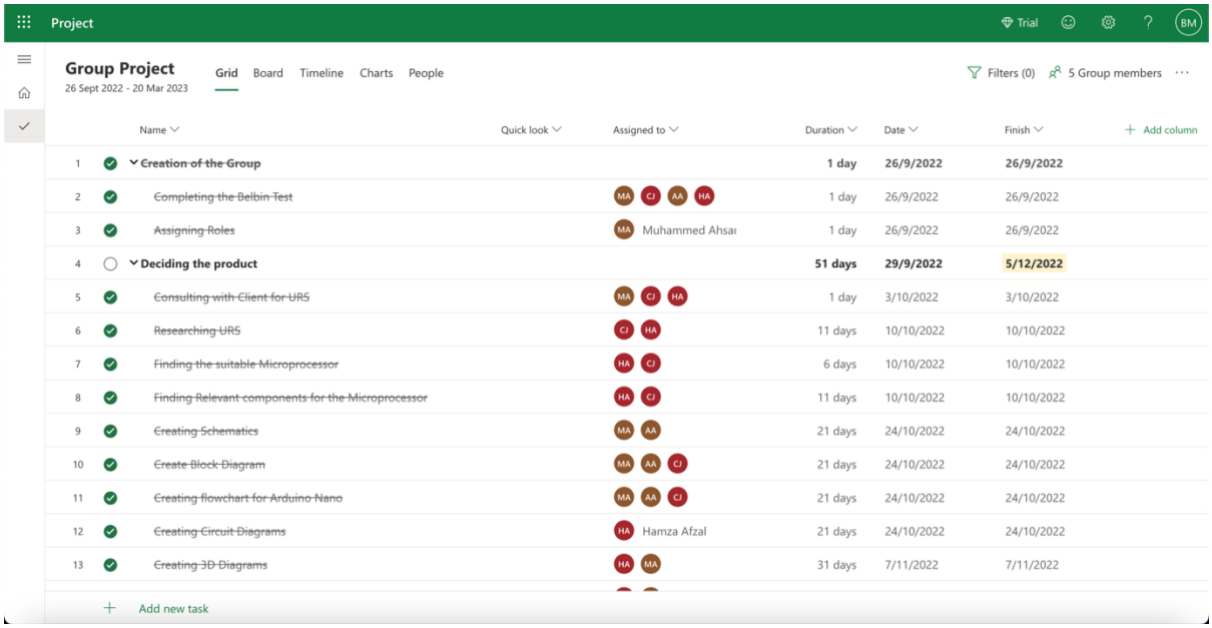
- Specific risks

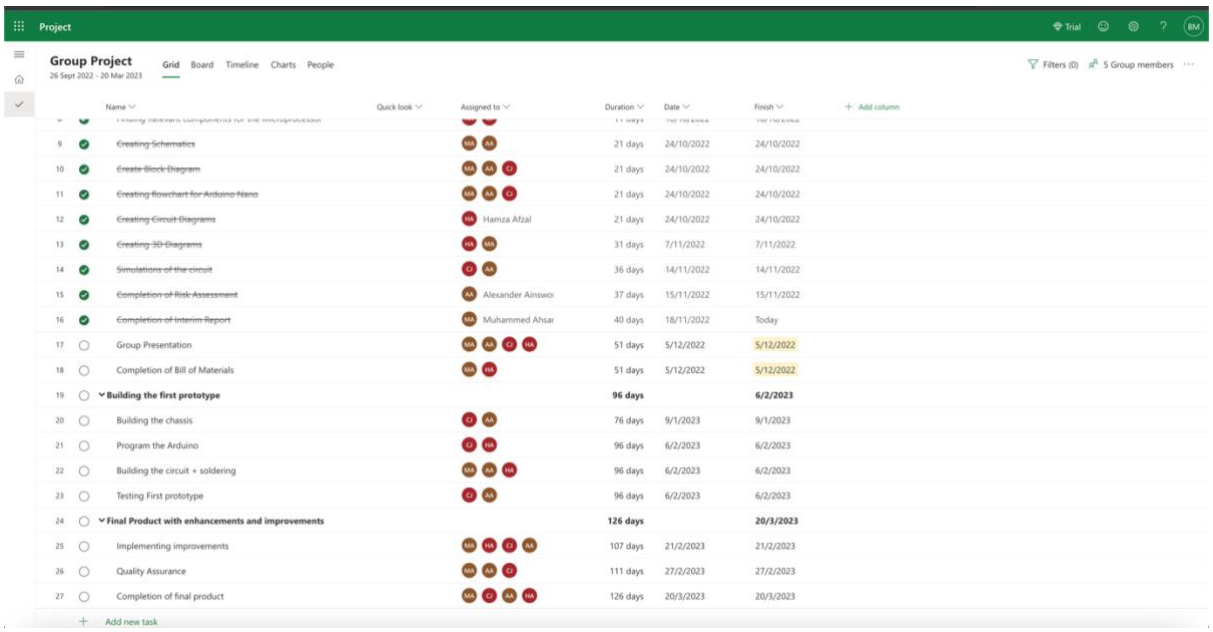
Specific risks are risks that are special to the project of subject. This included things like making sure specific soldering techniques are being carried out. Soldering irons don't generally have a place in everyday, urban environment.

Risk No.	Description of the risk	Probability of the risk	Effect on the project	Contingencies/actions To mitigate the risk
1	Burn from soldering iron.	If soldering iron is handled with care, probability of risk happening is low.	Can slow progress down as person will have to take care of injuries.	Wear heat proof gloves.
2	Burn from hot solder splashing.	Fairly high probability of risk happening.	Takes up time but needing to take extra care is	Wear long sleeves to protect skin and wear safety goggles to protect eyes.

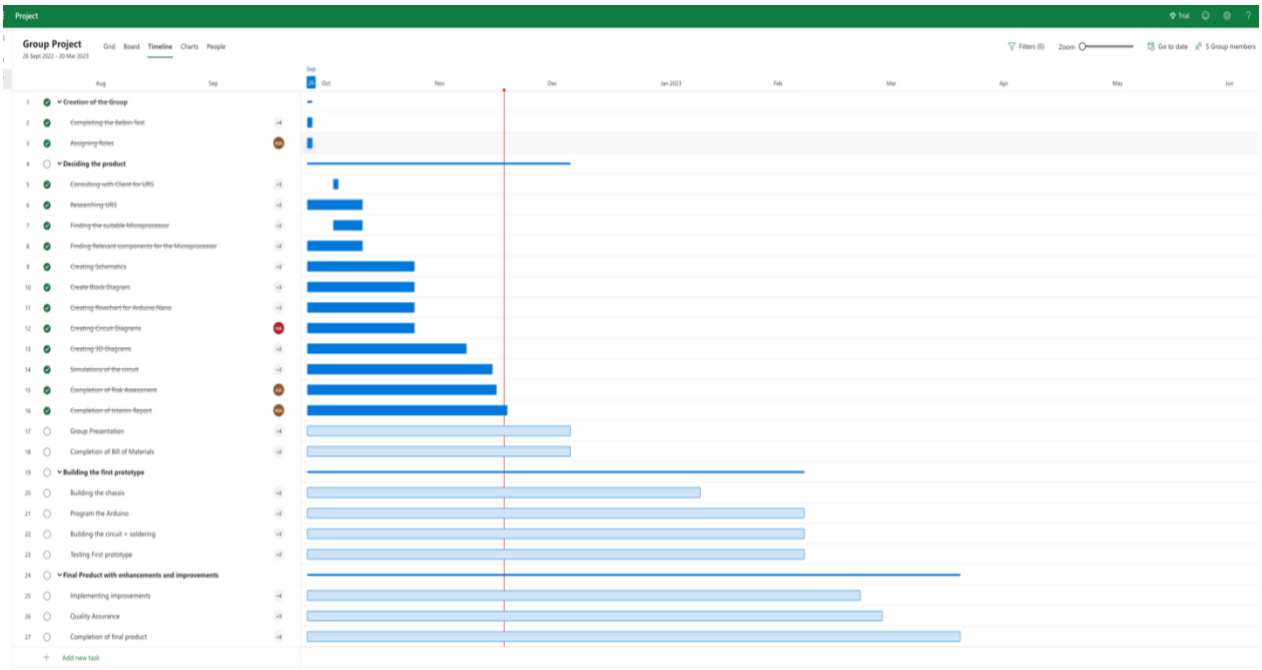
			important for safety.	
3	Short Circuit causing heat and possible fire.	High if components are damaged or not connected properly, very low if everything is connected as it should be.	Take extra time in building process as lots of attention will need to be put into the build to mitigate risk.	Test every component and connection/solder join, to make sure everything is in working order. This can be done easily by using a multimeter.
4.	Physical impact to fingers from building the product.	Fairly high if not being careful. Low if extra care is taken and you're paying full attention to what you're doing.	This will take extra time as it is most important to be safe when physically building the chassis of our product.	Keeping aware of surroundings and using building tools appropriately.
5.	Burn from welding	Heat and sparks could burn when welding, high probability without appropriate gear.	Will be strongest way of constructing our project but requires the correct knowledge on how to weld.	Wear correct protective gear and face shield, have the knowledge on welding techniques and methods.

WBS and Gantt Chart





These are the WBS of the tasks for the Gantt chart which was created on MS Project. Each task has a date and duration and has each of the members aligned to each task.



This is the Gantt chart of the overall project. The dark blue bars represent the completion of the tasks, and the light blue tasks shows the non-completion of tasks. The thin lines represent the duration of the overall task.

Current state of project

As of the 18/11/2022, we have completed the Belbin test, assign roles, and have decided the project, completed the URS and have now completed the steps required for the Interim Report template. After submission, we will continue to update and use MS Project for tracking and start our next task which is preparation for the group presentation.