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بعنوان:

Etude et réalisation d'une commande de chaise dentaire par Arduino

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الإهـــداء

الى بلسم الشفاء الى بفيضهم أزدان فكري ووجداني إلى من حصدوا الأشواك عن طريقي ليهدوا لي طريق ألتمس فيه علما إلى من قال فيها الله تعالى:

{وَاخْفِضْ لَهُمَا جَنَاحَ الذُّلِّ مِنَ الرَّحْمَةِ وَقُل رَّبِّ ارْحَمْهُمَا كَمَا رَبَّيَانِي صَغِيرًا} سورة الإسراء الاية 24

إلى أمي ..... أمي .... أمي......... أبي

وإلى كل من ساهم في بناء فكرة من افكاري حفظكم الله ورعاكم

علي عبد الله

الإهـــــداء

إلى من وضع المولى - سبحانه وتعالى - الجنة تحت قدميها، ووقَّرها في كتابه العزيز...

أتت بي الى الحياة لأسمو بها الأعالي.

(أمي الحبيبة) أدامك الله علينا خيرا وبركة.

إلى من أجله وأقدره وارفع من قدره بين العالمين؛ الذي لم يتهاون يوم في توفير سبيل الخير والسعادة لي..

فلقد كان له الفضل الأوَّل في بلوغي التعليم العالي.

(أبي المُوقَّر) بارك الله في عُمره.

إلى عائلتي وأصدقائي ومعارفي الذين أُجلُّهم وأحترمهم..

إلى كل من علمني علما انتفع به وكان لهم أثر في حياتي أساتذتي ....

ادام الله عليكم الصحة والعافية........

أُهدي لكم بحثي ....

أحمد الصديق

الشكر والتقدير

النفوس النقية مجبولة على حب من أحسن إليها ووقف بجانبها وقت الشدائد

والصعاب، والرسول الكريم ﷺ يقول: "لا يشكر الله، من لا يشكر الناس"، نتوجه

بالشكر إلى الأستاذ عبد السلام كيفوش والاخ أيمن بلودينة والاخ رزاق لخضر

الذين لم يبخلوا علينا بعلمهم، ولا بجهدهم في سبيل المعرفة والعلم.

Abstract:

Using machine systems in medicine, doctors can improve diagnostics and treatment processes and improve patient care in general. These devices are known to operate with programmable logical controllers and microcontroller devices, which are very expensive systems with poor maintenance capability as opposed to what is known as Arduino so that it is defined as an open-source environment that is easy to develop and modify and high-efficiency projects at little cost. So, we suggested that we create a control system for the dental chair by Arduino as a first model for medical devices and the results were not entirely good where the chair problems worked.

Key words:

Dental chair, PLC, Arduino, automatic control, smart systems, medical robots.

Résumé:

En utilisant des systèmes de machines en médecine, les médecins peuvent améliorer les diagnostics et les processus de traitement et améliorer les soins aux patients en général. Ces dispositifs sont connus pour fonctionner avec des contrôleurs logiques programmables et des dispositifs de microcontrôleur, qui sont des systèmes très coûteux avec une faible capacité de maintenance par rapport à ce qu'on appelle l'Arduino de sorte qu'il est défini comme un environnement open source qui est facile à développer et à modifier et des projets à haute efficacité à faible coût. Nous avons donc suggéré de créer un système de contrôle pour la chaise dentaire par Arduino comme premier modèle pour les appareils médicaux et les résultats n'étaient pas entièrement bons lorsque les problèmes de chaise ont fonctionné.

Mots-clés:

Chaise dentaire, API, Arduino, commande automatique, systèmes intelligents, robots médicaux.

ملخص:

باستخدام الانظمة الالية في الطب، يمكن للأطباء تحسين عمليات التشخيص والعلاج وتحسين رعاية المرضى بشكل عام. ومن المعروف عن هذه الاجهزة انها تعمل بوحدات التحكم المنطقية القابلة للبرمجة وأجهزة microcontroller وهي انظمة ذات تكلفة كبيرة مع امكانية صيانة ضعيفة عكس ما يعرف عن الأردوينو بحيث يعرف على انه بيئة مفتوحة المصدر سهلة التطوير والتعديل ومشاريع ذات كفاءة عالية بتكلفة قليلة لذا اقترحنا ان نقوم بإنشاء نظام تحكم لكرسي الاسنان بواسطة الأردوينو كنموذج اول عن الاجهزة الطبية وكانت النتائج جيدة حيث عمل الكرسي بشكل تام دون اي مشاكل.

كلمة مفتاحية:

كرسي الأسنان، وحدات التحكم المنطقية القابلة للبرمجة، الأردوينو، التحكم الآلي، الأنظمة الذكية، الروبوتات الطبية

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Introduction:

We present this research to all interested in the subject of this research, whether from teachers or from my brothers and sisters my fellow students, this topic of research is on the subject (...... Study and accomplish control of the dental chair by Arduino...), and we wish that this research at a scientific level is acceptable to you.

Medicine is a science that studies diseases and injuries and how to treat them and maintain human health. It is a vast and diverse field encompassing many disciplines such as surgery, esoteric diseases, pharmacology, diagnosis, medical imaging, etc.

Medicine is one of the most important areas in life, it keeps people healthy and helps them to live better and longer. Medicine also helps improve quality of life, treating diseases and injuries that affect people's lives and reduce their ability to work and participate in society.

Medical tools have evolved over the years, using simple tools in the past, such as scalpel, scissors and needles. But with the advancement of technology, modern medical tools have emerged that help diagnose and treat diseases better and faster.

Technological tools are one of the most important tools in medicine, helping to improve the quality of health care and reduce medical risks and errors. Through the use of technology, diseases can be diagnosed faster and more accurately, and can be treated better and more effectively.

For example, modern medical imaging can be used to accurately diagnose diseases and injuries, such as MRI and CT scans. Surgical robots can also be used for accurate and safe surgery.

In addition, technology can be used to improve patient care, such as using medical applications to remind patients to take medications and medical visit appointments, and to facilitate the exchange of information between patients and doctors.

In general, medicine is one of the most important areas in life, the development of medical tools and modern technology has helped to improve the quality of health care and maintain human health.

Therefore, the machine system is one of the most important assistive modern technologies. The machine systems are a set of devices and programs that work together to carry out specific tasks. These systems have developed over the years significantly, and have become used in many areas including medicine.

Historically, the use of machine systems in medicine has been limited to the use of simple devices such as oxygen pumps and blood pressure measurements. But as technology has evolved, modern medical devices have emerged that use machine systems to better and faster diagnose and treat diseases.

For example, machine systems can be used to diagnose diseases, such as using artificial intelligence to analyze medical images and accurately diagnose diseases. Machine systems can also be used in the treatment of diseases, such as the use of surgical robots for accurate and safe surgery.

In addition, automated systems can be used to improve patient care, such as the use of medical applications to remind patients to take medications and medical visit appointments, and to facilitate the exchange of information between patients and doctors.

One of the most important systems currently used in medicine is artificial intelligence and machine learning technology. Doctors can use these techniques to analyze medical data and diagnose diseases accurately and quickly. These techniques can also be used to improve treatment processes and reduce medical risks and errors.

In general, the use of machine systems in medicine is one of the most important developments in this field. These techniques have helped to improve the quality of health care and reduce medical risks and errors, and they continue to evolve and improve continuously.

We have worked hard to reconcile the elements of this research. The research on this topic is multifaceted and not easy to reconcile. We are sure that our esteemed professors will expand their chest and we hope that their time will also allow them to read the research fully so that they can be a comprehensive view of all the elements in the research.

We have selected the dental chair as a medical device for study so we have improved a model of control systems by Arduino so that it is easy to maintain and less expensive than the current control system using microcontroller, this research includes the following addresses and elements:

Chapter I: Dental chairs display

In this chapter we defined the device and its uses and mentioned the most important parts and components that exist with the working and operating principle.

Chapter II: Automated systems

We mentioned programmable logical controllers (PLC), the way of working and the parts intervening in it and then continued to talk about Arduino and the way it is used.

Chapter III: Realization

We have completed a prototype of the completed project with a mention of the parts used in it.

We hope that our distinguished teachers and colleagues will not reply to our request to give us suggestions, assessment and constructive criticism so that I can correct my mistakes. which is undoubtedly present in the search but certainly inadvertently of me, At the end of this introduction, I thank God Almighty for the grace of science and hope that he will perpetuate it on us. It makes it a useful science, until it is beneficial and beneficial to others, and we always wish God success, repayment and success.

Chapter 01: Dental chairs display

1.1. Introduction

The medical profession is one of the best and noblest in society. It is a profession of compassionate hearts that works in the service of mankind to relieve people of their feelings and pain. Doctors are angels of mercy who endure, suffer and tire in order to serve their patients and watch their comfort and see him well and recover.

The physicians' profession is one of the most difficult in society. It is one of the human occupations that society needs most. It is an old profession from the outset. It relied on simple prescriptions for doctors to try to heal their patients and then took the profession to develop and progress until it reached the use of all modern equipment and tools to work on the comfort of patients and treat them from their illnesses.

The study of medicine involves various specializations and disciplines, each doctor specializing in a specific field. Some medical specializations include cardiology, endocrinology, and neurology.

Dentistry is a branch of medicine that focuses on the study, diagnosis, treatment, and prevention of oral and dental diseases, as well as conditions affecting the face, jaws, teeth, and surrounding tissues. It encompasses several sub-disciplines.

Dentistry is a specialization within the Faculty of Medicine that deals with oral and dental health, as well as gum-related issues and other related matters.

Attention has been paid to human teeth since ancient times, with ancient civilizations working to solve dental problems, and Pharaonic civilization is the first to work in dentistry 3,000 years ago.

Successive cultures such as Greek and Arab cultures then developed this field, adding many recent discoveries to it.

One of the things that has been developed is the equipment and tools used by the dentist and its importance is the dental chair, which is considered as a versatile medical device and tools making it the basis of the dental clinic.

The dental chair has many medical tools and devices assisting the doctor's work that need a good installation and coordination to facilitate their control. What are the components of the dental chair? What is the principle of dental chair work? What are the ways of controlling it?

1.2. Dental Chair:

It is one of the most important equipment used in the dental clinic through which follow-up, examination and identification of the developments of the dental condition from all sides of the mouth. The chair is equipped with all the aspects that the doctor adjusts to examine the mouth besides the required lighting and places to put the inspection tools during the detection It helps the patient relax and helps the doctor to ease the examination, detection and modern types of electronic dentist chairs through touch that helps to operate, stop and control the chair system [1].

Figure 1.1: Dental chair

1.3. Dental Chair Device Components:

1.3. 1. Chair:

The main component of the dental chair device is the chair itself. It is designed to provide comfort and support to the patient during dental procedures.

Figure 1.2: Chair

1.3.1.1. Chair base:

This is the foundation of the dental chair and supports all other components.

Figure 1.3: Chair base

1.3.1.2. Chair backrest:

This is the part of the chair that supports the patient's back and can be adjusted for comfort.

Figure 1.4: Chair backrest

1.3.1.3 .Headrest:

The headrest is attached to the back of the chair and is used to support the patient's head and neck during dental procedures.

Figure 1.5: Headrest

1.3.1.4 .Armrests:

Armrests are located on both sides of the chair and are used to support the patient's arms during dental procedures.

Figure 1.6: Armrest

1.3.1.5. Footrest:

The footrest is located at the base of the chair and is used to support the patient's feet during dental procedures.

Figure 1.7: Footrest

1.3.2 .Pneumatic foot pedal:

pneumatic key ferry presses by foot to open the compressed air pass gate of air compressor.

Figure 1.8: Pneumatic foot pedal

1.3.3. Lighting arm: "Lamp arm"

A dental light is located above the patient's head and is used to provide illumination during dental procedures.

Figure 1.9: Lamp arm

1.3.4 .Arm machinery:

"Instrument arm" and sometimes called "tray" or **"** The tool holder **"**

1.3.4.1 .Arm machinery Components:

The tool holder consists of several components, namely:

1. Base: is the component that is installed on the arm of the device and in turn carries the rest of the components.

2. Arm: It is installed on the base and used to modify the angle and location of the tool holder.

3. Clamp: Used to install tools in the tool holder.

4. Detailed: Used to stabilize the clamp and allow it to move in all directions.

5. Handle: Used to adjust the angle and location of the clamp and the tools it carries.

6. Installation piece: used to install the tool holder on the machine arm.

7. Control tool: used to modify the angle and location of the tool holder.

Figure 1.10: Arm machinery

1.3.4.2. type of tools

Tools carried by a tool holder such as this type of tool can include:

1. Wrench: A tool used for gripping and turning nuts, bolts, and other objects.

2. Key screws: A tool used for turning screws with a specific head shape, such as Phillips or flathead.

3. Screwdriver: A tool used for turning screws with a flat or Phillips head.

4. Drill: A tool used for making holes in various materials.

5. Chainsaw: A mechanical saw used for cutting wood or other materials.

6. Hammer: A tool used for striking or driving nails, pins, or other objects into or out of materials.

7. Magnetic screwdriver: A screwdriver with a magnetic tip that holds screws in place.

8. Wire cutter: A tool used for cutting wires or cables.

9. Pipe installation key: A tool used for tightening or loosening pipe fittings.

10. Key to fuse installation: A tool used for installing or removing fuses in electrical systems.

11. Key to installation of electrical appliances: A tool used for connecting or disconnecting electrical appliances to power sources.

12. Key to the installation of sanitary ware: A tool used for connecting or disconnecting plumbing fixtures, such as sinks or toilets.

Figure 1.11: Arm machinery-2-

1.3.4.3. Tray holder:

This is a tray that can hold dental instruments and supplies within easy reach of the dentist or assistant.

Figure 1.12: Tray holder

1.3.5 .Spit and watercourses: "Cuspidor"

A cuspidor is a bowl or container used for spitting out saliva, typically. It is also referred to as a spittoon or spitting pot. The term "cuspidor" comes from the Latin word "cuspis," meaning "point" or "tip," as the original cuspidors were pointed at the top to prevent spills. Nowadays [2].

In the context of spit and watercourses, a cuspidor can be a potential source of contamination if not properly cleaned and disinfected. Saliva can contain various microorganisms, including bacteria and viruses, that can be transmitted through contact with contaminated surfaces or droplets. If a cuspidor is not emptied, cleaned, and disinfected after each use, it can become a breeding ground for harmful microorganisms.

Additionally, if a cuspidor is emptied into a sink or drain, it can contribute to the buildup of biofilm and organic matter, which can clog pipes and create an environment for bacterial growth. This can lead to foul odors and potential health hazards.

Therefore, it is important to follow proper infection control protocols and guidelines when using and cleaning cuspidors. This includes using disposable liners or cups, emptying and cleaning the cuspidor after each use, and disinfecting it with an

appropriate solution. By doing so, the risk of contamination and spread of infectious diseases can be minimized [3].

Figure 1.13: Cuspidor

1.3.6 .Auxiliary arm: "Assistant arm"

The auxiliary arm is part of the dental chair used to support the patient's mouth and head during dental treatment. It can be adjusted so that it moves independently to provide comfort to the patient and facilitate the treatment process for the doctor. It can also be used to install treatment tools and other medical equipment.

Figure 1.14: Assistant arm

1.3.7 .Radiation perspective: "X -Film viewer"

"X-Film viewer" is a device used in the dental chair to display X-ray radiation captured for teeth. X-movies are installed on the device and can be displayed by the doctor to analyze the dental condition and determine appropriate steps for treatment. This device helps improve the accuracy of diagnosis and reduce the risk of radiation exposure due to the unnecessary need to re-capture X-rays in case the image is unclear [4] [5].

Figure 1.15: X -Film viewer

1.3.8 .Air compressor:

Air compressor is an essential part of the dental chair, which is used to operate various medical instruments found in the clinic such as drill, sanitation, piston etc. The device is connected to the clinic's compressed air system, and it pumps the air with high pressure to operate medical instruments with high efficiency. Air pressure is controlled by a manually controlled control switch by the doctor or nurse. The air pressure device is one of the core parts of the tooth chair and helps improve the working efficiency and get accurate and effective results [6] [7].

Figure 1.16: Air compressor

1.3.9 -Doctor's Chair:

The dental chair contains many important and necessary parts of the dental treatment process, one of which is "Doctor's Chair." This chair is used to put the patient in a comfortable position suitable for examination and treatment. The doctor's chair has a set of buttons and switches that control the movement of the chair, where the height of the chair can be changed, melanized and rotated accurately and smoothly. In addition, the doctor's chair has padded pillows to provide comfort to the patient, and safety belts to safely install during treatment. The doctor's chair is one of the most important parts of the dental chair, helping to achieve the patient's comfort and facilitate the treatment process.

Figure 1.17: Doctor's chair

1.4. Working and Operating Principle

1.4.1 .Dental Chair

There are two systems where the dentist's chair works.

• Hydraulic system by hydraulic pump and tank and two pistons to climb the chair and descend it and the other to advance the backrest "backrest" and back it. And a set of electric valves, and to control this process by a set of electric buttons.

Working principle: When we press the ascent button, for example, we give a directive for the electric valve to open and at the same time there is also a directive for the pump to work where you will push the hydraulic to push the piston mounted at the bottom of the chair and the chair starts to go up.

When you stop pressing the button the pump will stop working and at the same time the valve is closed and the oil is not allowed to go back.

The rest of the operations are the same principle.

This system is expensive for many accessories and needs maintenance.

• The engine solenoid system is operated by a motor installed in a screw axis. When the motor rotates counterclockwise, the chair starts to rise; When the rotation turns clockwise, the chair begins to descend.

The same way the backrest works.

This system is inexpensive, economical and clean for lack of oil, as well as low breakdowns and easy to maintain (but loud and slow to move).

The chair's dimensions are dysfunctional, but most of them are around 180 × 175 × 85 cm. The weight is approximately 150 kg.

There are types of modern chairs operated by electronic cards with one touch running the system and another stop (processing panel - minicomputer).

The headrest proves its position and direction manually.

1.4.2. Side Unite.

Which consists of:

• Spit "Spittoon with water supply" and pipe processing.

• The mug water tube can be controlled by manual water tap or by an electrical button connected with an electric valve that opens when pressed.

• Another tube is running continuously to the spit and closing when finished, it can also work electrically.

• "Saliva Ejector" saliva absorbent operates with two systems, either by running water in the Venture tube and sucking saliva with runoff. Or by airflow and the more runoff the sucking increases.

• High volume suction device is powered by an electric suction motor, used in the case of surgical operations.

• Bottle for storage of compressed water for cooling and spraying cases during drilling machines work etc.

• Lighting arm: It has a halogen lamp with a capacity of 50-70W 12-24V, reflective to shine the lighting straight and center.

1.5. Conclusion

In the end, the dental chair is arguably an essential part of the dental world, helping to provide comfort and security for patients and doctors alike. To achieve this goal, the chair consists of several different components, including seat, backstops, medical tools, and electronic devices. The chair's work relies on modern and sophisticated technologies to provide a comfortable and effective medical experience. Thanks to these ingredients and techniques, doctors can perform the necessary treatments thoroughly and smoothly, while patients are satisfied and confident in the treatment they receive.

If we can say at the end, the dental chair is a modern geometric masterpiece that combines comfort with high performance, which is indispensable in the world of dentistry.

Chapter 02: Automated systems

2.1. Introduction:

However, modern technologies include not only a medical chair component, but also automated systems used in the treatment process. Among these automated systems, PLC and Arduino stand out as the latest techniques used in dentistry.

PLC (Programmable Logic Controller) systems are used in control of machinery and industrial processes, used in dentistry to control processes such as running water and air pumps, moving seats and medical tools. PLC systems feature easy programming and control, making them ideal for use in a sophisticated medical environment.

Arduino is an electronic system used in the design of various electronic devices, used in dentistry to control processes such as the operation of medical instruments, temperature control and lighting. Arduino is easy to use and learn, making it ideal for use in a medical environment where speed and precision are required in operations.

Thus, the use of PLC and Arduino systems in dentistry helps to improve health care quality and reduce costs, and helps to provide a more comfortable and effective medical experience for patients and doctors. This underscores the importance of technological innovation in improving the health-care sector in general and in dentistry in particular.

2.2. Programmable Logic Controllers (PLC)

The Programmable Logic Controllers (PLC) system occupies a specific place among the automation engineer, between the wired techniques and the computer means. At the first, he borrows simplicity, robustness and low cost; the latter, flexibility and the adaptability conferred by their programmable nature [8]. This work has a dual purpose:

present and explain the PLC as a machine, system and tool, in the context of programmable logics and in relation to its areas of application. This approach, although thorough does not imply on the part of the reader no particular computer

knowledge; - be a reference manual by analyzing and classifying information and data relating to ATMs programmable, their environment, their implementation, both technically speaking, economic and financial. In this regard, particular attention has been paid to assessment and selection criteria. It therefore addresses a broad range of category of readers, from the end user who wishes to learn the ATM or structure their knowledge, up to the decision-maker faced with an automation plan in project.

2.2.1. Definition

Programmable Logic Controllers (PLC) is a particular type of computer, robust and responsive, with physical inputs and outputs, used to automate processes such as machine control on an assembly line in a factory, or the operation of automatic handling systems. Where older automated systems used hundreds or thousands of relays and cams, a simple PLC is sufficient. The programmers of these APIs are called automaticians [9] [10].

Figure 2.1: Automate SIEMENS

2.2.2. General PLC structure:

The principal characteristics of a programmable industrial controller (PLC) are [11]:

Rack, box or cards

22

- Compact or modular

- Supply power

- Volume memory

- Backs up (EEPROM, stack, etc.)

- Inputs/Outputs Number

- Extra modules (analogue, communicating, etc.)

- Language of programming

APIs in waterproof are used for harsh environments (temperature, dust, spray hazard, etc.) supporting a wide range of temperature, humidity, etc. The industrial environment takes three forms:

- Physical & mechanical environment (dust, temperature, moisture, vibration);

- Chemist pollutant;

- Electrical perturbation. (Electromagnetic disturbance).

Figure 2.2: PLC units

2.2.3. Automated System Internal Organization (PLC):
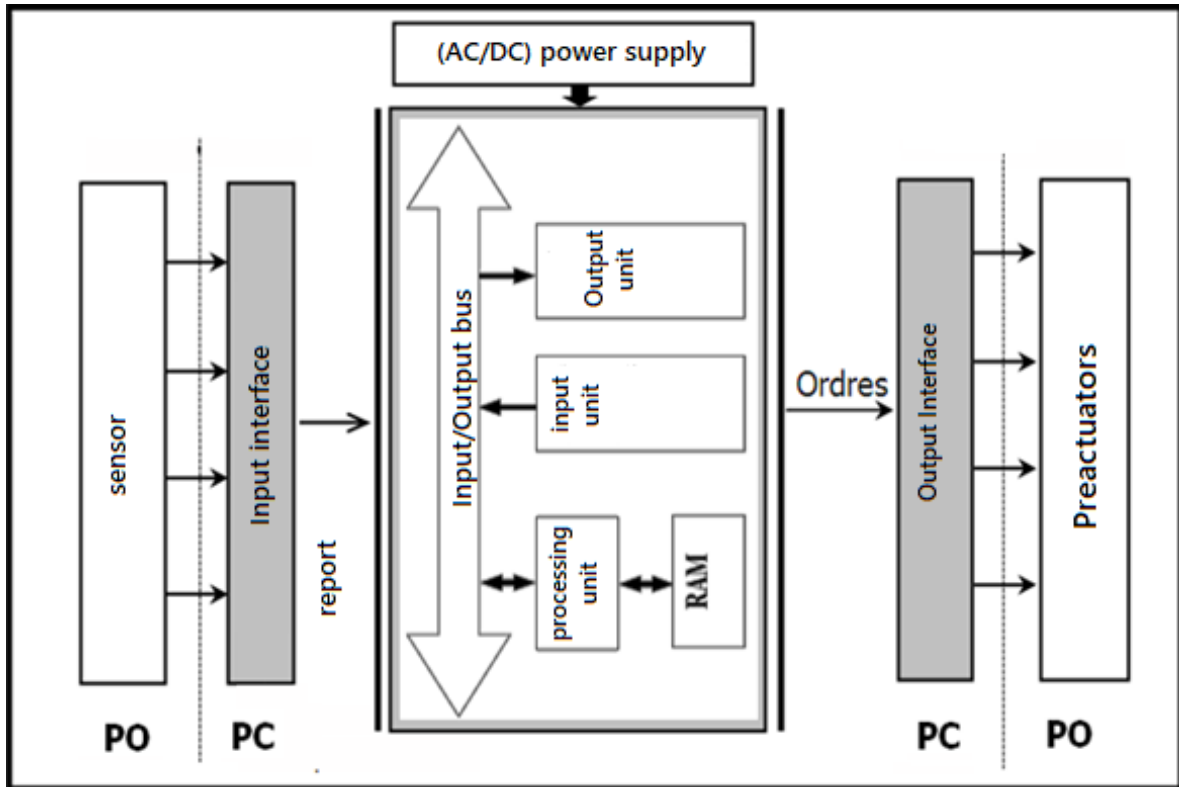
APIs have four main parts (Figure 2.3):

Figure 2.3: Internal structure of an industrial programmable automation system (PLC)

- A treatment unit (a CPU processor);

- A memory;

- Input-output modules;

- Input-output interfaces;

- A 230 V, 50/60 Hz (AC) - 24 V (DC) power supply.

The internal structure of an industrial programmable controller (PLC) is quite similar to that of a simple computer system [11].

The CPU is the grouping of the processor and the central memory. It controls the interpretation and execution of program instructions [12].

Instructions are performed one after the other, sequenced by a clock.

Two types of memory coexist:

- The program memory where the programming language is stored. It is usually frozen, that is to say read only. (ROM: ROM)

- Read-write data memory during operation is RAM (RAM). It is part of the input-output system. It freezes the values (0 or 1) present on the lines of inputs, with each cyclical consideration of it, it stores the calculated values to place on the outputs. [12].

2.2.4. Operating:

The pre-actuators are controlled by the programmable controller based on the program stored in its memory, taking into account the system's state information received.

Generally, programmable controllers used in industry operate in cycles (as shown in figure 2.4). Their microprocessors handle logical functions such as "AND" and "OR", timing, counting, and calculations. The microprocessor is connected to memory and input/output (I/O) interfaces through parallel links called 'bus', which transfer information in binary format. When the inputs and outputs are in sync, the processing cycle begins by considering the inputs stored in memory for the entire cycle duration [13][14].
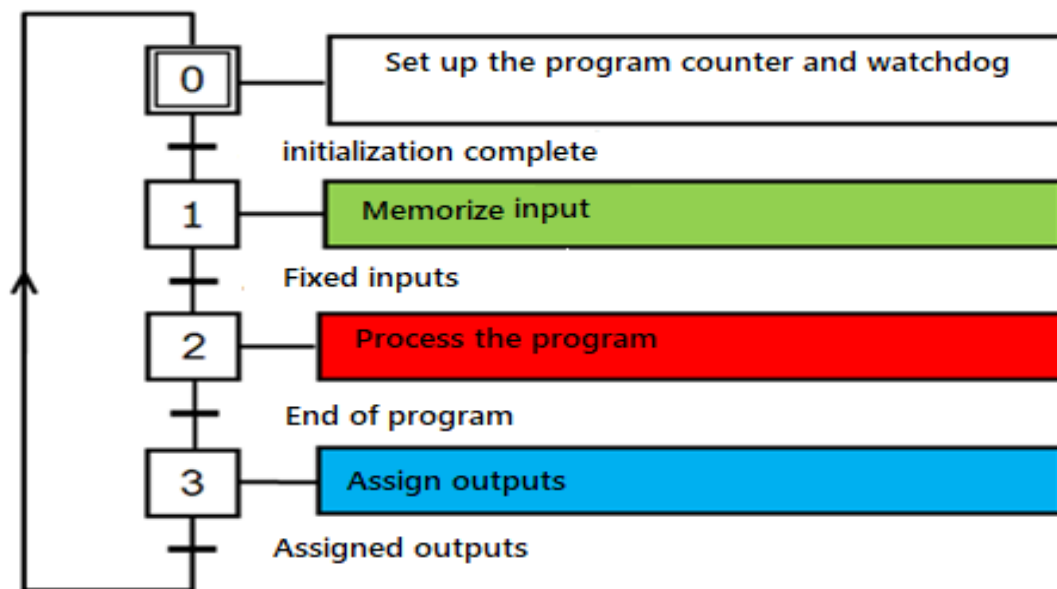

Figure 2.4: Cyclical operation of an API

eeAfter receiving the program instructions, the processor proceeds to execute them one by one, with the results being stored in memory after each instruction. Upon completion of the cycle, the outputs are influenced by a binary state through communication with relevant memories. It is worth noting that the response time to a

change in an input state may take between one and two cycle times, with the average duration of a cycle ranging from 5 to 15 milliseconds, as illustrated in Figure 2.5) [15].
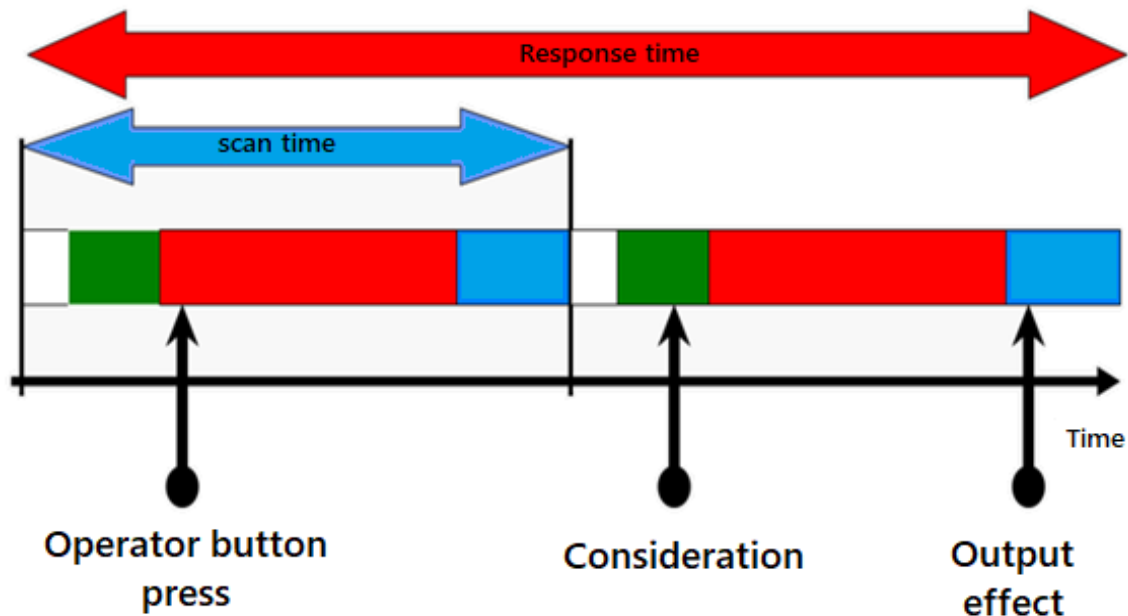

Figure 2.5: Polling Time vs Response Time

There are other, less common modes of operation:

synchronous with the inputs only;

asynchronous.

2.2.4.1. Memory:

The system is specifically designed to effectively receive, manage, and store a diverse range of information from various components such as the programming terminal being used (whether it's a PC or a console) and the processor which is responsible for the execution of the program. Moreover, it also receives valuable data from the sensors incorporated into the system.
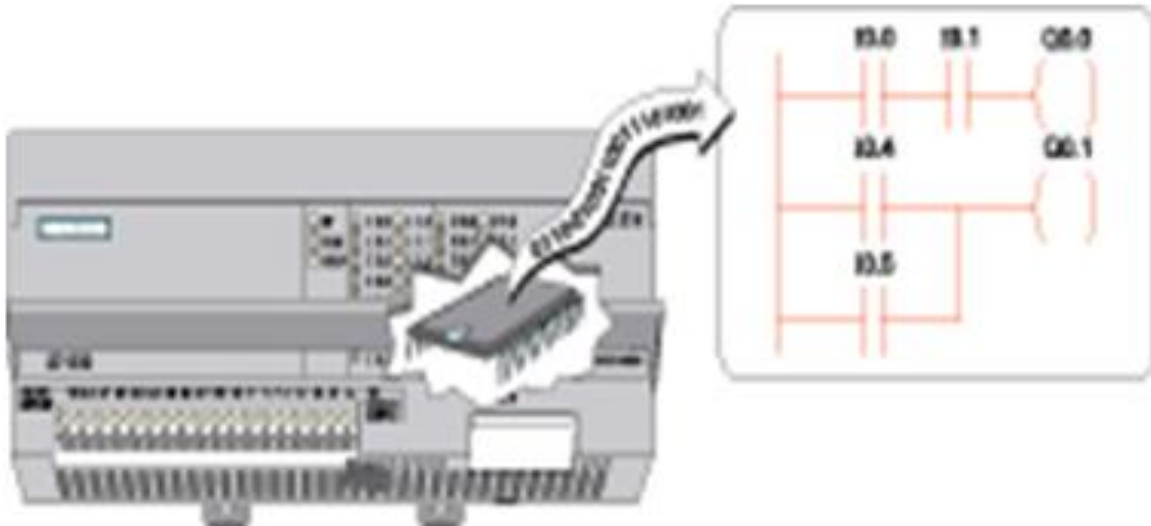
Figure 2.6: Memory

There are two types of memories in automatons that perform different functions [16]:

- The Language memory where the programming language is stored. It is generally frozen, i.e. in reading only. (ROM: dead memory).

- Memory Work usable for read-write during operation is RAM (live memory). It erases automatically when the controller stops (requires a backup battery).

Distribution of memory areas:

- Image table of entries
- Output Image Table
- Memory of internal bits
- Memorandum application program

2.1.4.2. The processor:

The role of the memory controller is twofold. Firstly, it is responsible for organizing the relationships between the memory area and the input/output interfaces. Secondly, it executes the program instructions [16] [17].

2.2.4.3. Interfaces and I/O cards:

The input interface of the system is equipped with particular input addresses, to which each sensor is connected. Similarly, the output interface of the system has

specific output addresses, and each fractionator is associated with one of these addresses [18].

The quantity of inputs and outputs in an automation can vary depending on its type. Generally, I/O cards come with modularity's of 8, 16, or 32 channels. The available voltages are normalized, ranging from 24, 48, 110, or 230 volts of continuous or alternating current [19] [20].
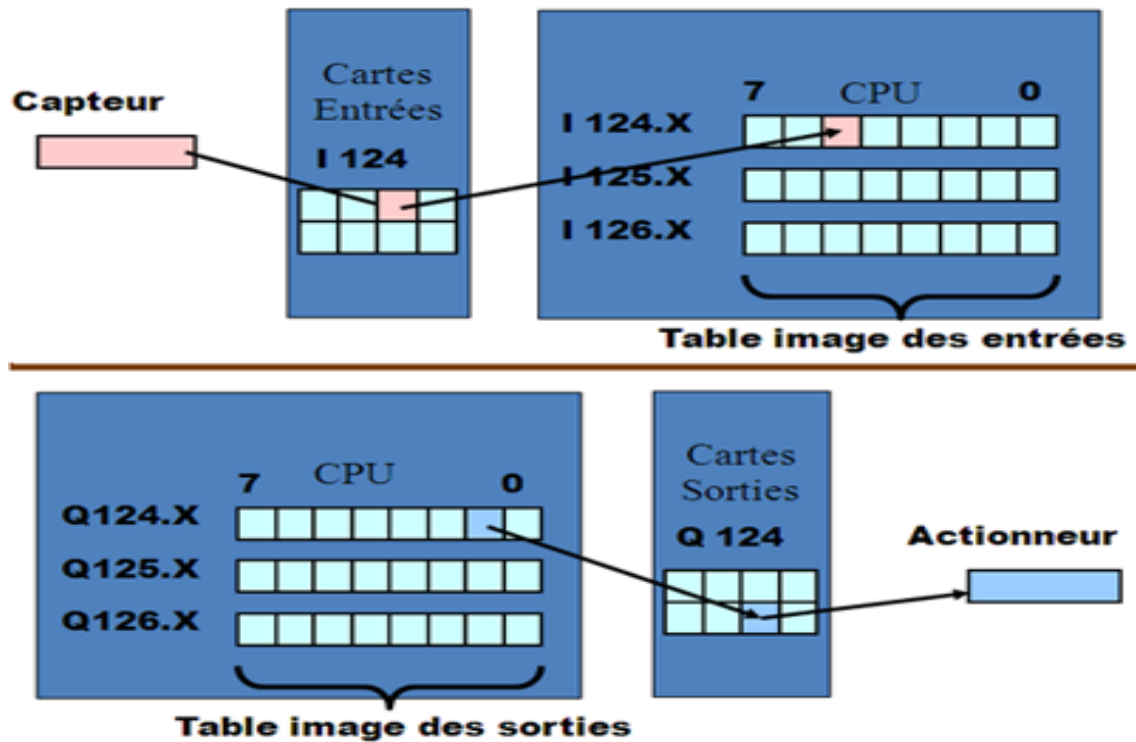

Figure 2.7: Input/output interfaces

2.2.4.3.1. Input cards:

Their purpose is to receive data from sensors, adjust the signal by formatting it, suppress interference, and electrically isolate the control unit from the operational component [18] [21].
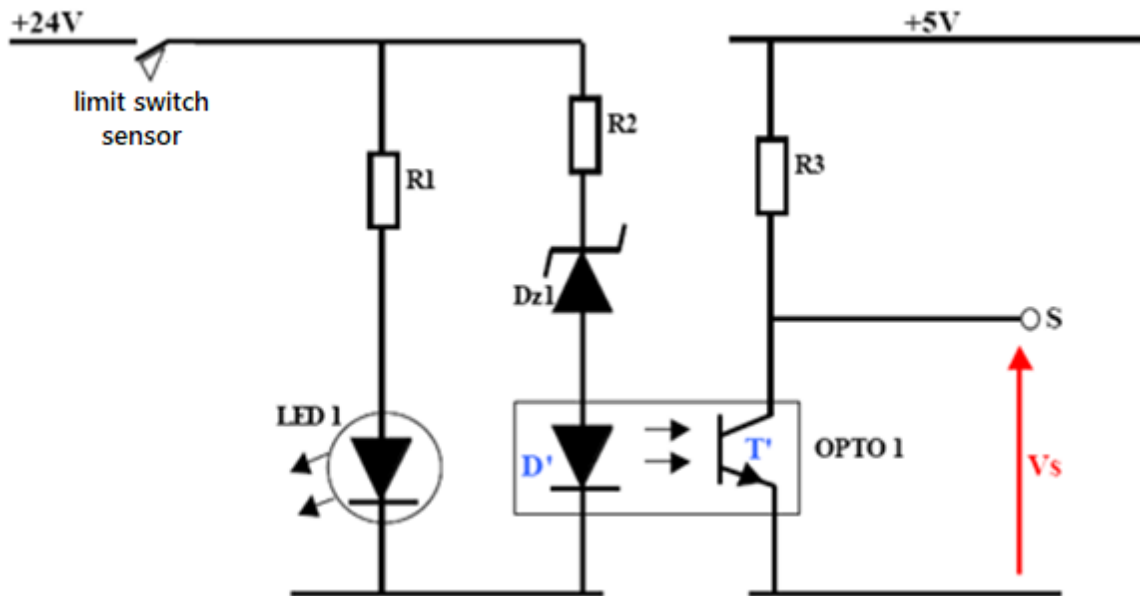
Figure 2.8: Example of a typical PLC input map

2.2.4.3.2. Output cards:

In order to ensure a galvanic isolation between the control unit and the operating part of the system, the pre-actuators and signalling elements are specifically engineered to regulate and adjust voltage levels of the control unit [22].
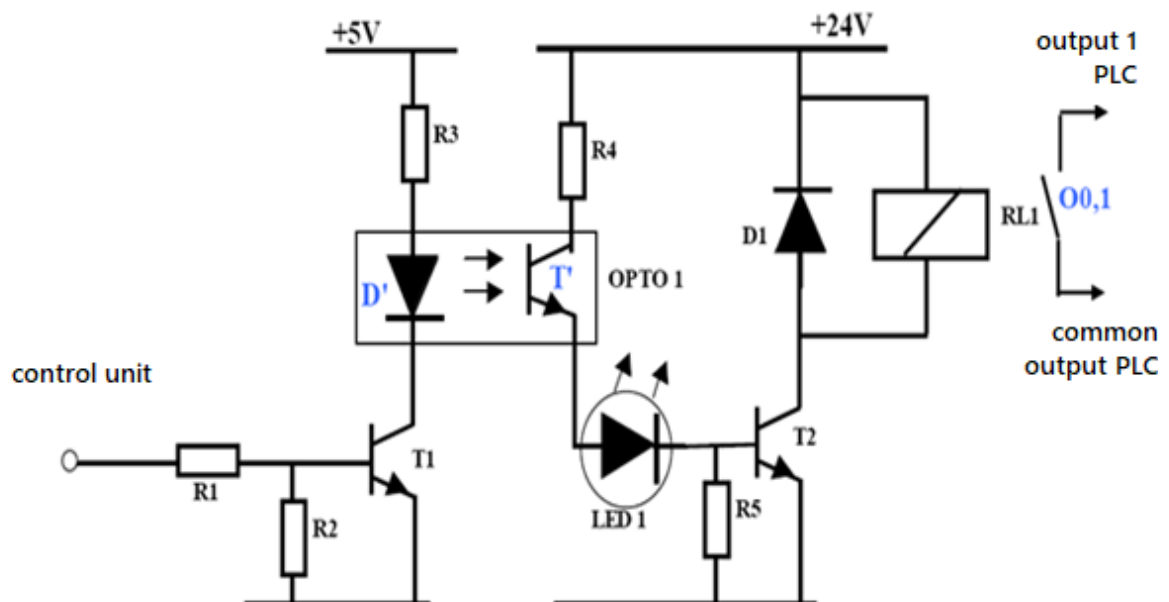

Figure 2.9: Example of a typical PLC output card

2.2.4.4. Models of cards:

- Fast counting boards: Fast card counting enables the collection of high-frequency data that cannot be processed within the time frame of a programmable logic controller (PLC) when receiving a signal from a position encoder [23].

- Axis control boards: are responsible for accurately positioning mechanical components along one or multiple axes. An example of this is the ability to operate a servomotor and obtain position information through an encoder. This enables precise closed-loop position control [24] [25].

- Analog input/output boards: are essential for microprocessor processing as they enable the acquisition of analog signals and their digital conversion. These boards also perform the inverse function of analog output. Normalization of analog quantities is typically done using either a 0-10V or a 4-20mA scale [25].

- PID regulation boards

- Weighing cards

- Communication boards (RS485, Ethernet...)

- Remote input/output cards

Figure 2.10: Example of Card

2.2.4.5. The power supply:

The current controllers are all furnished with a power supply of 240V, operating at 50/60Hz, and 24V DC. In addition, the inputs are set to 24V DC and grounding connections must be established [26].

2.3. Arduino

Arduino is a company that produces open-source hardware and software. Arduino-Community is a group of users who design and use microcontroller-based development panels called Arduino Units. These modules come in different images and are open-source testing platforms. The most commonly used language with Arduino is C language, and Arduino Library is constantly increasing thanks to open-source society. To start programming, you need to download the integrated development environment (IDE) from their website. Once you open the IDE, you can configure the panel and port settings to allow you to load the code. First, connect the Arduino panel to your computer via USB cable. Then, select the panel you use from the tool list and go to the board. If you use Uno or Uno-compatible version, select Arduino Uno. If you use another panel/copy, select it. Next, select the COM port to which the panel connects from the tool list and then the port. Your board must now be ready for programming, and you can start writing and loading the code [27].
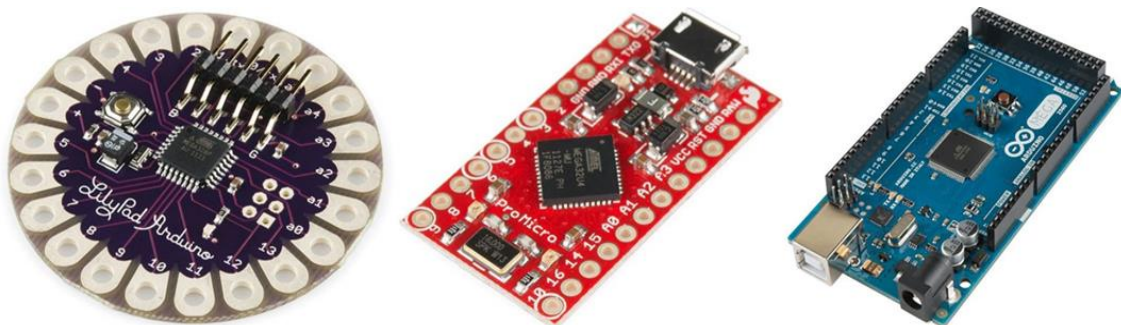

Figure 2.11:(From left to right) Lilypad, Sparkfun Pro Micro, Arduino Mega

The typical way of programming for Arduino is through the use of Arduino IDE, which runs on the C programming language. This option provides access to a vast and ever-growing library of Arduino, which owes its expansion to the open-source community [27] [28].
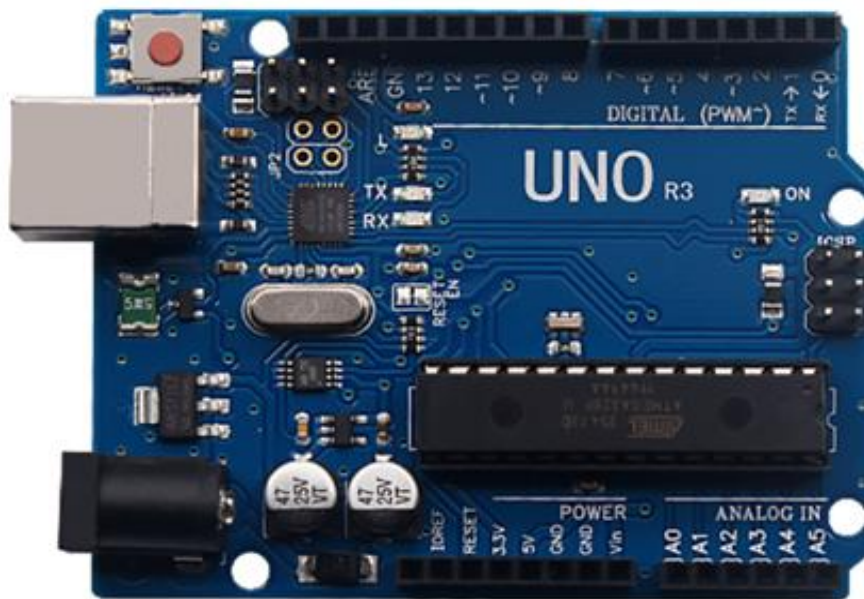
Figure 2.12: Arduino Uno R3 dev. Board

2.3.1. Arduino IDE: Initial Setup

The Arduino Integrated Design Environment (IDE) is a software where code editing can be done. In order to use it.

- One does require an Arduino board machine and compatible USB cable to connect to the computer.

- The latest version of the software (1.8.16) can be downloaded from https://www.arduino.cc/en/main/software.

- After turning on the plate and ensuring that power is being pulled from the USB connection, the green power index (PWR) will glow indicating that it has power.

- Once the program is up and running, one can start writing code. The picture in Figure 2.13 illustrates the Arduino IDE after it has been opened.
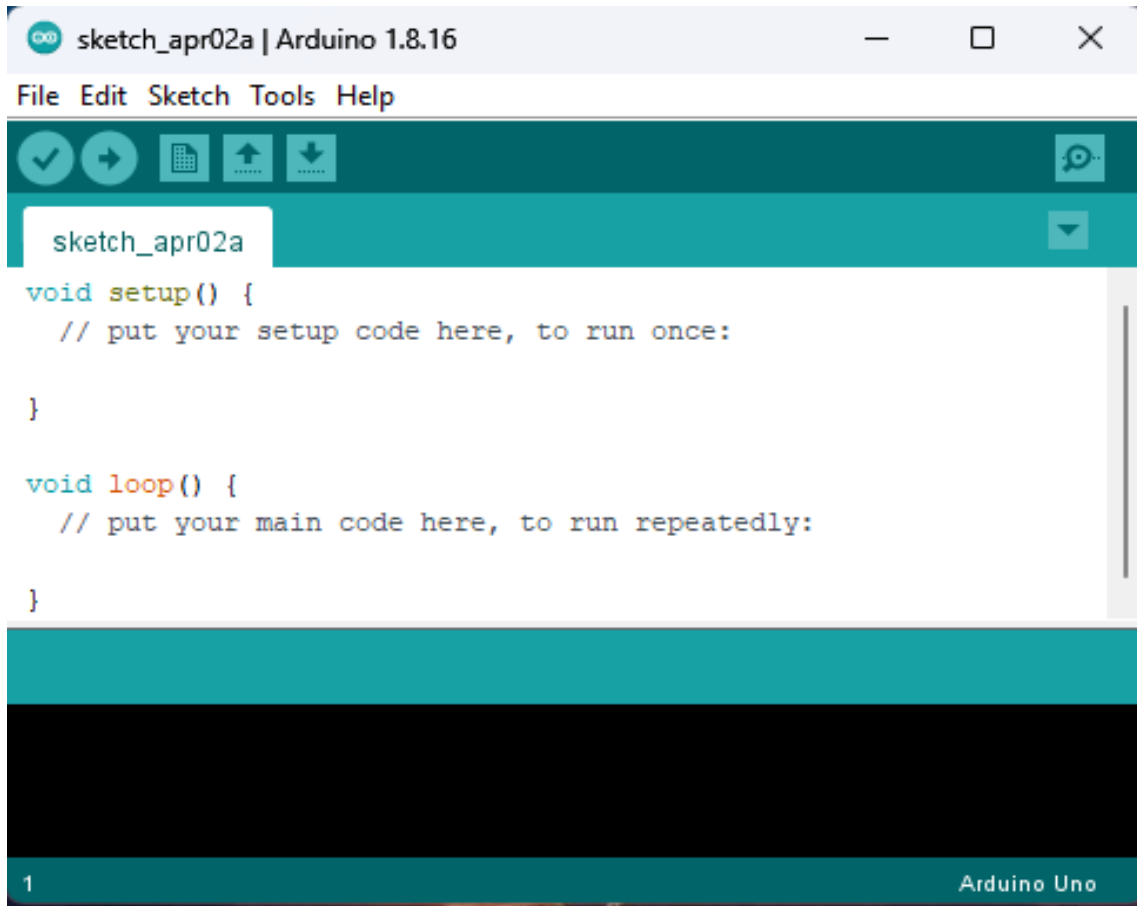
Figure 2.13: Arduino IDE Start Window

2.3.2. IDE: Board Setup

Once the software interface is visible, it is necessary to inform the Arduino IDE about a specific type of board onto which code needs to be uploaded. In order to achieve this, the list of tools located in the menu bar at the top must be accessed and navigated to the panel. It should be noted that this list comes pre-populated with all currently available Arduino boards that have been released by the Arduino team [27].

In case a reproduction board such as Funduino, Sainsmart, IEIK, or any other Uno-compatible board is being utilized, it is recommended to choose Arduino Uno. However, if a different type of board or copy is being used, it should be ensured that the particular board is selected in the settings. [29] [30].

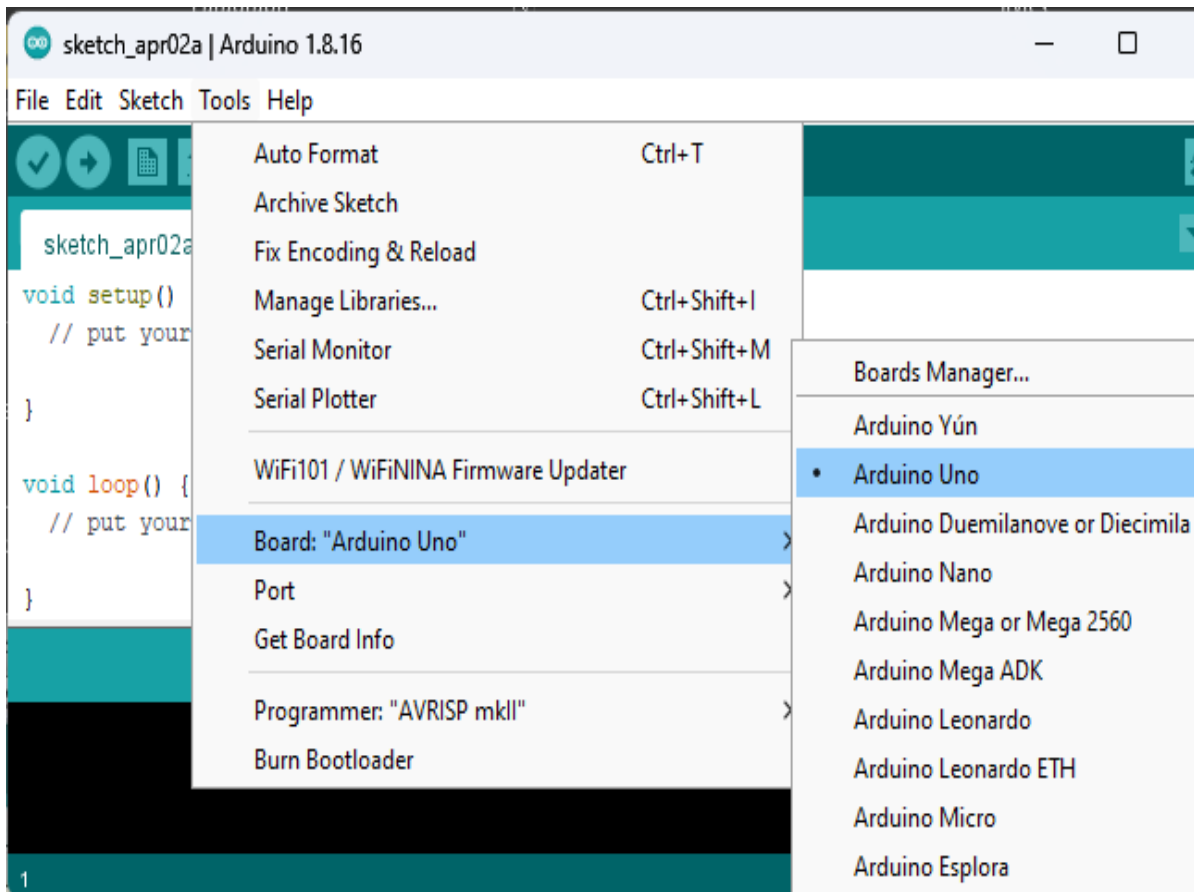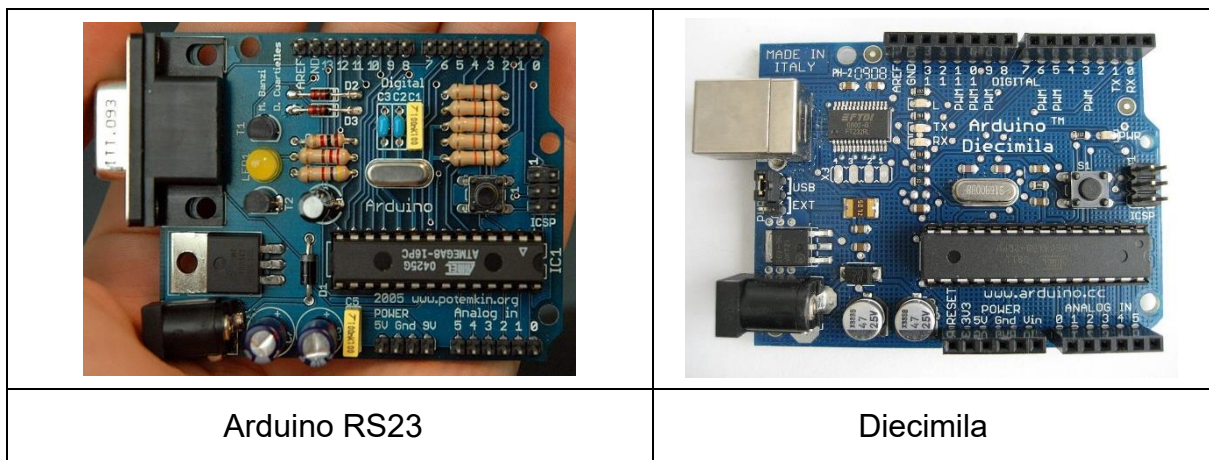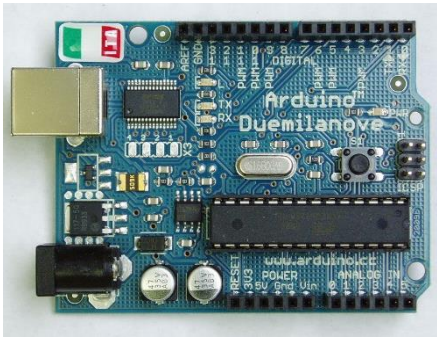The image (Figure 2.14) below shows the choice of the desired board type.

Figure 2.14: Arduino IDE: Board Setup Procedure

2.3.3. Official Boards:

In this table (Tab-1-) you find the most official and popular painting.

Tab-1-: Official Boards [31]

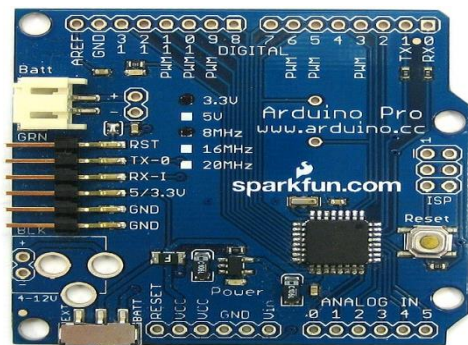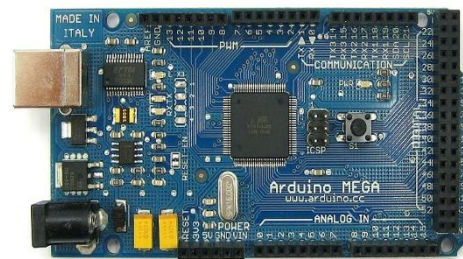|	
Arduino RS23	Diecimila

Duemilanove.	Uno R2 [32]
Uno SMD R3 [33]	Leonardo
Arduino Pro " sparkfun"	MEGA [34]
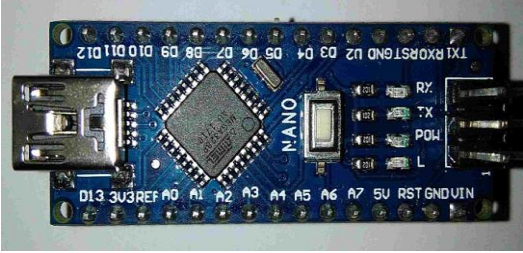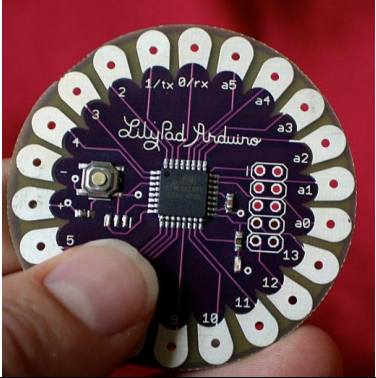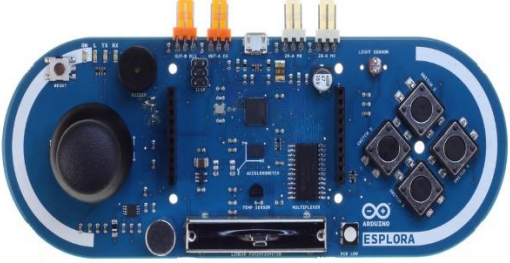
NANO [35]	Lily Pad 00
Robot	Esplora
Ethernet	YUN

2.3.4. IDE: COM Port Setup

Once the IDE is opened, the user should configure the board and port settings to allow for code uploading. The Arduino board can be connected to the computer via a USB cable. From there, the appropriate board can be selected from the tools list and then the user can select the menu tools and then com port. All of the available open com ports and any recognized Arduino boards will be displayed, and the user can then choose the appropriate port that connects to the board from the list. If the Arduino IDE was downloaded prior to connecting the board, the USB drivers should

be automatically installed upon connection. The latest version of the Arduino IDE should recognize the connected boards and classify them according to the com port they use. If the setup process is successful, the board type and com number should be visible at the bottom right of the Arduino IDE [27] [29].

Note that an available COM port is occupied by Arduino Uno; it will not always be shown as COM3 in the picture (Figure 2.15).
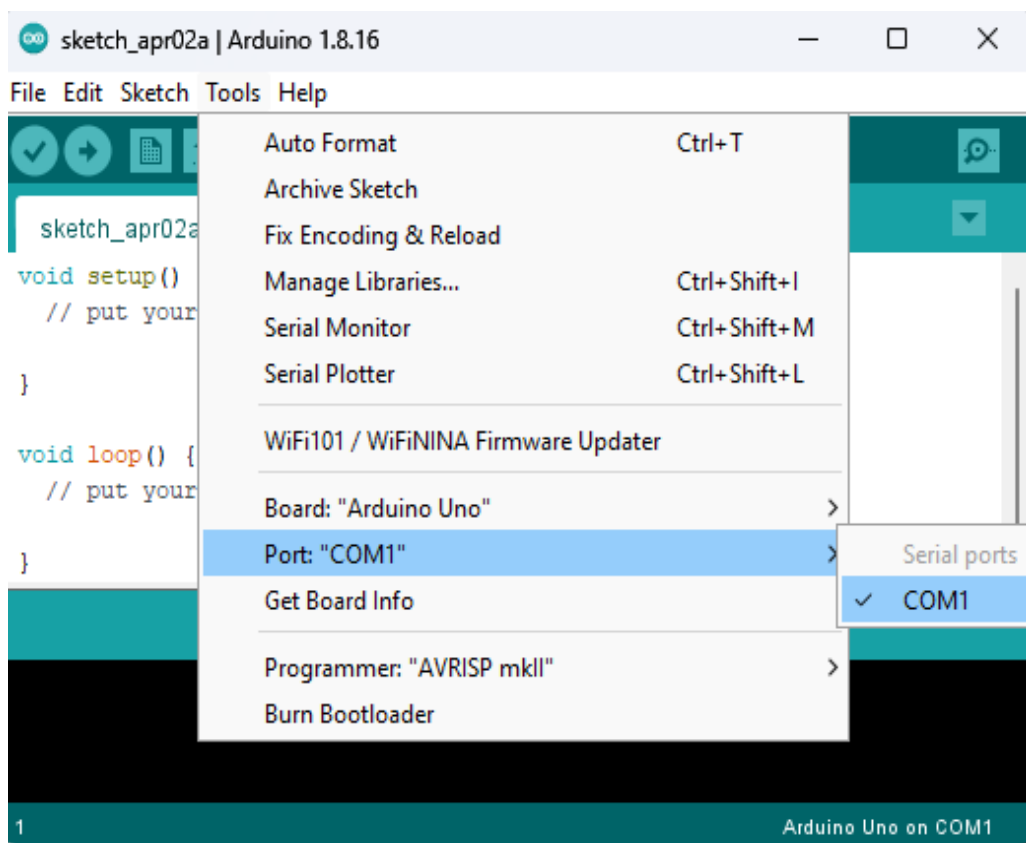
Figure 2.15: COM Port Setup in Arduino IDE

At this point, the board should be set up for programming, and one can begin writing and uploading code [27].

2.3.5. IDE: Code Structure " Sketch"

A program called a sketch is created using the Arduino IDE. The sketch is saved on the development computer as a text file with the file extension ".ino". Prior to version 1.0 of the Arduino software (IDE), the sketch was saved with the extension

".pde". The most basic program in C/C++ for Arduino consists of only two functions: setup() and loop() [36].

The setup() function is called once when the sketch starts after power-up or reset and is used to initialize variables, input and output pin modes, and other libraries needed in the sketch. This function is similar to the main() function in other programming languages [37].

The loop() function is executed repeatedly in the main program after the setup() function exits and controls the board until it is powered off or reset. This function is similar to a while(1) loop in other programming languages [37].

2.3.5.1. Manage Libraries

Like many other programming platforms, libraries are embedded in the program that provide essential functions and can import other libraries and expand the capabilities and features of the Arduino board. These libraries are roughly divided into those that interact with a particular component or that implement new functions.

To import a new library, one should go to sketch in the menu bar and then import library as pictured (figure 2.16) [38].
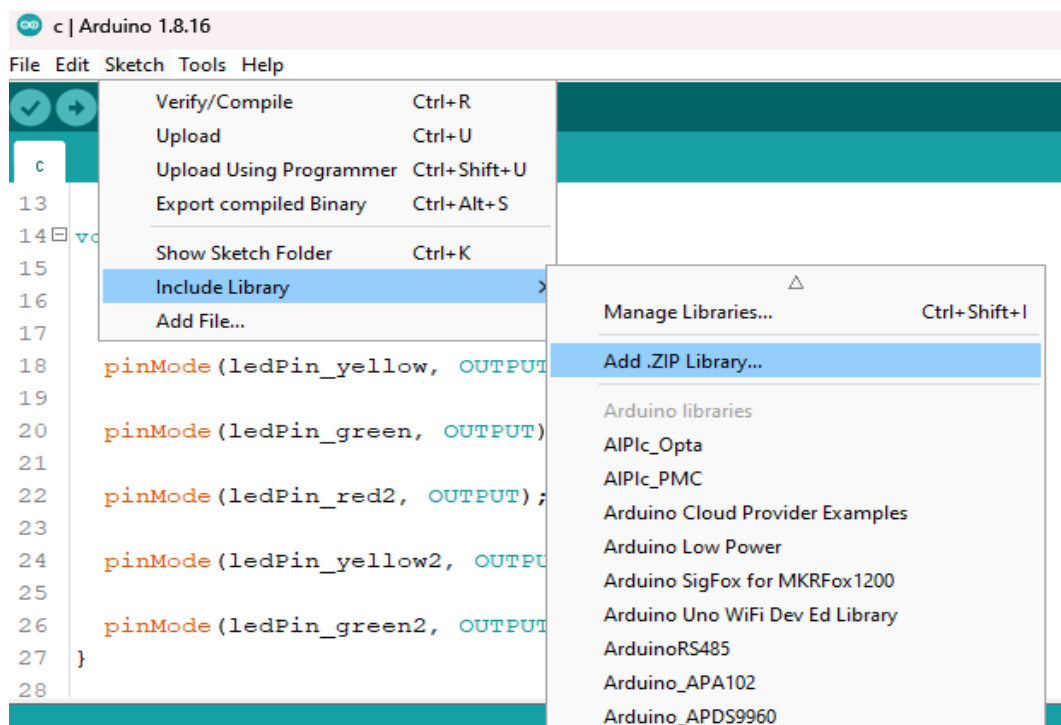
Figure 2.16: Import Library

The structure of the library and the declaration of all its variables and functions are described in the ".h" file within the IDE program. Meanwhile, the execution of the function can be found in the ".cpp" file. When there is a need to update a library that is already available in the list of libraries or when updating it for use in the code, the method is as follows: one must navigate to the list of tools for managing libraries and then search for the library to be used. After finding it, one should click on the installation as shown in photo (figure 2.17), which demonstrates the search and installation process. [38].

Figure 2.17: Manage Library

2.2.5.2. ARDUINO Pins:

The user needs to select their pin and its corresponding functions by utilizing the "define pinname pin number #" feature.

The function, whether input or output, can be chosen through the application of the pinMode() function, as demonstrated in the top section of the software coding example provided in the image (figure 2.18) [39].

2.3.5.3. Variable:

Value is stored for future use through storing data obtained from a sensor, for example. To advertise a variable, one can simply specify its type, name, and initial value.
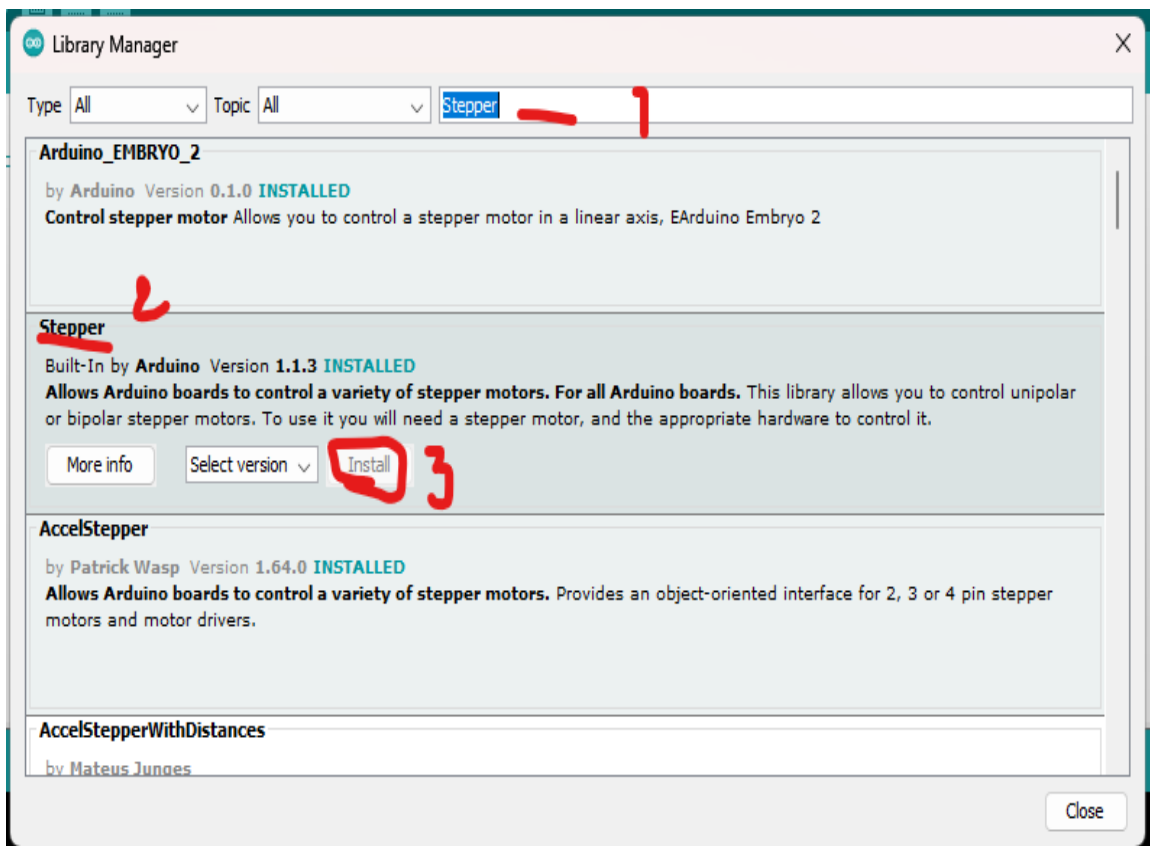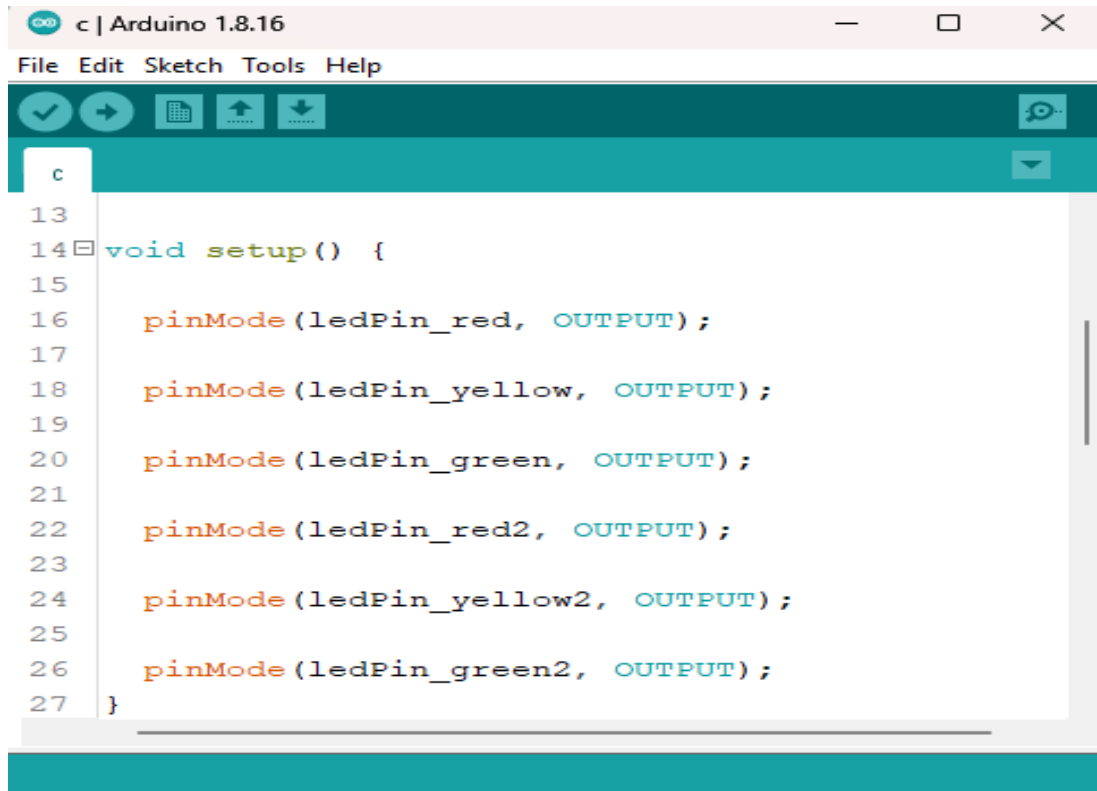
In class programming, a set of functions and variables are kept together in one place as instances.

Each category has a special function known as a constructor, which is used to create an analog to the category. To use category functions, the example needs to be advertised.

2.3.5.4. Setup():

Each sketch of Arduino is required to have a preparation function, which determines the initial condition of the device upon booting and is executed only once [39]. The following selection will be made here:

- o   The pin function is used in conjunction with the pinmode function.
- o   The initial case of Arduino pins was rephrased.
- o   The class configuration was reconfigured.
- o   Modifying variables to suit a particular context or situation.
- o   Methodology for writing code

Figure 2.18: Void Setup

2.3.5.4. Loop():

The "ring function" is a crucial component of every Arduino sketch. Once the setup is complete, this function is implemented as the main function of the sketch. This function operates continuously in a loop, driving the main logic of program [40].

Figure 2.19: Void Loop

2.3.6. Check and uploading:

After writing the code we check the existing errors by pressing Check Button:

 On the shortcut above the page

After checking the code, we upload it to the panel via USB by pressing

Upload Button:

Photo 2.20 showing used buttons

Figure 2.20: Shortcut

2.4. Conclusion

Ultimately, it can be argued that technology plays a crucial role in improving the quality of health care and saving costs, especially in dentistry. Thanks to ongoing

developments in this area, patients can now benefit from a more comfortable and effective medical experience, and doctors can benefit from more accurate and effective tools in treating patients. Therefore, investing in technology in the healthcare sector is a smart investment that helps improve patients' lives and improve the future of health care in general.

Chapter 03: Realization

3.1. Introduction:

In the world of electronics, designing electrical circuits is a crucial process that finds its application in numerous areas. This involves the use of various electronic components such as resistors, capacitors, converters, timers, and more, which necessitates the use of specialized software for their design and creation. This article will discuss the significance of power and control circuit design, as well as the protocols used in this field such as Arduino Uno, Servo Motor, Joystick, and Relays. Additionally, we will explore some free programs that can be used to create electrical circuits.

3.2. Control and design:

3.2.1. Power and control circuits:

3.2.1.1. The power circuits:

The power circuits of dental chairs vary from one company to another and from one model to another, but in general, the power circuit contains the following elements:

1. Voltage adapter: its function is to convert the voltage from household voltage to the appropriate voltage to power the motors in the chair.
2. Control Switch: Used to turn on and off the motors in the chair.
3. Engines: Used to power up, down, tilt and other movements in the chair.
4. Emergency battery: used for power outages to power engines for limited time.
5. *Protection devices:* used to protect the power circuit and engines from damage in case of any system fault.

We take Fedesa Astral dental chair as a model to work on:

The Fedesa Astral Dental Chair features a power circuit that has a 24V voltage adapter, and a control switch that can be used to control chair functions such as height, bending and rotation. It also has smooth and quiet engines to provide maximum comfort to the patient, and an emergency battery that ensures the continuity of running

the chair in case of power outages. It also includes protective devices such as overload protection and overcurrent protection to ensure user and patient safety.

The power circuit in the Fedesa Astral dental chair is one of the most important features that makes this chair ideal for use in dental clinics. This circuit consists of a range of important parts and components that work integrated to provide the best experience for patients and doctors.

This circuit includes the voltage adapter, which converts the high voltage into a low voltage as it converts the voltage from the AC current of 220v to the 24v DC current used to power engines and other devices in the chair. Which helps save energy consumption and improve work efficiency.

The power circuit also includes a cooling and heating system, which helps to provide a comfortable temperature for patients during treatment. These ingredients are highly efficient and flexible, helping to provide a comfortable experience for patients at all times.

3.2.1.2. The control circuits:

We also find the chair control system, which controls the lifting, lowering, tilting and other movements of the chair, such as automated systems, micro control and other systems. In our experience, we used Arduino as a control system.

In the control circuit, we find Arduino UNO card and compressors to control side parts such as water faucet and joystick to control the chair position such as height, bending and rotation.

3.2.2. Protocols and Design:

3.2.2.1. TB6600 4A 9-42V Stepper Motor Driver Controller:

This is a professional two-phase stepper motor driver which offers both speed and direction control. It features a 6-dip switch which allows you to customize the micro step and output current. With a total of 7 micro step options (1, 2 / a, 2 / b, 4, 8, 16, 32) and 8 current control options (ranging from 0.5a to 3.5a), this driver provides a high level of precision and flexibility. Additionally, all signal terminals utilize high-speed optocoupler isolation, which helps to enhance its anti-high-frequency interference capability.

3.2.2.1.1. Features:

 ➢ Support eight types of current control.

 ➢ Support 7 types of adjustable micro steps.

 ➢ Interfaces are equipped with high-speed optocoupler isolation.

 ➢ Automatic semi-flow mechanism to minimize heat.

 ➢ Large heat sink for wider surface area.

 ➢ The ability to resist high-frequency interference.

 ➢ Anti-reverse protection for input.

 ➢ Protection against overheating, over-current, and short circuits.

Figure 3.1: TB6600 Stepper Motor Driver Module

3.2.2.1.2. INPUT & OUTPUT:

• Signal Input:

 ➢ PUL+   Pulse +

 ➢ PUL-   Pulse -

 ➢ DIR+   Direction +

 ➢ DIR-   Direction -

 ➢ EN+ Off-line Control Enable +

 ➢ EN- Off-line Control Enable -

- Motor Machine Winding:

    - A+   Stepper motor A+
    - A-   Stepper motor A-
    - B+   Stepper motor B+
    - B-   Stepper motor B-

- Power Supply:

    - VCC   VCC (DC9-42V)
    - GND   GND

3.2.2.1.3. Electrical Specification:

Tab-2-: Electrical Specification:	
Input Current	0~5.0A
Output Current	0.5~4.0A
Power (MAX)	160W
Micro Step	1, 2/A, 2/B, 4, 8, 16, 32
Temperature	-10~45°C
Humidity	No Condensation
Weight	0.2 kg
Dimension	96*56*33 mm

3.2.2.2. Stepper motor

Stepper motors have different phases that help to align the rotor. Therefore, it is possible to convert out-of-phase pulse trains into angular displacements.

Since the sequence sent to achieve a given displacement is known, the position can be known without additional sensors and the motor can be precisely controlled in an open loop.

Figure 3.2: Stepper motor " NEMA17"

Basic code :

```
1  #include <Stepper.h>
2  const int stepsPerRevolution = 200;  // change this to
3  // for your motor
4  // initialize the stepper library on pins 8 through 11:
5  Stepper myStepper(stepsPerRevolution, 8, 9, 10, 11);
6  void setup() {
7    // set the speed at 60 rpm:
8    myStepper.setSpeed(60);
9    // initialize the serial port:
10   Serial.begin(9600);
11 }
12 void loop() {
13   // step one revolution  in one direction:
14   Serial.println("clockwise");
15   myStepper.step(stepsPerRevolution);
16   delay(500);
17   // step one revolution in the other direction:
18   Serial.println("counterclockwise");
19   myStepper.step(-stepsPerRevolution);
20   delay(500);
21 }
```

Figure 3.3: Basic code for Stepper motor

3.2.2.3. Joystick

The joystick can be in various places, such as a game controller, toy controller, or even a large real machine such as an excavator controller.

It is composed of two potentiometers square with each other, and one push button. As a result, the joystick provides the following outputs :

- An analog value (from 0 to 1023) corresponding to the horizontal position (called xs-coordinate)

- An analog value (from 0 to 1023) corresponding to the vertical position (called y-coordinate)

- A digital value of a pushbutton (high or low)

The combination of two analog values can create 2-d coordinates with the center being values when the joystick is in the rest position. The real direction of the coordinates can be identified simply by running a test code (in the next part). Some applications may use all three outputs, while others may only use some of the three outputs.
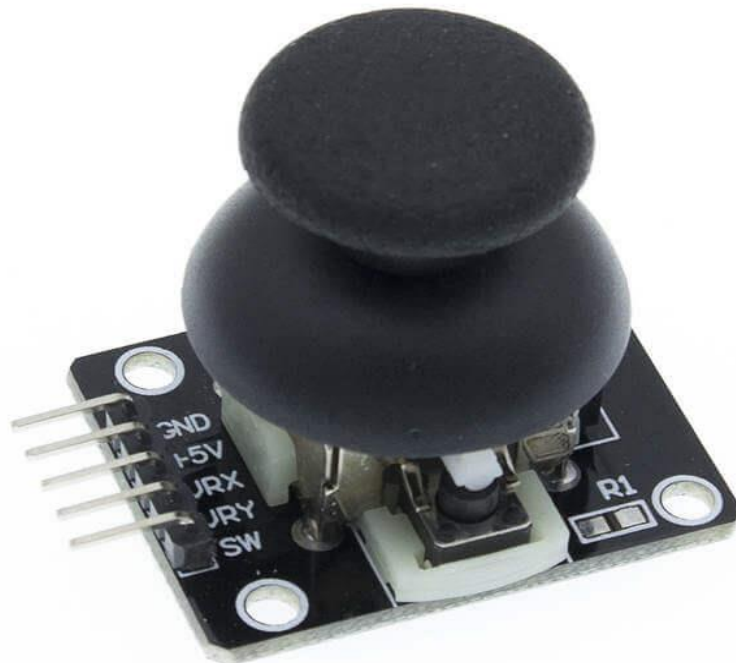

Figure 3.4: JOYSTICK Arduino

Five pins are found on a joystick:

- the GND pin that must be connected to 0v/GND
- the VCC pin requiring a connection to 5v
- the VRX pin those outputs an analog value corresponding to the joystick's horizontal position or x-coordinate
- the VRY pin those outputs an analog value corresponding to the vertical position or y-coordinate
- the SW pin - the output from the joystick's pushbutton which is typically open. If a pull-up resistor is utilized in this pin, the sw pin will be high when pressed and low when released.

How to work :

When the joystick's thump is pushed to the left or right, the voltage in the VRX pin is altered within a range of 0 to 5v (0 on the left and 5v on the right). The corresponding voltage value is directly proportional to the thump's position, resulting in a reading on the analog pin of the Arduino between 0 and 1023 .

Similarly, when the joystick's thump is pushed up or down, the voltage in the VRY pin is changed within the same range of 0 to 5v (0 when pushed up and 5v when pushed down), resulting in a corresponding voltage value that is proportional to its position and a reading on the Arduino's analog pin within the same range.

When the joystick's thump is pushed in any direction, the voltage in both VRX and VRY pins is altered in proportion to its position on each axis .

Furthermore, if the joystick's thump is pushed from top to bottom, the in-built pushbutton is engaged, causing a change in the output of the SW pin from 5v to 0v. By using a pull-up resistor in the SW pin, the reading value on the Arduino's digital pin is changed from high to low.

How to program for joystick:

The joystick has two parts: analog (X, Y axis) and digital (pushbutton).

For the analog parts (X, Y axis), it just needs to read the value from analog input pin by using analogRead() function.

```
#include <Joystick.h>
#include <AccelStepper.h>

// Define the stepper motor pins
#define STEPPER_PIN_1 8
#define STEPPER_PIN_2 9
#define STEPPER_PIN_3 10
#define STEPPER_PIN_4 11

// Define the joystick pins
#define JOYSTICK_X A0
#define JOYSTICK_Y A1
void setup() {
  // Set the speed of the stepper motor
  stepper.setMaxSpeed(MAX_SPEED);

  // Set the joystick pins as inputs
  pinMode(JOYSTICK_X, INPUT);
  pinMode(JOYSTICK_Y, INPUT);
void loop() {
  // Read the joystick values
  int joystickX = analogRead(JOYSTICK_X);
  int joystickY = analogRead(JOYSTICK_Y);

  // Map the joystick values to a range of -100 to 100
  int joystickXMapped = map(joystickX, 0, 1023, -100, 100);
  int joystickYMapped = map(joystickY, 0, 1023, -100, 100);
```

Figure 3.5: program control stepper motor with joystick

3.2.3. Design:
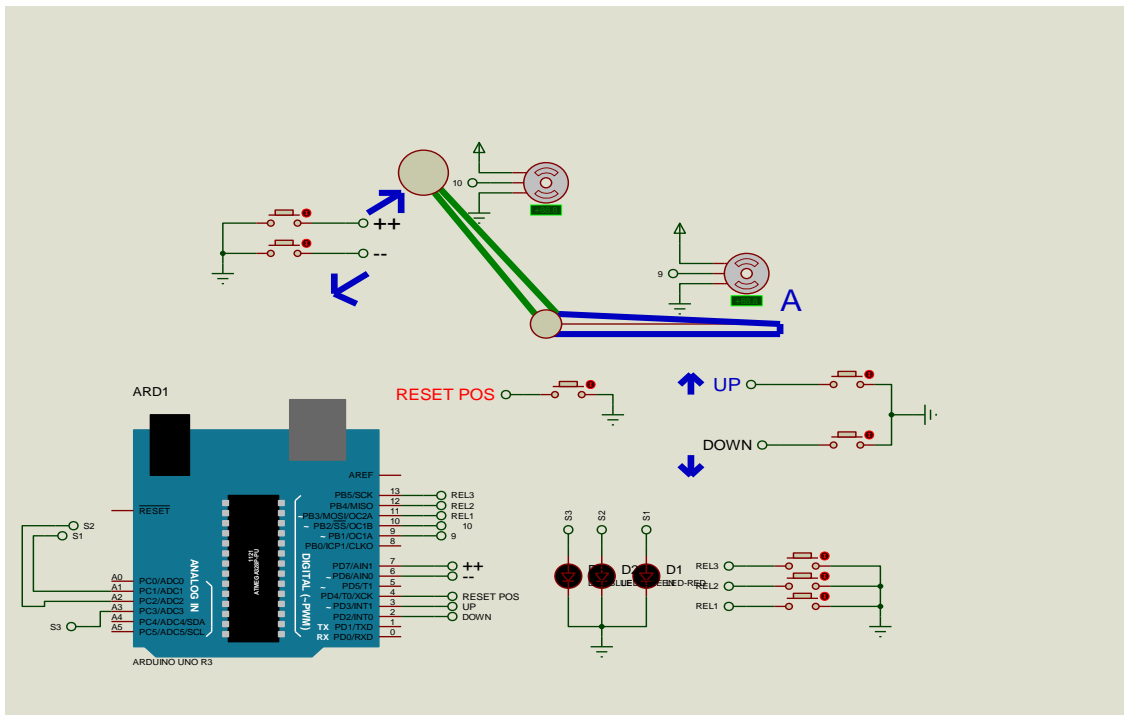
Figure 3.6: Design

3.3. Prototype:

Prototypes are an experimental process where design teams implement ideas in making concrete forms Teams build prototypes with varying degrees of accuracy to capture and test design concepts on users.

So, it was our share that we created a prototype dental chair that works by Arduino and its movement is controlled by Joystick using 2 NEMA 17 step motor in backrest motion and NEMA 23 in chair base movement.
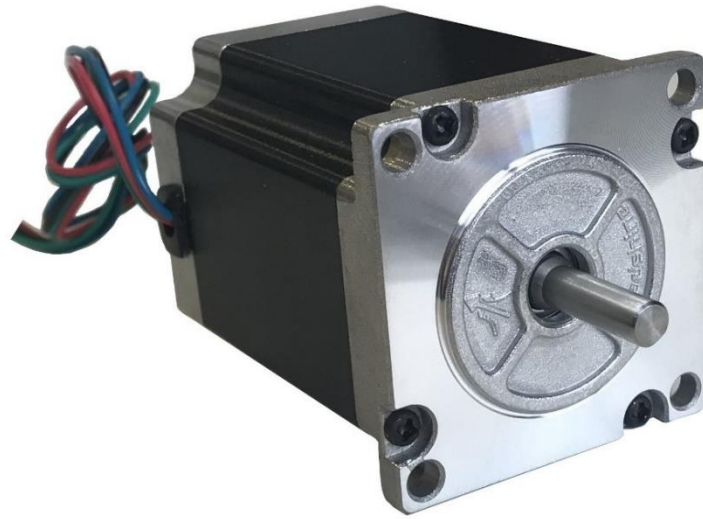
Figure 3.8: Stepper Motor "NEMA23"

3.4. Conclusion:

Despite all the obstacles to prototype formation, it is a good prototype that works smoothly and balanced, and these are some of the images of the prototype.

Figure 3.9: Prototype

Conclusion:

1. General

Using machine systems in medicine, doctors can improve diagnostics and treatment processes and improve patient care in general. As these techniques continue to evolve, health care is expected to be significantly improved in the future. It is essential that doctors and patients benefit from the benefits of these technologies and that they are effectively used to improve the quality of health care and as a contribution from us we have listed Arduino as an automated dental chair control system to simplify maintenance and as we know Arduino is a tool for making devices that can capture and control things from the world of devices more than your computer. It is an open source programmed electronics platform based on a simple accurate control card, a real integrated development environment program, to write, assemble and transfer the software to the Arduino card. In order to achieve the desired goal in this work, many software are assembled in order to achieve such a result.

2. Problems encountered

This achievement is not without difficulties. It should be noted that we have had several problems, particularly in reconciling the parts to obtain the required performance. However, it can be said that despite these difficulties, the results achieved through this, whether practical or theoretical, have opened the door for further studies.

3. Project perspectives

It is our fervent hope that this project will serve as a foundation for others and undertake further studies to integrate them into more complex systems.

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