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SMART CHARGING SYSTEM

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ملخص

استجابةً للحاجة المتزايدة إلى حلول شحن آمنة وذكية للهواتف المحمولة في الأماكن العامة، يقدّم هذا المشروع تصميم وتطوير محطة شحن ذكية للهواتف. يتكوّن النظام من عدة خلايا شحن فردية، تحتوي كل واحدة منها على حامل آمن ونظام تحكّم ذكي يعتمد على التحقق ببصمة الإصبع. يهدف هذا الشاحن إلى ضمان حماية فعالة للجهاز، وتحديد هوية المستخدم، وتوصيل الطاقة بشكل آمن. وسيتولى منطق تحكّم متقدّم إدارة عملية الشحن، موفّرًا الحماية من الشحن الزائد ومنع الوصول غير المصرّح به. يهدف هذا المشروع التعاوني إلى توفير حل موثوق وسهل الاستخدام لمستخدمي الهواتف الذكية في البيئات العامة، دون الاعتماد على الطاقة الشمسية أو واجهة عرض.

Résumé

En réponse au besoin croissant de solutions de recharge sécurisées et intelligentes pour les téléphones portables dans les espaces publics, ce projet propose la conception et le développement d’une station de recharge intelligente pour smartphones. Le système se compose de plusieurs cellules de recharge individuelles, chacune équipée d’un support sécurisé et d’un système de contrôle intelligent basé sur l’authentification par empreinte digitale. L’objectif de ce chargeur est d’assurer une protection efficace de l’appareil, d’identifier l’utilisateur et de fournir une alimentation électrique en toute sécurité. Une logique de contrôle avancée gérera le processus de recharge, en offrant une protection contre la surcharge et en empêchant tout accès non autorisé. Ce projet collaboratif vise à fournir une solution fiable et facile à utiliser pour les utilisateurs de smartphones dans les lieux publics, sans recourir à l’énergie solaire ni à une interface d’affichage.

ABSTRACT

In response to the growing need for secure and intelligent mobile charging solutions in public spaces, this project presents the design and development of a smart phone charging station. The system consists of multiple individual charging cells, each equipped with a secure holder and intelligent access control via fingerprint authentication. The charger is designed to ensure effective device protection, user identification, and safe energy delivery. Advanced control logic will manage the charging process, providing protection against overcharging and unauthorized access. This collaborative project aims to offer a reliable and user-friendly solution for smartphone users in public environments, without relying on solar energy or display interface.

Acknowledgement

First and foremost, we express our gratitude to God, for without His guidance and facilitation, we would not have been able to accomplish this work. We owe Him our thanks for the patience, strength, and determination He has granted us.

We extend our sincere appreciation to our esteemed supervisor, Dr. Abdul Wahab Khatara, for his continuous support and wise guidance throughout the various stages of this project. His expertise and dedication have significantly impacted the successful completion of this endeavor.We also wish to express our deep gratitude to the respected members of the discussion committee for accepting to evaluate this humble work, as well as for their valuable time and insightful feedback.

Lastly, we would like to convey our heartfelt thanks to all the professors who have accompanied us throughout our academic journey, for the knowledge and guidance they have provided.We hope that this project will serve as a tangible step towards realizing innovative entrepreneurial ideas that contribute to the development of technological solutions aimed at public use, particularly in the field of smart phone charging.

LIST OF FIGURES

Abbreviation

Wireless: A method of communication that does not require physical cables; data is transmitted through electromagnetic waves.

Wired: A method of communication using physical cables to transmit data or power.

AC: Alternating Current, an electric current that periodically reverses direction.

DC: Direct Current, an electric current that flows consistently in one direction.

RF: Radio Frequency, a type of electromagnetic wave used in wireless communication systems.

USB: Universal Serial Bus, a standard interface used for connecting peripherals and transferring data.

LCD : Liquid Crystal Display, a type of flat-panel screen commonly used in electronic devices.

PIN: Personal Identification Number, a numeric code used for user authentication and access control.

Table of contents

Chapter 01 : Advancements in Phone Charging Technologies a Technical Insight

Chapter 02 : Modelisation of a smart charging system

Chapter 03:Prototype, design and impremention

General introduction

GENERAL INTRODUCTION

The demand for portable products is rapidly increasing, with no signs of slowing down in the near future. Alongside this growing demand, user expectations for advanced features and enhanced capabilities have also risen. As a result, energy consumption has become a central factor in overall performance. Key aspects such as how long a device can operate before needing a recharge, how quickly it can be recharged, and the battery's durability over time have become essential criteria influencing the user experience. This highlights the importance of having a solid understanding of battery types and various charging techniques.[1]

Smartphones have become an integral part of our daily lives, serving multiple roles in productivity, entertainment, and communication. With rapid technological advancements, these devices have grown increasingly powerful and efficient, leading users to rely on them more than ever across various aspects of life. However, this growing dependence has raised concerns about battery life and whether smartphones can keep up with such intensive usage. To address this challenge, several advanced charging technologies have emerged, including fast charging, wireless charging, reverse charging, and smart charging systems that utilize artificial intelligence to optimize charging efficiency and reduce energy consumption.[2]

With the continuous rise in smartphone usage and the increasing reliance on mobile devices throughout daily life, the demand for practical and secure charging solutions in public settings has become more pressing than ever. In response to this challenge, the concept of a smart charging system was introduced—one that rethinks how users interact with public charging infrastructure. Rather than offering basic power outlets, this system focuses on delivering a more intelligent and user-centric experience through the design of modular smart charging cell.

Developed using SolidWorks, the design of this system incorporates advanced features such as fingerprint authentication and intelligent power management. These features are intended to enhance both the security and efficiency of the charging process. The goal is to create a scalable and reliable solution that addresses the growing dependence on mobile devices, while simultaneously ensuring device safety, optimizing energy consumption, and meeting the need for accessible charging options in public spaces.

Chapter 01

Advancements in Phone Charging Technologies a Technical Insight

1 Introduction

In recent years, there have been significant advancements in battery charging technology, particularly due to the prevalent use of portable devices like smartphones, tablets, and smartwatches. These innovations have concentrated not only on increasing charging speeds but also on implementing smarter and more efficient techniques to improve user experience and ensure the safety of devices. The range of options has expanded to include fast wired charging, wireless charging, reverse charging, and sophisticated power management systems, all of which have become more advanced and varied. This evolution highlights the increasing demand for effective solutions to accommodate the intensive daily usage of mobile devices.

FIGURE1.1: THE EVOLUTION OF THE MOBILE PHONE BETWEEN 1973-2014 [17]

2 Wirrless -Wired technology and history

Wireless charging technology facilitates the convenient transfer of power from a source, such as a charger, to a device, such as a smartphone, across an air gapeliminating the need for cumbersome wiring. This form of wireless power transfer operates without physical connections, relying instead on electromagnetic principles.[4]

The origins of wireless power transmission trace back to the late 19th and early 20th centuries, a period marked by groundbreaking advancements in electromagnetic research. These early innovations laid the groundwork for contemporary methods of electrical energy transfer. Over the past two decades, rapid progress in wireless technologies has reignited interest in this field. The resurgence has been fueled in part by renewed attention to the theories and inventions of Nikola Tesla, which have captured public imagination and inspired new research into practical applications.[4]

Numerous scientists and inventors have contributed to the evolution of wireless power. A closer look at their backgrounds reveals their motivations and research methodologies. Their pioneering work addressed complex challenges and established core theories that underpin today's wireless power systems. The patents, academic papers, and experimental results they produced serve as valuable documentation of the technology's practicality and potential.[4] Wireless power transmission is primarily classified into three modes: conduction, induction, and radiation. Each mode is governed by specific theories that describe how electromagnetic waves can effectively carry power from a transmitter to a receiver without the use of physical conductors. These principles provide a theoretical framework for understanding and improving wireless energy transfer technologies.[4]

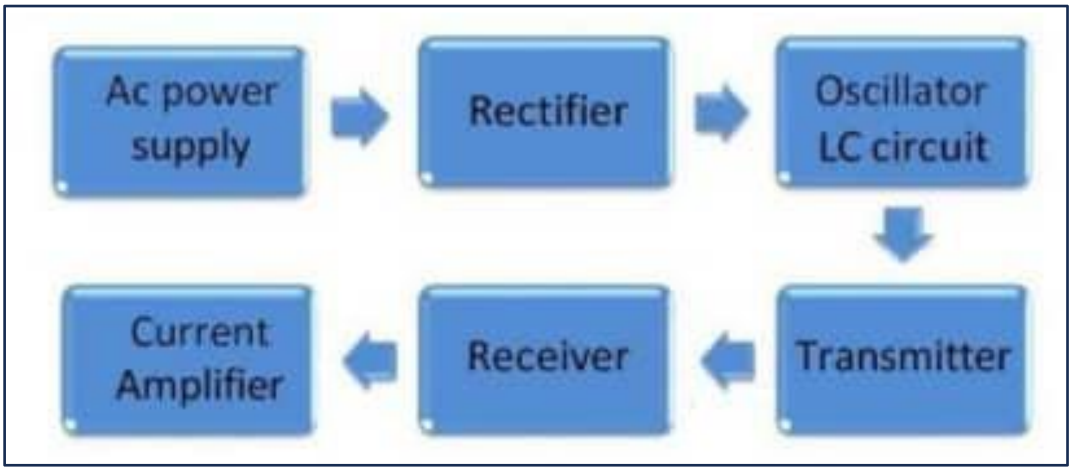

FIGURE1.2: BLOCK DIAGRAM OF WIRELESS[5]

2.1 Wireless charging techniques

2.1.1 Inductive coupling technique

A wireless charging system utilizing magnetic resonance coupling, an advanced variant of inductive coupling, functions by creating an alternating current (AC) signal in the transmitter circuit. This signal is wirelessly conveyed through radiating components that act as transmitter coils, generating a fluctuating magnetic field. When a receiver coil is placed within this magnetic field, electromagnetic induction induces an electric current. Subsequently, the receiver circuit converts the AC signal into direct current (DC), which is appropriate for charging mobile devices. This approach facilitates effective power transfer over short distances without requiring physical connectors, rendering it highly suitable for contemporary wireless charging solutions.[6]

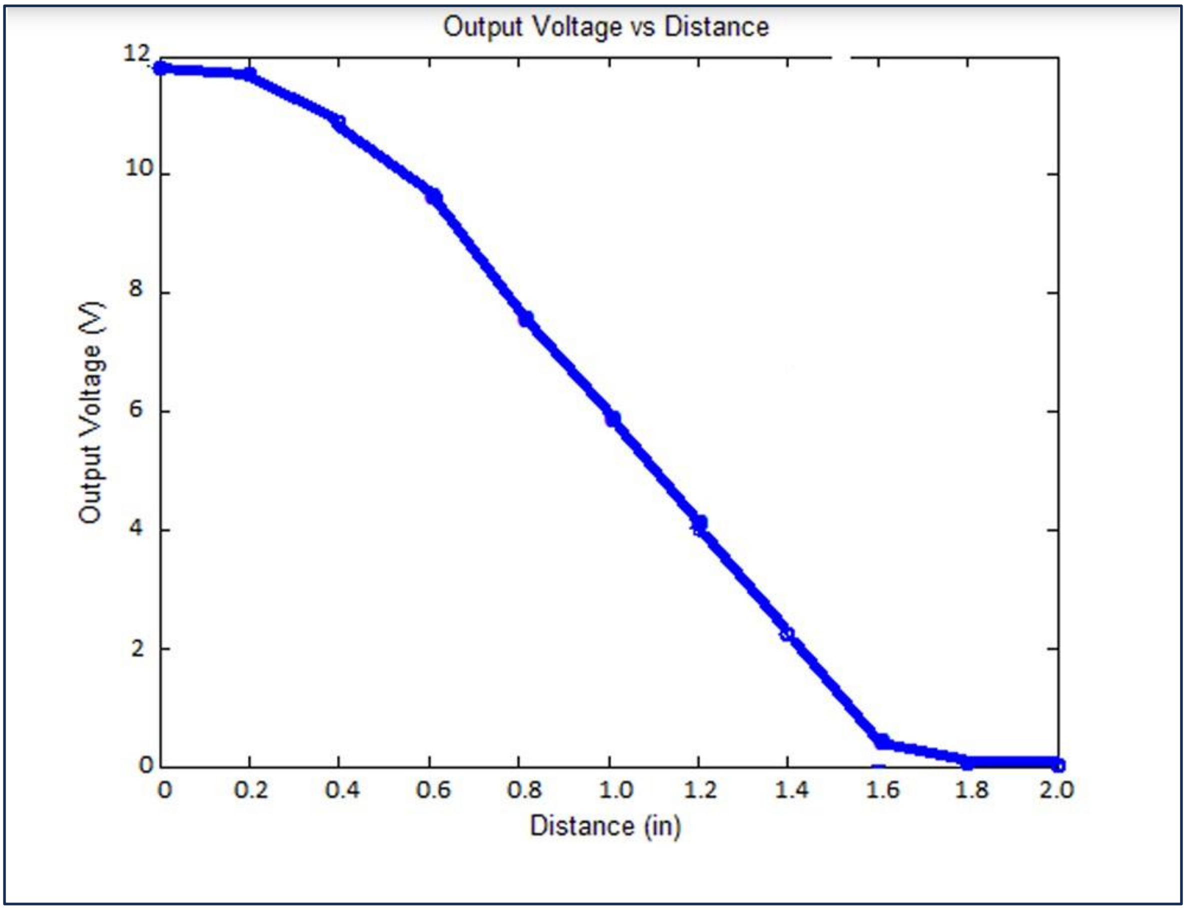

FIGURE1.3: GRAPH BETWEEN VOLTAGE AND DISTANCE[7]

2.1.2 Magnetic resonance coupling technique

The Magnetic Resonance Coupling technology employed in the proposed system is based on the principle of wireless electrical energy transfer through the magnetic field generated by alternating current, avoiding the need for energy radiation techniques that necessitate long-distance energy transmission. This system utilizes near-field technology, allowing energy transfer over short distances through the magnetic resonance interaction between two identical frequency coils (radiators). An alternating current (AC) signal at a frequency of 10 megahertz is generated using a Wien Bridge Oscillator circuit built on an operational amplifier (Op-Amp) within the transmission unit. This AC current produces an oscillating magnetic field in the transmitting coil, and when the receiving coil is positioned nearby and tuned to the same resonant frequency, it induces a current in the receiving coil via electromagnetic induction. After the energy is received, the alternating current is converted into direct current (DC) using a rectification circuit that includes a voltage doubler based on germanium diodes, which are characterized by their low threshold voltage, thereby enhancing energy conversion efficiency. This concept is widely applied in wireless charging applications that require high efficiency in energy transfer over short distances.[8]

2.1.3 RF Radiation

The technology of charging through radio frequency radiation (RF Radiation) relies on transmitting energy via radio or microwave waves, which typically travel through the air at the speed of light in a direct manner. The process begins with the conversion of alternating current (AC) into direct current (DC), which is then transformed into radio frequency (RF) signals using a device known as a 'magnetron' within the transmission unit. These waves propagate through the air to reach a receiving device equipped with a specialized antenna called a 'rectenna,' which subsequently converts these waves into usable electrical energy (DC) for charging the device. Although other wave types, such as infrared or X-rays, could be utilized, safety concerns limit their application. This technology is considered a promising method for wirelessly charging phones and devices from a distance without the need for cables or direct contact with the charger.[4]

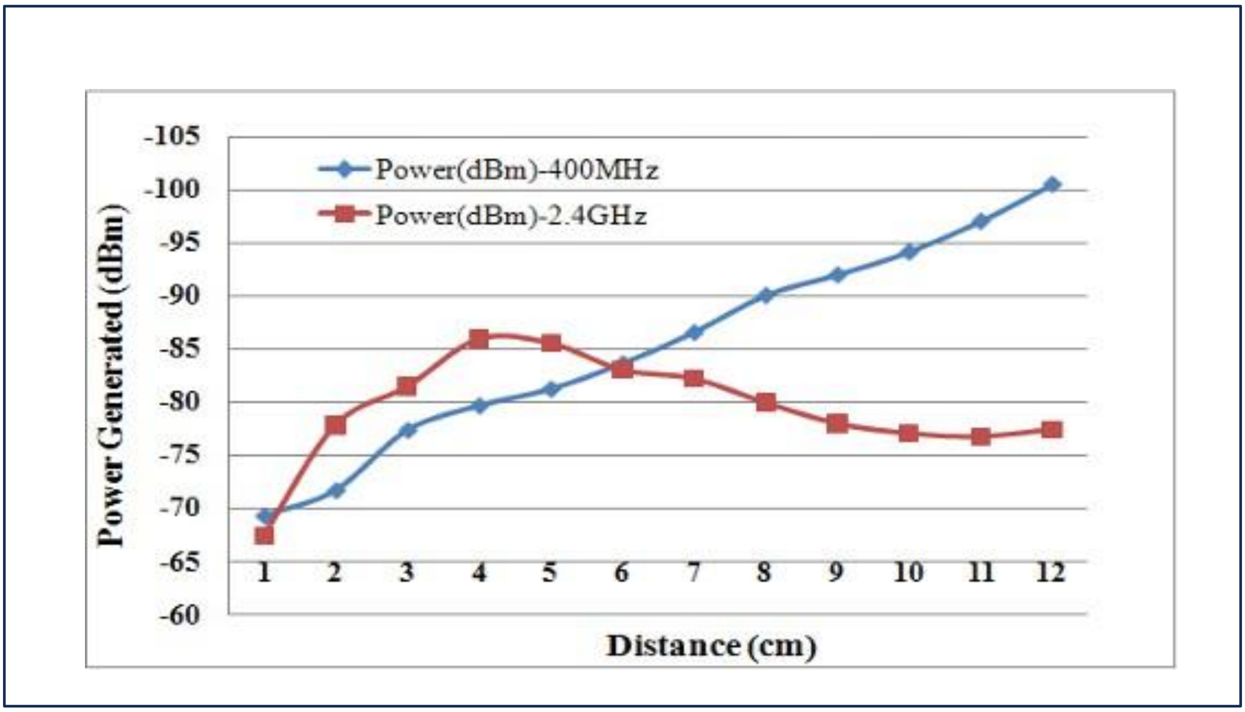

FIGURE1.4: POWER GENERATED AT VARIABLE DISTANCE FROM 13DBM RF SOURCE[9]

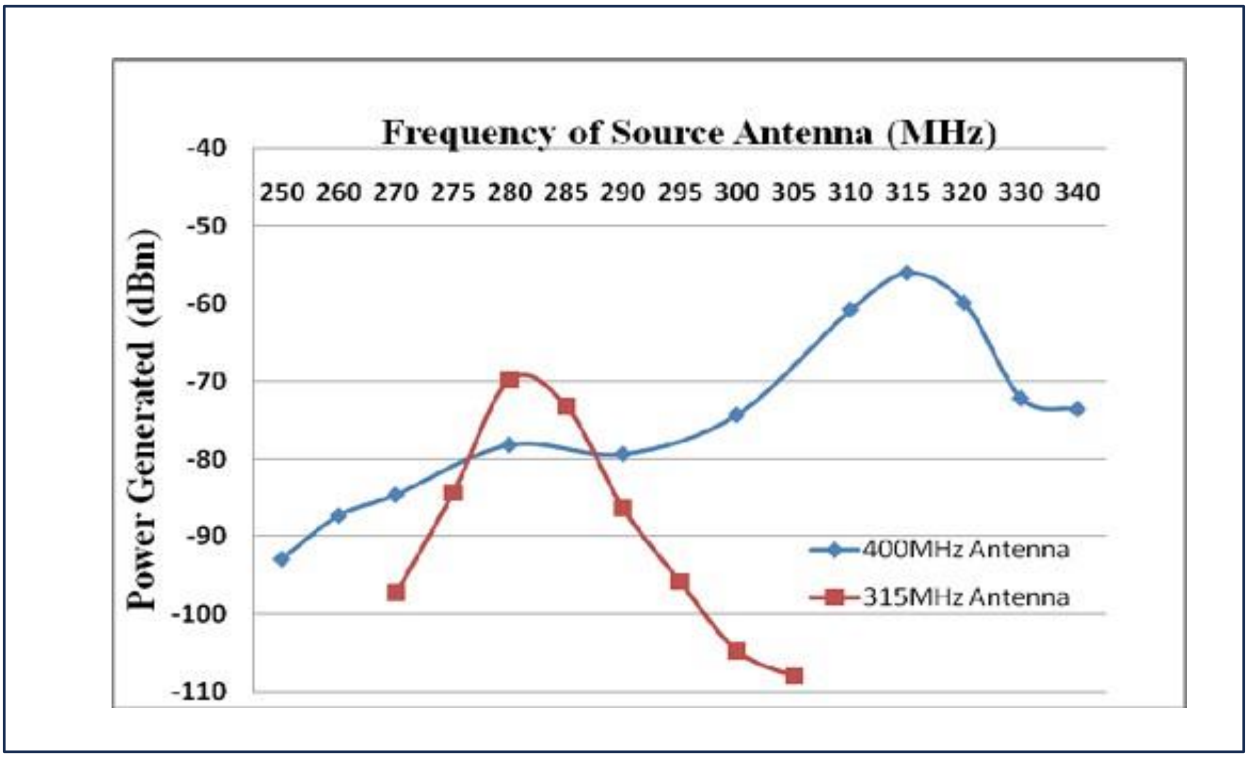

FIGURE1.5: OUTPUT POWER AT 2CM FROM 13DBM RF SOURCE[9]

2.1.4 Advantage and disadvantages of Wireless charging technique

2.1.4.1 Inductive coupling technique (advantages)

This technique is widely acknowledged as being safe for use in human-related applications, posing minimal risk during operation. One of its most notable characteristics is the simplicity of its design, which allows for seamless integration into a wide range of technological and industrial systems. This structural straightforwardness not only reduces the complexity of implementation but also minimizes the need for extensive modifications or specialized training. As a result, the method has seen significant adoption across various sectors. Its growing popularity is primarily due to its consistent reliability and user-friendly nature, both of which make it an attractive solution for developers and end-users alike.[4]

2.1.4.2 Inductive coupling technique (disadvantages)

One of the primary drawbacks associated with this technology is its limited operational range, which significantly constrains its practical usability. In most cases, effective performance requires the charger and the device to be positioned in very close proximity to one another. This physical limitation reduces the flexibility of usage, particularly in dynamic or mobile contexts. Furthermore, during operation, the system tends to generate a noticeable amount of heat, which could potentially affect the efficiency and long-term durability of the components involved. Another challenge lies in the necessity for precise alignment between the transmitter and the receiver, a requirement that makes it less suitable for applications where movement or misalignment is expected. These factors collectively reduce its viability in scenarios demanding high mobility or adaptability.[4]

2.1.4.3 Magnetic resonance coupling (advantages)

This approach offers a significant improvement in terms of positioning flexibility, allowing electronic devices to be charged efficiently even when they are not placed in perfect alignment with the charging source. Such flexibility enhances user convenience and reduces the constraints typically associated with conventional charging methods. In addition, the system is capable of supporting the concurrent charging of multiple devices, each potentially requiring different levels of power. This multi-device compatibility contributes to greater overall efficiency and makes the solution particularly well-suited for complex or high-demand environments, such as shared workspaces or smart infrastructure setups. Another notable advantage is that the technology operates without the need for a direct line of sight between the charger and the device, thereby broadening the range of possible applications and further enhancing its practicality in real-world scenarios.[4]

2.1.4.4 Magnetic resonance coupling (disadvantages)

Although this technology presents several noteworthy advantages, its practical deployment is accompanied by certain challenges most notably the relative complexity involved in both its initial implementation and ongoing configuration. Setting up the system often requires specialized knowledge, careful calibration, and precise alignment with existing infrastructure, which may not be feasible in all operational contexts. Additionally, one of the limiting factors is its relatively short effective charging range when compared to other charging technologies. This constraint significantly reduces its suitability for applications that demand a high level of mobility or where devices are frequently moved. As a result, while the technology may perform well in controlled or stationary environments, it is generally less optimal for dynamic settings where user movement and device relocation are common.[4]

2.1.4.5 RF radiation (advantages)

This technology is distinguished by its capability to support wireless charging over extended distances, a feature that proves especially beneficial for mobile devices and systems deployed in remote or hard-to-reach areas. Unlike conventional charging methods that require close proximity or direct physical contact, this approach enables greater spatial flexibility, allowing devices to remain functional and continuously powered even when they are located far from the primary charging source. Such an extended range not only enhances user mobility but also opens the door to a wide array of innovative applications, particularly in sectors such as transportation, agriculture, and environmental monitoring. The increased freedom of movement afforded by this capability fosters the development of more adaptive and autonomous systems, contributing to the evolution of modern technological ecosystems..[4]

2.1.4.6 RF radiation (disadvantages)

One of the most pressing concerns associated with this technology pertains to safety, particularly due to the potential health risks linked to prolonged exposure to high levels of radio frequency (RF) energy. Scientific studies have suggested that elevated RF exposure may lead to biological effects, prompting the need for stringent safety standards and regulatory oversight during system deployment. Beyond health considerations, another limitation lies in the relatively low energy transfer efficiency commonly observed in such systems. A significant portion of the transmitted energy may be lost during the process, thereby reducing overall effectiveness and potentially increasing operational costs. Furthermore, for the system to function optimally, it generally requires a clear and minimally obstructed path between the transmitter and receiver. The presence of physical barriers or interference can significantly degrade performance, limiting the range and consistency of the charging process. These factors collectively highlight critical challenges that must be addressed to ensure safe, efficient, and practical implementation.

.[4]

2.2 Wired charging techniques

2.2.1 Charging using USB cable

The USB Type-C port is utilized for charging smartphones by connecting a cable between the device and a power source, such as a wall charger or a computer. This port facilitates the flow of electrical current from the charger to the phone's battery, enabling it to recharge. USB Type-C is regarded as a modern interface that has gradually gained popularity across various devices, and many manufacturers rely on it in the design of their smartphones. Electrical current travels through the cable's wires to the charging circuits within the phone, which regulate the charging process and control the amount of incoming current to safeguard the battery.[10]

2.2.2 Charging using Power Bank portable battery

The power bank serves as a portable charger, supplying energy to devices such as smartphones while on the go, particularly in the absence of electrical outlets. It consists of a rechargeable battery and a voltage regulator, such as the IC 7805, which adjusts the output to 5 volts, the standard voltage for most devices. Despite its advantages, some traditional designs face limitations in the number of ports and high costs, as well as a lack of support for powering other USB devices. Consequently, a new design has been proposed that offers greater flexibility and efficiency to overcome these limitations.[11]

FIGURE 1.6: POWER BANK

2.2.3 Charging using car charger USB port

The USB port has become an essential feature in modern cars, providing a convenient way to charge electronic devices such as smartphones, tablets, and wireless headphones while on the road. Typically, these ports operate according to USB standards like USB 2.0 or USB BC 1.2, which can deliver a current of 500 milliamps to 1.5 amps at a voltage of 5 volts, allowing for a charging capacity of up to 7.5 watts. As technology progresses, newer vehicles are increasingly supporting USB Type-C ports and USB Power Delivery (PD), capable of supplying up to 100 watts of power, which enables the charging of larger devices like laptops. Additionally, the role of USB ports in vehicles has expanded beyond charging; they can also facilitate data transfer.[10]

FIGURE1.7: EVOLUTION OF USB CONNECTORS[10]

PED	Voltage	Maximum current
Laptop	19.5 V	2.31 A and 3.34 A
MacBook	16.5 V and 14.5 V	3.65 A and 3.10 A
Tablets	5 V	2 A
Smartphones	5 V	1.5 A

2.2.4 Charging using USB port on computer

The USB port on computers serves as a common charging method for various portable electronic devices, including smartphones, smartwatches, and wireless earbuds. Most USB ports in computers adhere to specifications such as USB 2.0 or USB 3.0, which deliver a current ranging from 500 milliamperes to 900 milliamperes at a voltage of 5 volts, resulting in a charging capacity between 2.5 watts and 4.5 watts. Although the charging capability from a computer is often lower than that of dedicated chargers or USB ports found in modern vehicles, it remains a practical option, particularly in work settings or locations lacking alternative power sources. As computers have evolved, we have begun to see support for USB Type-C and USB Power Delivery (PD) ports, which enable faster and more powerful charging, reaching up to 100 watts, thus allowing for the charging of laptops and larger devices through the same port.[10]

2.2.5 Charging using System Powered by Solar Energy

This intelligent system operates by converting solar energy into electrical energy using fixed solar panels, which is then stored in a lead-acid battery to ensure a continuous power supply. The system offers multiple charging ports, including dedicated DC outputs for charging smartphones and tablets, as well as AC outlets designed for devices that require higher power, such as laptops. Additionally, the system is equipped with wireless charging pads to provide a modern and convenient charging experience. Energy distribution from the battery to these ports is managed by a voltage regulator that stabilizes the output at 5 volts, along with an inverter that converts direct current to alternating current, ensuring compatibility with various types of devices. To ensure safe usage, a charge controller is integrated to protect the battery from overcharging, along with electrical safety mechanisms for users in public spaces.[13]

FIGURE1.8: CHARGING STATION PROTOTYPE[13]

2.2.6 Advantage and disadvantages of Wired charging technique

2.2.6.1 Charging using USB cable (advantages)

Modern USB cables, particularly those of the USB-C type, are distinguished by several advantages that make them the preferred choice for charging and data transfer. Firstly, they offer higher charging speeds due to their support for fast charging technology, allowing for the efficient delivery of power to devices. Additionally, they facilitate faster data transfer compared to older Micro-USB cables, enhancing the speed and effectiveness of file sharing. A notable feature is their reversible design, which eliminates the concern of cable orientation during connection, thereby improving user convenience. Furthermore, these cables exhibit broad compatibility, being utilized across smartphones, laptops, tablets, and even some gaming consoles. Lastly, they support advanced technologies such as USB Power Delivery (PD), enabling power transfer of up to 100 watts, making them ideal for efficiently charging multiple devices.[10]

2.2.6.2 Charging using USB cable (disadvantages)

Despite significant advancements in shipping and data transfer technologies, several challenges persist, particularly regarding cable compatibility and pricing. For instance, Type-C cables often come at a higher cost compared to traditional cables, and some non-original variants may be of inferior quality or unsafe, adversely affecting user experience. Furthermore, the incompatibility of these cables with older devices that utilize Micro-USB ports presents a drawback that users must navigate by employing an adapter. Additionally, the susceptibility of low-quality cables to damage with frequent use underscores the importance of selecting reliable and more durable products.[10]

2.2.6.3 Charging using Power Bank portable battery (advantages)

The power bank is characterized by numerous features that make it an ideal choice for daily use. It is user-friendly for on-the-go charging, allowing smartphones to be powered up anytime and anywhere without the need for a fixed electrical source. Additionally, it is compatible with various devices that operate via USB ports, such as lamps and fans. Furthermore, its design can be easily expanded to include additional charging ports, enhancing its versatility. In terms of cost, it is relatively inexpensive compared to commercial alternatives, and its compact size and lightweight nature facilitate portability. Moreover, its straightforward design does not require advanced technical skills for either usage or manufacturing, and it can be charged with any available charger while consuming minimal energy.[11]

2.2.6.4 Charging using Power Bank portable battery (disadvantages)

Despite the advantages of power banks, there are several drawbacks that warrant consideration. One of the most significant issues is the limited charging capacity, which may not suffice for multiple device charges, particularly in smaller models. Additionally, the time required to recharge the power bank itself can be lengthy, especially for those with larger capacities. Some models may lack effective protection systems, increasing the risk of overheating or damage to the devices being charged. Furthermore, the battery's efficiency may decline over time with frequent use, reducing its ability to store energy. Lastly, if a power bank is not used for extended periods, its battery may experience self-discharge, rendering it ineffective.[11]

2.2.6.5 Charging using car charger USB port (advantages)

A USB car charger is user-friendly and allows for simultaneous charging of multiple devices through various ports. It enables you to charge your phone or tablet while driving, providing convenience for those on the go. Additionally, it is compatible with most electronic devices that utilize a USB port, such as smartphones and tablets, enhancing its usability. Furthermore, the USB car charger is a cost-effective option compared to other chargers, making it a popular choice among users.[14]

2.2.6.6 Charging using car charger USB port (disadvantages)

Although a USB charger in a car has its benefits, it can sometimes result in slower charging, especially if the USB port lacks fast charging capabilities. Moreover, repeated use of the car for charging can adversely affect the battery, leading to a decrease in its longevity over time. This charging method may also disrupt the functioning of other devices, including the radio or sound systems, which can compromise their efficiency. Additionally, it is essential to recognize that the USB charger necessitates the engine to be on for power supply, preventing device charging when the vehicle is off.[14]

2.2.6.7 Charging using USB port on computer (advantages)

Charging via a computer is characterized by its accessibility and flexibility, as any computer equipped with a USB port can be used to charge a phone or electronic devices without the need for a specific charger. Furthermore, the current supplied by the USB port is generally safe for the battery, thereby minimizing the risks of overcharging. Additionally, the USB port allows for simultaneous charging and data transfer, making it convenient for use during work or study.[15]

2.2.6.8 Charging using USB port on computer (disadvantages)

Although the process of charging via a computer is quite simple, it has its share of limitations. The primary concern is the slow charging speed, particularly with USB 2.0 ports that offer a weak current. Moreover, charging is interrupted when the computer is turned off or enters sleep mode, which can lead to users not realizing that the charging has stopped. This approach is not ideal for devices that demand higher energy levels, and regular use of the USB port for charging may eventually cause it to wear out.[15]

2.2.6.9 Charging using System Powered by Solar Energy (advantages)

The use of solar energy for charging is distinguished by its dependence on a renewable and cost-free energy source, rendering it a suitable option for regions without access to electricity. Its small form factor facilitates incorporation into portable gadgets or allows for independent usage. The system boasts an impressive efficiency rate of 92.6% in stable operational conditions and is compatible with USB charging, making it suitable for a wide range of portable devices. Additionally, it features electrical safety systems that ensure secure operation.[16]

2.2.6.10 Charging using System Powered by Solar Energy (advantages)

Solar energy charging faces several limitations, the most significant of which is the restricted output from small solar cells, resulting in longer charging times compared to conventional chargers. Additionally, the efficiency of the system is influenced by the size of the solar cells, which cannot be excessively large in portable devices. Even with the inclusion of a lithium-ion battery to enhance performance, environmental factors such as lighting and temperature can adversely affect the efficiency of the solar cells[16]

Chapter 02

Modelisation of a smart charging system

1 Modelisation

1.1 using for domestic space with one box

In this section, the focus is on the development of a smartphone charging cell tailored for local settings, including schools and government offices. This cell is characterized as a standalone unit that combines a built-in phone charger with a holder and safety features, allowing users to charge their phones securely and effectively. The objective of this design is to meet the growing energy needs in areas regularly visited by the public, utilizing smart solutions that are compatible with the local context regarding structure, safety, and ease of use. Furthermore, this model takes into account practical and social dimensions to ensure smooth integration into public spaces without hindering operations within these institutions.

FIGURE2.1: A SMART PHONE CHARGING IN DOMESTIC SPACE

1.1.1 The challenges associated with mobile phone shipping in domestic space

Numerous users opt to charge their smartphones in communal areas via the USB ports of computers, a method that tends to be impractical. These ports often supply a low voltage that fails to meet the charging efficiency required by modern devices, causing a significant delay in the charging process, particularly for phones that necessitate higher energy levels. Moreover, the continual use of USB ports can result in their degradation or malfunction over time, leading to potential damage to both the devices and the computers.[15]

Many individuals also resort to using portable chargers (Power Banks) to recharge their phones in public spaces. Although this solution is convenient and accessible, it is subject to several limitations, the most significant of which is its limited capacity, rendering it inadequate for meeting the demands of frequent charging throughout the day. Furthermore, many of these devices lack effective protection systems, which heightens the risk of sudden overheating, potentially resulting in device damage or even thermal incidents.[11]

1.1.2 The solutions provided challenges associated with mobile phone shipping in domestic space by our product

In response to the limitations associated with traditional smartphone charging methods in public spaces, the smart charging cell offers a comprehensive and reliable solution. It first addresses the issue of charging through computer USB ports, which typically provide insufficient power for modern devices, resulting in significantly slow charging times. By supplying a dedicated and stable power source, the cell ensures faster and more efficient charging, particularly for devices that require higher energy levels. Additionally, it helps mitigate the risk of port damage caused by frequent use, thereby preserving the integrity of both mobile devices and institutional equipment.

Contrary to portable chargers (Power Banks) that are constrained by limited capacity and require frequent recharging, the smart charging cell is specifically designed to enable continuous and repeated use without any loss in performance. It also incorporates advanced safety mechanisms, such as temperature monitoring and current regulation, which significantly lower the risk of overheati ng and related accidents. Therefore, the smart charging cell is a more secure, sustainable, and user-friendly option for daily applications in public and semi-public spaces.

In addition to its primary functions, the smart charger can be connected to digital management systems that allow supervisors to monitor usage patterns, diagnose faults, and optimize energy distribution remotely. This contributes to enhancing operational efficiency and paves the way for the integration of future features such as access control based on usage, data analysis, and even powering from renewable sources.

1.2 Using for public space with one box

For use in public spaces such as airports and travel stations, a smartphone charging unit is being developed to suit environments characterized by high traffic and dense populations, while adhering to safety, efficiency, and user-friendliness standards. This unit is distinguished by its independent design, featuring a built-in charger, a phone holder, and a security system that prevents theft or tampering during the charging process. The aim of this design is to meet the needs of travelers and visitors who frequently require device recharging during waiting periods or transit, making the provision of a secure and intelligent charging source essential. Additionally, this unit considers aesthetic and organizational aspects to seamlessly integrate into public spaces without disrupting the flow of movement or the overall appearance of the area.

FIGURE2.2: A SMART PHONE CHARGING IN PUBLIC SPACE

1.2.1 The challenges associated with mobile phone shipping in public space

Charging mobile phones in public areas faces various challenges that compromise both service effectiveness and user safety.A primary concern is the slow charging rate of standard chargers that utilize USB cables, which can be a significant hindrance, especially in locations where individuals are in a hurry, such as airports and transit stations, where time is critical.[14], [15] Moreover, the potential for traditional chargers to overheat introduces an additional risk, as this can result in device malfunctions or even incidents caused by excessive heat.[11] Additionally, there is an increasing apprehension regarding the exposure to negative frequency energy from some wireless charging methods that operate on radio frequency (RF) waves, which could negatively impact users' health with frequent exposure.[4]

1.2.2 The solutions provided challenges associated with mobile phone shipping in public space by our product

In response to the challenges posed by the sluggish charging speeds of conventional USB cable chargers, a smart charging cell has been developed featuring advanced high-efficiency fast charging technology that accommodates a wide range of smartphones. This innovation enables devices to charge in considerably less time, rendering it ideal for bustling environments like airports and transit stations, where time constraints are paramount for users.

Recognizing that traditional chargers may lead to overheating during their operation, which can cause harm to devices or pose thermal risks, the smart charging cell has been designed with a cutting-edge thermal management system. This system is equipped with embedded thermal sensors and an automatic cutoff function that triggers when it detects any significant rise in temperature, thereby ensuring the safety of both the user and the device.

In light of the growing concerns regarding the health impacts associated with certain wireless charging technologies that utilize radio frequency (RF) waves, the smart charging cell offers a secure solution by employing protected wired charging. This system incorporates reinforced cables and internal insulation that minimizes any leakage or unwanted exposure to electromagnetic energy, thereby ensuring a healthy and safe.

1.3 Smart charging system with multi box

The multi-cell charging system is regarded as an advanced solution aimed at enhancing user experience in public spaces as well as in home or office environments. The concept of this system revolves around integrating multiple charging cells into a single holder, allowing several users to charge their devices simultaneously and securely. Each cell is equipped with a charging port and a designated area for placing the phone, along with an integrated protection system to prevent theft or unauthorized use.

One of the significant concepts in this type of system is central fingerprint control: instead of employing a separate fingerprint reader for each cell, a single reader connected to a central control unit is utilized. Upon fingerprint verification, permission is granted to open an empty charging cell within the system, or the same fingerprint can be used to reopen the previously utilized cell. This streamlines the management process and reduces hardware costs.

FIGURE2.3: SMART CHARGING SYSTEM WITHOUT SAFTEY SYSTEM

1.3.1 Using for public space

In public spaces such as universities, government offices, airports, or shopping centers, charging systems necessitate a high level of security due to the large and diverse user base. Consequently, these systems are typically equipped with comprehensive protection that includes electronic locks, fingerprint or card readers, and surveillance cameras utilized for security purposes as well as for documenting access and identifying users. Additionally, they are often supported by electronic payment systems that facilitate charging fees paid via mobile phones, cards, or digital wallets, thereby ensuring the safety of assets, continuity of service, and ease of remote management.

FIGURE 2.4: SMART CHARGING SYSTEM WITH SAFETY SYSTEM

1.3.2 Using for domestic space

In home environments or semi-private settings such as small offices, hotels, or personal use, smart charging systems are designed to be simpler and less complex, reducing the need for intricate protection systems. Typically, these systems are utilized without fingerprint readers or electronic locks, as the users are known and limited. The emphasis is placed on ease of use and organized energy efficiency, and some additional features may include charging time control or energy consumption monitoring through a connected application, but without significant security complications. The cells can be designed to be either open or closed with simple covers, making them suitable for secure and self-monitored environments.

FIGURE2.5: A SMART CHARGING SYSTEM WITH MULTI-CELLS

2 Organigram general of smart charging system

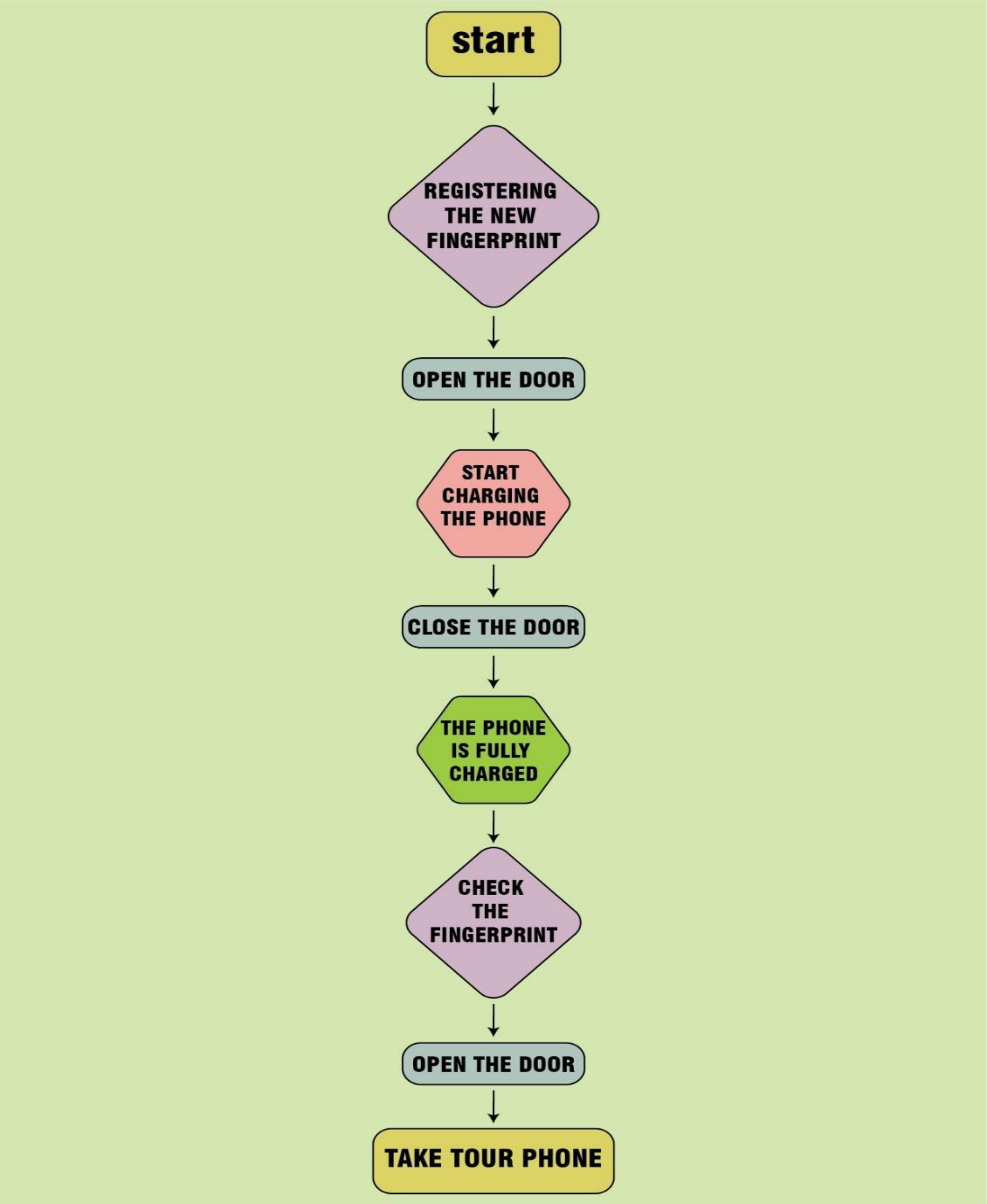

FIGURE 2.6: ORGANIGRAM GENERAL OF SMART CHARGING SYSTEM

Chapter 03

Prototype, design and imprementation

1 Introduction

In this chapter, we will explore the technical and physical characteristics of the smartphone charging cell that we have designed and developed. The purpose of this section is to provide a thorough explanation of the product's components, including the outer structure crafted from Plexiglass and the internal electrical pathway that relies on an integrated electronic system, in addition to reviewing the smart features that ensure a safe and fluid user experience. This analysis underscores how the integration of design and function is realized in a practical product that is applicable in real life.

2 Block of product

This product has been designed to provide a secure and practical means of charging smartphones in public spaces. The design combines safety with ease of use, allowing users to charge their devices within a locked and secure compartment without the need to remain beside it. This solution is ideal for public locations such as airports, malls, universities,and cafes.

The product consists of a sturdy outer structure equipped with several essential components that ensure safety, efficiency, and user-friendly interaction. In the following sections, we will explain each external component and its role in the usage process.

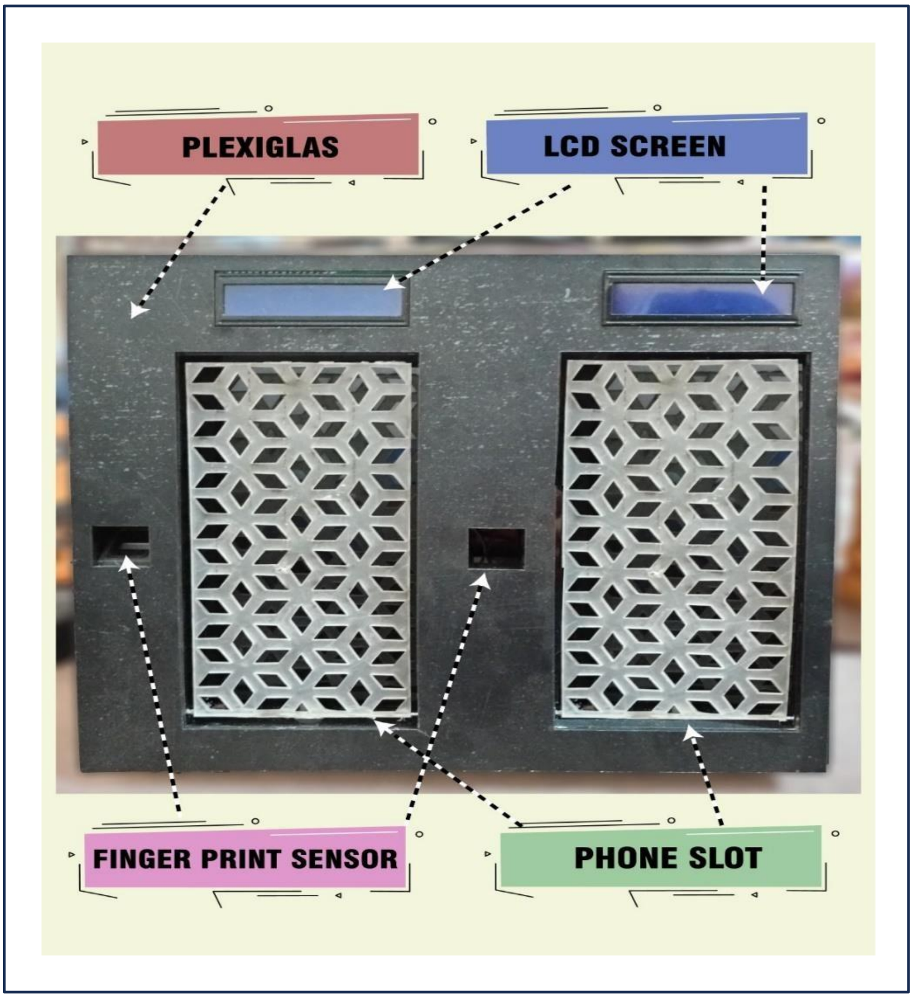

FIGURE3.1: THE OUTER STRUCTURE OF PRODUCT

2.1 Plexiglass

The use of Plexiglass in the manufacturing of the external structure of the phone charging case has been approved due to its unique properties that combine aesthetics and durability. This transparent and lightweight plastic material is well-known for its high resistance to breakage, ease of shaping, and precision in cutting. In our design, we utilized black Plexiglass with a thickness of 2 mm, which adds a modern and elegant touch while maintaining structural integrity. This material has enabled us to execute a precise engineering design while preserving a sleek and contemporary appearance suitable for public use, especially with the case dimensions measuring 27 cm in length, 25 cm in width, and a side thickness of 6 cm, making it compact and practical. Additionally, the ease of cleaning this material and its scratch resistance ensure that its appearance and quality are maintained over the long term.

2.2 Phone slot

The device is equipped with a designated phone slot, which has dimensions of 18.5 cm in length,9 cm in width, and 3 cm in depth. This configuration allows for adequate space to accommodate most smartphone types securely, ensuring a perfect connection with the charging interface. The compartment is protected by a transparent cover made from Plexiglass, which allows for a clear view of the phone while it is charging, while also ensuring its protection from tampering or falling when utilized in public settings.

2.3 Fingerprint sensor

The device is equipped with a Fingerprint Sensor, a modern and secure method for unlocking the charging cover. This technology offers ease and speed of use, allowing the user to access their phone with just a single touch, eliminating the need to enter codes or remember passwords. In comparison to traditional security methods such as PIN codes or numeric passwords, fingerprint recognition is more efficient and secure, reducing the likelihood of forgetting the code or making input errors, which could lead to an uncomfortable experience or unwanted delays for customers. Therefore, the adoption of the fingerprint sensor reflects our commitment to user comfort and a seamless experience while maintaining a high level of securit

2.4 LCD display

Equipped with a digital LCD Display, the device provides clear and smooth instructions and guidance for the user. This screen is vital for enhancing the user experience, as it illustrates the operational steps of the device, such as entering a fingerprint, confirming it, and managing the protective cover. It also displays real-time messages that inform the user about the charging status or any critical alerts, making the interaction with the device intuitive and easily understandable, even for novice users. This display is a central element in ensuring quick and effective communication between the user and the system.

3 Circuit diagram

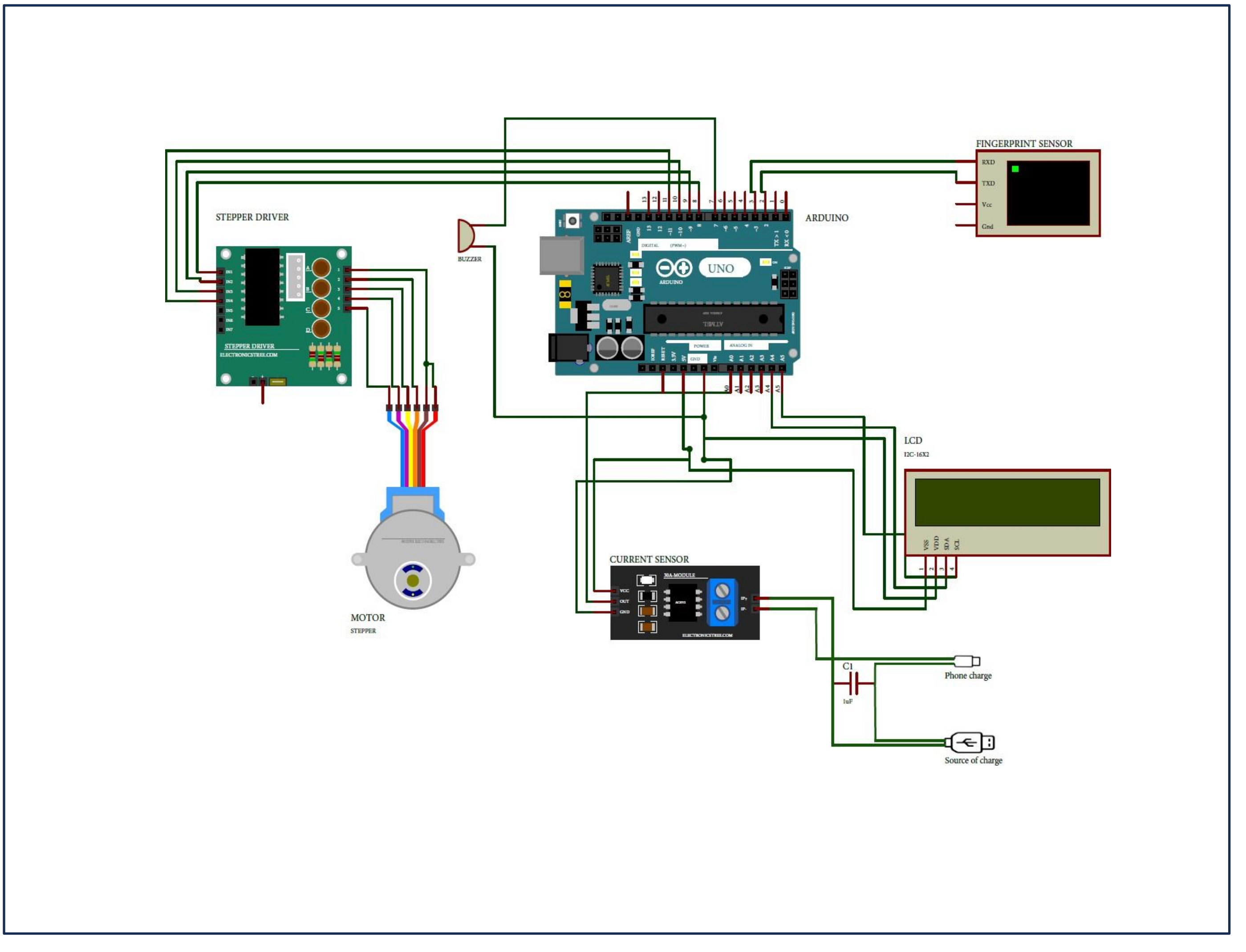

FIGURE3.2: CIRCUIT DIAGRAM OF PRODUCT

3.1 Arduino UNO

→ The primary control unit that manages the entire system's operation.

3.2 Fingerprint Sensor

→ It verifies the user's identity through their fingerprint.

3.3 LCD 16x2

→ It displays system instructions and the charging status to the user.

3.4 Stepper Motor

→ It opens and closes the cover of the charging cell.

3.5 Stepper Motor Driver

→ It precisely controls the operation of the stepper motor.

3.6 Current Sensor (ACS712)

→ It monitors the charging current to protect the device and ensure the phone's presence.

3.7 Buzzer

→ It emits an audible alarm in case of an error or alert.

3.8 USB Charging Port

→ The phone charging port located within the cell.

3.9 Power Source (5V/9V/12V)

→ The power supply for operating the system and charging phones.

3.1 O Capacitor (1µF)

→ It stabilizes the signal and reduces electrical noise in the circuit.

Functioning Principle

The system transitions to standby mode as soon as it is powered on, with the Arduino UNO controller initializing the connected electronic components, which include the fingerprint sensor, display screen, stepper motor, and current sensor. In the initial phase, a welcome message and instructions are presented on the LCD screen, prompting the user to place their finger on the fingerprint sensor for identity verification. Upon scanning the fingerprint, the sensor transmits the data to the controller via Serial Communication for comparison with pre-stored data. If the verification is successful, the controller signals the stepper driver to activate the stepper motor and open the transparent cover that secures the charging port. Immediately after the cell is opened, current monitoring is activated by the ACS712 sensor, which measures the electric current flowing through the charging port connected to the user's phone, aiming to monitor the charging status and ensure its stability, with the option to trigger alerts through the buzzer in case of detecting abnormal current. During the charging period, status data is periodically displayed on the LCD screen. Once the process is complete or the phone is removed, an automatic command is sent to the motor to close the cover and return the system to standby mode to prepare for a new user.

4 Electrical components

In order to ensure optimal functionality, reliability, and user safety in the phone charging case, each electronic component has been selected with great care according to its specific role within the system. The selection criteria were founded on efficiency, compatibility with the microcontroller, ease of integration, and the availability of components in the marketplace. The subsequent section will offer a detailed analysis of each component employed in the circuit, along with the technical justification for its incorporation into the overall design.

4.1 ARDUINO UNO

The Arduino UNO board functions as a microcontroller that utilizes the ATmega328P chip, acting as the primary control unit within the system. Its selection is attributed to its user-friendly programming capabilities, broad support, and compatibility with a range of sensors and components, rendering it suitable for integrated electronic projects.

4.2 LCD

In this project, a 16x2 LCD screen with an I2C interface has been adopted due to its ability to display information clearly and in an easily readable format, such as the charging status or fingerprint verification results. This screen is characterized by its low power consumption and the ease of connecting it to an Arduino board using only two wires (SDA and SCL), which simplifies wiring complexity and allows for the availability of additional ports for other components.

4.3 FINGER PRINT SENSOR AS608

The AS608 sensor is utilized for secure user identification prior to granting access to the charging port. It was selected due to its high accuracy in recognition, rapid response time, and ease of integration with Arduino systems via serial communication (UART). Additionally, its compact size and ability to store fingerprints within a single unit make it ideal for embedded security applications.

4.4 CURRENT SENSOR ACS712,30A

The ACS712 30A current sensor was utilized due to its high accuracy and rapid response in measuring electrical current. This sensor is characterized by its ease of connection with microcontrollers, and it offers electrical isolation thanks to Hall effect technology, which protects the circuit from excessive currents. The sensor's capability to measure currents up to 30 amperes makes it suitable for safely and effectively controlling the charging of smartphones.

4.5 STEPPER MOTOR 28BYJ-48 5VDC

The 28BYJ-48 5VDC stepper motor was selected over the SG90 servo motor due to its superior rigidity and safety features, which are enhanced by the integrated self-braking system (frainage). This system enables the motor to maintain its position without the need for continuous power, thereby reducing the likelihood of breakage or slipping during stops. Additionally, its design provides precise motion control and operates at a low voltage of 5 volts, making it suitable for small electronic systems that require mechanical stability and ease of programming.

4.6 BUZZER

The Buzzer is employed as a sound alert to inform users of errors during the input process, such as incorrect fingerprint entries or attempts to unlawfully open or damage the door. It generates a noticeable alert sound that immediately attracts attention when any issues or tampering attempts arise, thus reinforcing the security of the system and assisting in the rapid response of the user or the device administrator.

4.7 LED

LED lights have been utilized as a visual indicator to demonstrate the system's status, where the LED is employed to indicate that the phone is charging. Additionally, it is activated or deactivated to signify whether the door is open or closed. This component contributes to providing a straightforward and direct means for the user to monitor the charging status or security condition.

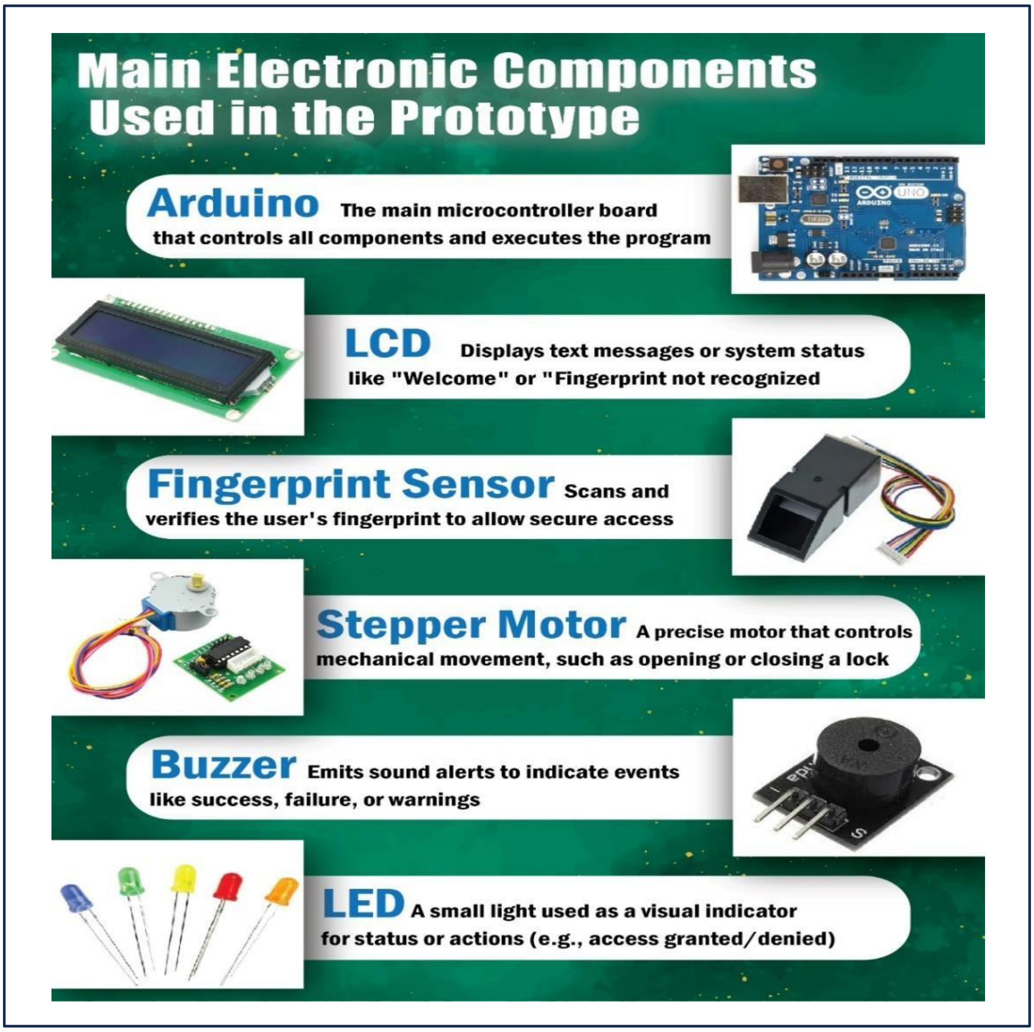

FIGURE 3.3: MAIN ELECTRONIC COMPONENT USED IN PROTOTYPE

5 product payment feature

5.1 Payment Integration via QR Code

The device features a QR Code Scanner unit that links the user directly to a specific electronic payment platform. When the code is scanned with a smartphone, the user is taken to a secure online interface, where they can choose the Cell ID they wish to utilize (such as cell 1, 2, or others), and then easily follow the payment steps. Once the payment is completed, a digital signal is sent to the Microcontroller to automatically activate the charging of the phone located in the designated cell. This process ensures an effective integration between the electronic system and digital content, offering a user experience that is convenient, quick, and secure.

5.2 Future Development & Support Model

The feature of payment through the electronic platform represents a significant step towards transforming the device into a smart product based on digital services. In the future, this system could be developed to include multiple payment methods such as credit cards, digital wallets, or even NFC systems, thereby expanding the scope of commercial use. Additionally, the system could be linked to a database for managing reservations or monitoring the performance of cells remotely. This payment model serves as a form of sustainable support for the product, as it allows users to contribute to the funding of the service they benefit from, which helps ensure the project's continuity and development over time.

FIGURE3.4: SMART PAYMENT INTEGRATION FOR PHONE CHARGING

6 Organigram of product

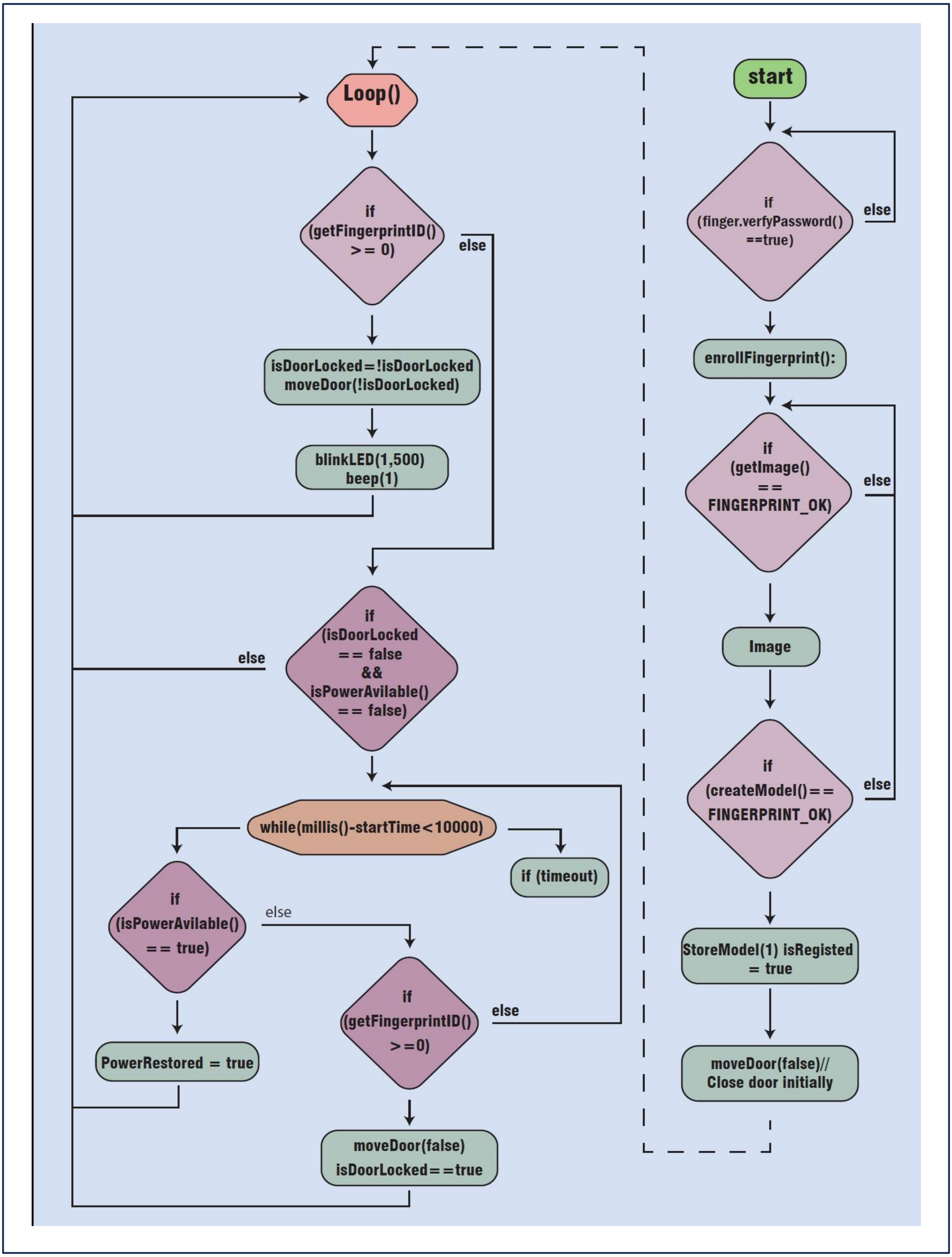

FIGURE 3.5: A SPESIFIC ORGANIGRAM OF PRODUCT

General conclusion

General conclusion

The "Smart Phone Charger" project is regarded as a promising initiative towards the development of a technological infrastructure that serves users in public spaces in a secure and organized manner.

The project is based on the concept of a cell containing several independent charging boxes, allowing each user to benefit from their own service without interference or overlap with others, thereby enhancing security and privacy. Additionally, the system relies on intelligent fingerprint control technologies and instant alerts to ensure safe and effective usage.

In light of the rapid technological advancement, this project holds promising prospects, such as the integration of smart monitoring systems, real-time tracking, electronic payment options, or even connectivity with mobile applications to enhance interaction and control. In the future, it could be expanded to include mobile charging stations or those powered by alternative energy, making it a flexible project adaptable to the needs of users in various environments, from universities to transportation hubs and shopping centers.

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People's Democratic Republic of Algeria

Ministry of Higher Education and Scientific Research

University of Ghardaia

Faculty of Sciences and Technology

Department of Automation and Electromechanics

SMART CHARGING SYSTEM

Supervision Team

Supervision Team	
Main Supervisor: KHATTARA Abdelouahab	Specialization : Energy management
Assistant Supervisor (01) : /	Specialization : /
Assistant Supervisor (02) : /	Specialization : /

Project Team

Project Team	Specialization	Faculty
HADBOUNE BRAHIM	Automation and systems	ST
KESBI REDOUANE	Automation and systems	ST
NEDJAR KHALED	Automation and systems	ST

Table of contents

I. project presentation

1. Project idea (proposed solution) :

1.1 Field of activity : Our primary focus is on the development and implementation of smart charging solutions.

1.2 Origin and Development of the Idea: The concept for the project emerged from research indicating that individuals require the ability to charge their mobile devices while commuting in public areas, underscoring the necessity of offering secure and readily available charging options.

1.3 What will it do? We are preparing to introduce an intelligent charging box specifically created for mobile phones.

1.4 How will this happen? This goal will be accomplished by creating an intelligent charging unit that integrates cutting-edge technologies in the industry, prioritizing quality and safety to fulfill the requirements of users in public areas.

1.5 Who will make this happen? A team of engineers and developers from various disciplines, in collaboration with strategic partners, will take charge of implementing the smart charging system.

1.6 Where will it be done? Locations like transportation hubs and airports were chosen due to their substantial foot traffic and considerable need for mobile charging solutions.

2. Proposed Values of this Project

2.1 Innovation: Addressing entirely new needs for which there were no comparable solutions before.

2.2 Performance: Guaranteeing that the product or service meets or exceeds customer expectations.

2.3 Customization: Providing the ability to adjust and tailor products or services to fulfill specific customer requirements.

2.4 Task Completion: Aiding customers in efficiently completing designated tasks.

2.5 Design: Developing designs that resonate with the preferences and situations of the customer.

2.6 Price: Providing products or services at a reduced cost to cater to price-sensitive customer demographics.

2.7 Cost Reduction: Supporting customers in lowering their own expenses.

2.8 Risk Reduction: Decreasing the risks customers encounter when buying products or services by providing assurances.

2.9 Accessibility: Ensuring that products or services are reachable for customers who previously lacked access.

2.10 Convenience/Usability: Ensuring that products or services are straightforward and user-friendly.

3. <u>The project team:</u>

- Khaled Nedjar: Accountable for programming and the design of electronic systems.
- Ibrahim Hadboun: Responsible for the design and optimization of the product's 3D model.
- Redouane Kasbi: Manages project oversight, conducts market research, and handles marketing.

4. <u>Our objictives:</u>

- Install intelligent and secure charging stations in busy public locations.
- Attain incremental market penetration: 5% in the short term, 20% in the medium term, and 40% in the long term.
- Create a sustainable revenue stream through charging services and digital advertising.

5. Time Line for project realization :

#	Task	1	2	3	4	5	6	7	8	9	10	11	12
1	Define project scope, objectives, deliverables, and success criteria.	✓											
2	Conduct market research and competitive analysis.	✓											
3	Develop project plan, including milestones, timelines, and resource allocation.		✓										
4	Design and develop hardware components.			✓									
5	Develop software components.			✓	✓	✓	✓	✓	✓	✓			
6	Conduct rigorous testing and validation of hardware and software components.									✓	✓	✓	
7	Secure regulatory approvals and certifications.										✓		
8	Establish manufacturing and supply chain processes.										✓		
9	Develop marketing and sales strategies.									✓	✓		
10	Launch product and begin sales and distribution.												✓

Total Project Duration: 12 months

- **Month 2:** Completion of project plan
- **Month 4:** Completion of product development
- **Month 10:** Secure regulatory approvals

5.1 Assumptions

- Many individuals encounter the issue of phone battery drain when outdoors, particularly in public areas that do not provide adequate charging options.
- There is an increasing need for intelligent, secure, and conveniently located charging stations in places like universities, shopping malls, and public transit hubs.
- Users generally favor permanent public charging solutions instead of depending on personal power banks.
- The local community is willing to embrace smart services that improve daily life experiences.
- The market for smart charging stations remains largely unexplored, presenting a significant opportunity for early market entry and growth.

5.2 Contingency Plans

- Delay in component supply:

Alternative: Build connections with various local and regional suppliers to prevent complete reliance on a single source.

- Low user engagement in early stages:

Alternative: Initiate focused marketing campaigns and provide free trial periods in busy public locations.

- Technical malfunctions or system breakdowns:

Alternative: Establish a remote monitoring system and plan routine maintenance to guarantee operational reliability.

5.3 Project Deliverables:

5.3.1 Smart Charging Unit Prototype

A complete hardware and software prototype that features charging ports, electronic design, and an intelligent control system.

5.3.2 Digital Management Interface and Documentation

An intuitive dashboard for system oversight, accompanied by user and maintenance manuals as well as a comprehensive technical report.

II. Innovative Aspect

1. Nature of Innovation for our product

1.1 Technological Innovation: with intelligent features. Unlike traditional charging stations, this system includes:

1.1.1 **The smart charging system offers an innovative solution for charging phones in public spaces by integrating modern technology Smart energy management :** it automatically recognizes the type of device and adjusts the power for safe and efficient charging.

1.1.2 **QR code payment :** allows users to quickly and easily pay for charging using their smartphones.

1.1.3 **User identity verification (optional) :** through a fingerprint sensor to ensure security and track individual usage.

1.1.4 **Energy efficiency:** designed with low-power components and automatically shuts off when not in use to minimize waste.

1.1.5 **Integrated digital screen:** to display advertisements or information, providing added value for users and operators.

1.1.6 **Modular design:** facilitates the upgrading or replacement of parts without the need to replace the entire system

1.2 Level of Innovation

The degree of innovation pertains to the application of novel technologies and concepts that set the project apart from conventional solutions. The Smart Charging System integrates fingerprint authentication for enhanced security, utilizes QR codes for effortless payment, and incorporates intelligent power adjustment according to the connected device. Additionally, it includes a remote monitoring dashboard that offers possibilities for digital advertising integration.

1.3 Uncertainty

The Smart Charging System might encounter technical uncertainties concerning device compatibility, sensor performance, and shifts in future technology. These elements could influence system stability and necessitate frequent updates.

- Variations in compatibility with various smartphones and charging standards may exist.
- Fingerprint sensors could be impacted by weather conditions or outdoor environments.

- Future advancements in mobile or network technologies may require hardware or software upgrades.

1.4 Market Uncertainty (High):

- It is uncertain whether users are inclined to pay for public charging, particularly when free options are accessible.
- A lack of public awareness and confidence in smart charging systems could impede their adoption.

2. <u>Innovation Areas for our product</u>

2.1 New operations : The Smart Charging System enhances operational efficiency in public areas by**:**

- Automating mobile device charging services, which minimizes the requirement for staff oversight.
- Producing usage reports and system diagnostics from a distance, thereby conserving time and reducing maintenance expenses.

2.2 New Features: The Smart Charging System introduces innovative features for both users and service providers, which include:

- QR code payment for convenient and secure access.
- Fingerprint authentication to ensure safe usage and personalized access.
- Remote monitoring of the system along with fault alerts.
- An integrated digital screen for advertisements or public information.

2.3 New Customers: The Smart Charging System broadens its target audience to:

- Travelers and commuters who require fast and reliable phone charging.
- Students, employees, and individuals in public areas with restricted charging options.
- Companies and organizations looking for enhanced services for their customers.

2.4 New Offerings: The system facilitates the introduction of new services, including:

- Digital advertising displayed on the screen during charging.
- Analytics and insights based on usage for location managers.
- Smart lockers or secure charging boxes available as a premium upgrade.

2.5 New Models: The Smart Charging System facilitates cutting-edge business models, including:

- Charging services based on pay-per-use or subscription.
- Collaborations between public and private sectors for city-wide implementation.
- Revenue sharing through advertisements with hosting locations.

III. Market Strategic Analysis

1. Market Segment

1.1 Potential Market: The Smart Charging System aims at a wide and expanding market segment fueled by the growing dependence on mobile devices. Its potential market encompasses:

- **Urban public** areas such as parks, transportation hubs, and shopping centers.
- **Educational establishments** like universities and schools where students frequently require charging facilities.
- **Tourist and travel centers** including airports, hotels, and bus stations.
- **Event locations** such as festivals, conferences, and sports venues.
- **Municipalities and smart city** projects seeking to provide enhanced public services.
- **As mobile connectivity and public transportation** continue to rise, the need for secure and accessible charging solutions is anticipated to grow significantly.

1.2 Target Market: The target market for the smart charging system includes individuals who frequently use their mobile phones in public spaces and require a secure, fast, and reliable charging solution. Specifically, it encompasses:

- Students and university staff within campus grounds.
- Travelers and commuters using transportation at bus, train, and subway stations.
- Shoppers and visitors in shopping centers.
- Attendees at events such as exhibitions, stadiums, and festivals.
- Businesses or municipalities aiming to provide added value to their customers or citizens.

1.3 Rationale for Choosing the Target Market:

The target market has been selected due to its significant reliance on smartphones and its frequent presence in public areas that often lack convenient or accessible charging options. Students, travelers, and urban residents represent segments that frequently experience battery depletion during their daily activities. By focusing on these groups, the smart charging system addresses a genuine and growing need, ensuring practical value, a high usage rate, and better opportunities for market penetration.

1.4 Potential for Scalability: The smart charging system is characterized by its high scalability, thanks to its modular design and reliance on technologies that can integrate with various environments. The project can be expanded to include:

- Multiple locations such as universities, shopping centers, transport stations, and tourist areas.
- Different models in terms of size, power, and number of ports to meet the needs of each site.
- Geographical expansion to include new cities and areas within the framework of smart cities.
- Additional services such as electronic payment, digital advertising, and integration with smartphone applications.

1.5 Main customer types include

- Universities and public areas seeking to provide easy charging options for students and guests.
- Commercial complexes and transit stations striving to improve customer experience.
- Local governments incorporating intelligent services into city infrastructure.

2. <u>Competitors and intensity of competition</u>

- In the Algerian market, there are presently no direct competitors providing a smartphone charging system that includes integrated safety and digital payment functionalities. This situation offers the product a first-mover advantage and a significant competitive edge.
- Nonetheless, indirect competition could arise from simpler alternatives like public electrical outlets or individuals utilizing portable power banks.
- Consequently, it is crucial to leverage this initial advantage to establish brand recognition and form strategic partnerships before other competitors enter the market.

3. Marketing Strategy

3.1 Emphasis on Value:

- The system offers users secure and rapid charging in public locations, with the option to pay via QR code, enhancing convenience and ease of use.
- It provides organizations with the opportunity to improve visitor experiences and deliver a modern service that adds value to the public environment.

3.2 Cost Reduction

- The system relies on energy-efficient electronic components, which reduces electricity consumption compared to traditional charging solutions.
- The modular design of the system facilitates maintenance or upgrading of its parts at a low cost without the need for complete replacement.

3.3 Exceptional Customer Service

- The system features an easy-to-use and intuitive interface to ensure a comfortable experience for all users.
- The platform offers quick technical support and immediate solutions for issues through remote system monitoring.
- The system interfaces can be customized in multiple languages to meet the needs of a diverse range of users in public spaces.

4. <u>Marketing channels</u>

4.1 Digital marketing: through social media, paid advertisements, and informative content to showcase the system's features.

4.2 Tech exhibitions and events: for direct participation and product presentation to partners and potential clients.

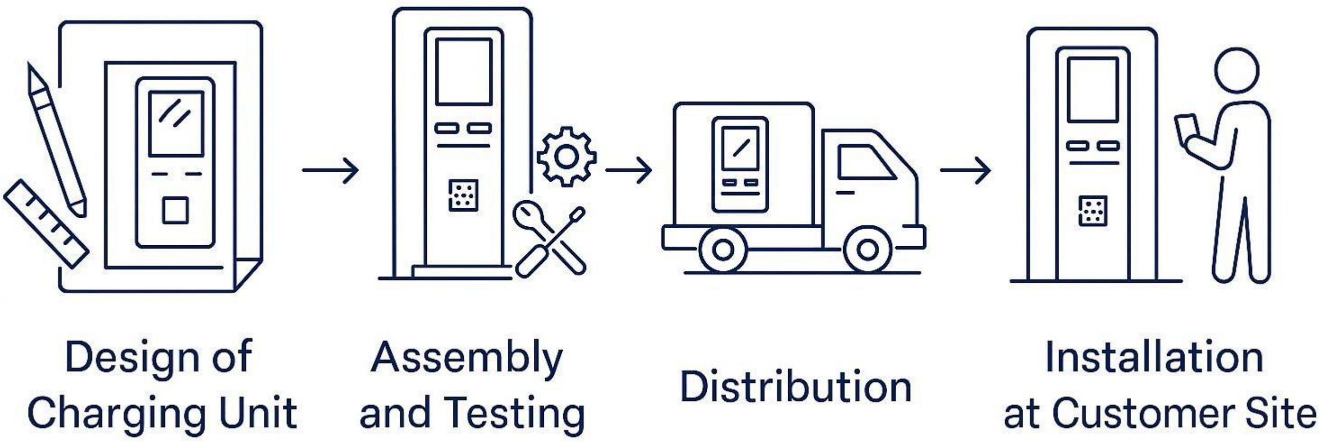
4.3 Corporate partnerships: with universities, municipalities, and commercial centers through live demonstrations.

4.4 The official online platform: to provide detailed information, purchase requests, and technical support**.**

4.5 Local advertisements: in transportation hubs, universities, and youth centers to attract attention to the service.

IV. Production and Organization Plan

1. The Production Process



2. Supply

2.1 Electronic components: Purchase control units (such as Arduino or ESP32), LCD screens, fingerprint sensors, and charging components.

2.2 Structures and packaging: Manufacture or purchase metal or plastic enclosures according to the design.

2.3 Software services: Develop embedded software, a QR payment system, and connect the system to the cloud interface.

2.4 Local and international supply: Work with local suppliers for general components and import advanced parts that are not available locally.

2.5 Shipping and distribution: Transport the final units from manufacturing workshops to installation points or customers.

3. Labor

Our smartphone charging station initiative is anticipated to generate between 15 and 25 direct job opportunities, covering areas from technical development to installation and support services.

3.1 Research and Development Positions

- **Embedded Systems Engineers:** Responsible for designing and programming microcontrollers and control logic.
- **Electrical Engineers:** Tasked with developing and optimizing hardware circuitry and power systems.
- **Product Designers:** Focused on creating user-friendly and durable enclosures.

3.2 Manufacturing Positions

- **Assembly Technicians:** Responsible for assembling both electronic and structural components.
- **Quality Control Inspectors:** Tasked with verifying that each unit operates properly prior to deployment.
- **Supply Chain Coordinators**: In charge of overseeing inventory management, sourcing components, and coordinating delivery.

3.3 Marketing and Sales Positions

- **Marketing Specialists:** Responsible for promoting the product to institutions and municipalities.
- **Sales Agents:** Tasked with managing client relationships and securing contracts.
- **Customer Support Representatives**: Focused on addressing inquiries and providing technical assistance.

3.4 Management Positions

- **Project Manager:** Responsible for supervising the overall advancement of the charging system implementation.
- **Operations Manager**: Tasked with guaranteeing seamless manufacturing and installation operations.
- **Finance and HR Officers:** Charged with overseeing budget management and personnel recruitment.

Furthermore, the project has the potential to create indirect job opportunities in areas such as transportation, maintenance, advertising, and the integration of digital payment services.

4. Key Partnerships

- **Business incubators**: for support and guidance during the early stages of a project.
- **Algeria Telecom:** to provide internet connectivity and the ability to integrate mobile payment services.
- **Foreign technology companies:** for collaboration in the development of advanced devices or smart features.
- **Entrepreneurship and innovation centers: for** opportunities in collaboration, promotion, and engagement in acceleration programs.
- **Municipalities and public institutions:** to host and support the installation of charging stations in public areas.
- **Research centers (such as the Scientific Research Center - CRI):** to enhance system performance and integrate it into smart city projects.

V. Financial Plan

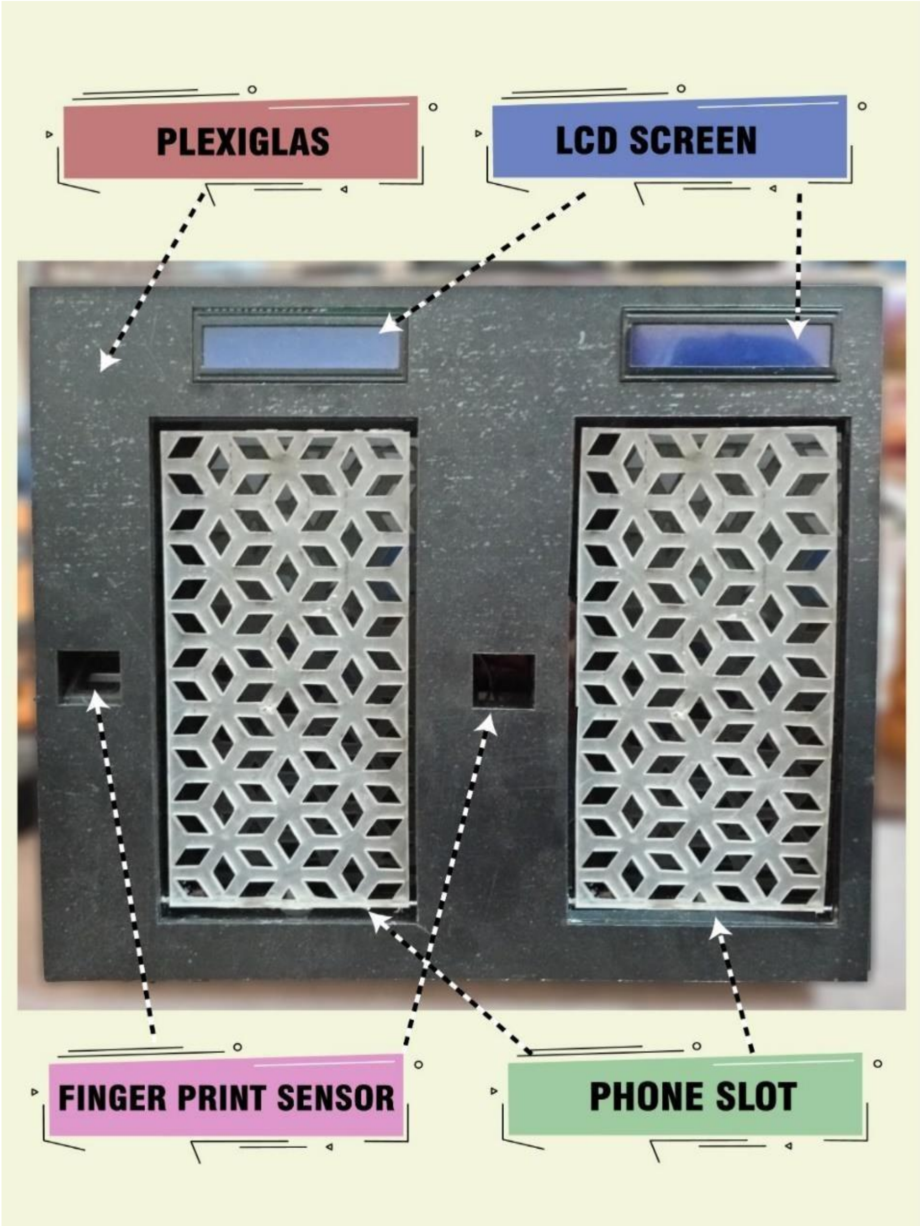
1. Costs and burde

Estimated Project Costs (in DZD)	
Item	**Cost**
Electronic components & materials	20,250.00
3D printing & enclosure fabrication	13,500.00
Assembly and testing	6,750.00
Miscellaneous	4,050.00
Total	51,300.00
Taxes and Legal Fees (in DZD)	
Description	**Cost**
Business registration	13,500.00
Intellectual property/legal documents	20,250.00
Compliance and certification fees	13,500.00
Total	47,250.00
Marketing and Advertising Budget (in DZD)	
Marketing Channel	**Budget**
Social media ads (Facebook, Instagram)	13,500.00
Printed materials (flyers/posters)	6,750.00
Promotional events / demos	6,750.00
Total	27,000.00

2. Income

Sales Forecast and Expected Revenue (in DZD)			
Year	**Estimated**	**Unit Price (DZD)**	**Expected Revenue (DZD)**
Year 1	50	5,400.00	270,000.00
Year 2	100	6,000.00	600,000.00
Year 3	200	6,750.00	1,350,000.00

VI. Experimental Prototype



- **Material:** Black Plexiglass, sturdy and contemporary (27×25×6 cm).
- **Slot Size:** Accommodates most phones securely (18.5×9×3 cm).
- **Security:** Unlock using the fingerprint sensor.
- **Display:** LCD screen for clear instructions and status.

BUSINESS MODEL CANVAS

Key Partnerships:

- ✔ Local governments and public space proprietors
- ✔ Technology and energy firms
- ✔ Developers and technical specialists
- ✔ Distributors or startup assistance programs
- ✔ Telecommunications providers
- ✔ Internet service providers
- ✔ Electronic payment gateway companies
- ✔ Marketing and advertising agencies
- ✔ Universities and research institutions
- ✔ Maintenance and repair service providers

Key Activities

- ✔ Designing and producing charging stations
- ✔ Identifying key locations for installation
- ✔ Maintaining devices and performing software updates
- ✔ Monitoring performance and conducting data analysis

Key Resources

- ✔ Technical team for hardware and software development
- ✔ Partnerships with energy and internet service providers
- ✔ Equipment for design and manufacturing
- ✔ Patent or industrial design registrations
- ✔ User database
- ✔ Custom operating system for devices
- ✔ Internal communication network for remote monitoring

Value Proposition

- ✔ Reliable and rapid mobile charging
- ✔ Available in public areas
- ✔ Accepts both cash and electronic payments
- ✔ Compatible with most smartphone models

Customer Relationships

- ✔ Intuitive and straightforward user interface
- ✔ Interaction through a mobile app or QR codes
- ✔ Notifications when charging periods are complete

Channels

- ✔ Platforms on social media
- ✔ Advertising campaigns in public venues
- ✔ A dedicated mobile application
- ✔ QR codes on the charging devices

Customer Segments

- ✔ Travelers and pedestrians in urban settings
- ✔ Our product is accessible to all segments of society
- ✔ Shoppers in malls and patients at hospitals
- ✔ Users of public transport systems

Cost Structure

- ✔ Manufacturing costs for devices
- ✔ Installation and maintenance costs
- ✔ Software and server expenses
- ✔ Marketing and promotional costs

Revenue Streams

- ✔ Fees charged (either cash or digital)
- ✔ Subscription plans billed monthly
- ✔ Advertisements shown on the device screen
- ✔ Selling usage data to partners (in a legal and secure manner)
- ✔ Commissions earned from third-party services (such as mobile accessories)
- ✔ Licensing technology to partners or local governments

الجمهورية الجزائرية الديمقراطية الشعبية
وزارة التعليم العالي والبحث العلمي
جامعة غرداية
حاضنة أعمال جامعة غرداية

رقم: 266/ ح.أ.ج.غ/2025

شهادة توطين مشروع مبتكر وفق القرار008 المعدل والمتمم للقرار1275

أنا الممضي أسفله، السيد: **د/ طالب أحمد نور الدين**

مسير حاضنة الأعمال: **جامعة غرداية**

المقر الاجتماعي/ العنوان: **المنطقة العلمية، ص ب 455، غرداية، 47000، الجزائر**

رقم علامة الحاضنة: **1004253146** بتاريخ: **2025/04/10**

طبيعة المشروع: **مؤسسة ناشئة**

أشهد أن الطالب(ة) / الطلبة التالية أسماؤهم:

الإسم واللقب	الطور الدراسي	التخصص	الكلية
رضوان قصبي	M2	آلية وأنظمة	العلوم و التكنولوجيا
إبراهيم حدبون	M2	آلية وأنظمة	العلوم و التكنولوجيا
خالد نجار	M2	آلية وأنظمة	العلوم و التكنولوجيا

تحت إشراف الأستاذ(ة)/الأساتذة التالية أسماؤهم:

الإسم واللقب	الرتبة	التخصص	الكلية
عبد الوهاب خطارة	أستاذ محاضر أ	آلية وأنظمة	العلوم و التكنولوجيا

تم توطينه على مستوى حاضنة أعمال جامعة غرداية - بمشروع تحت اسم:

Smart charging system.

خلال السنة الجامعية: **2025/2024**

سلمت هذه الشهادة بطلب من المعني للإدلاء بها في حدود ما يسمح به القانون.

حرر في غرداية بتاريخ: 16/06/2025

مدير الحاضنة

مسؤول حاضنة الأعمال
* طالب أحمد نور الدين *

الجمهورية الجزائرية الديمقراطية الشعبية
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جامعة غرداية
كلية العلوم والتكنولوجيا
قسم :الألية والكهروميكانيك

Université de Ghardaïa
Faculté des Sciences
et de la technologie

قسم الآلية والكهروميكانيك

شعبة :... الآلية ....

تخصص:... آلية وأنظمة

غرداية في :...2025/10/13

شهادة ترخيص بالتصحيح والايداع:

انا الأستاذ بن شعبان عاشور

بصفتي المشرف المسؤول عن تصحيح مذكرة تخرج (ليسانس/ماستر/دكتورا) المعنونة ب:

Smart charging system

من انجاز الطالب (الطلبة):

- نجار خالد
- حدبون ابراهيم
- قصبي رضوان

التي نوقشت بتاريخ :

2025 / 06 /23

اشهد ان الطالب/الطلبة قد قام /قاموا بالتعديلات والتصحيحات المطلوبة من طرف لجنة المناقشة وقد تم التحقق من ذلك من طرفنا

وقد استوفت جميع الشروط المطلوبة.

امضاء المسؤول عن التصحيح

مصادقة رئيس القسم

رئيس قسم الآلية والكهروميكانيك
عزاوي محمد

جامعة غرداية
قسم الآلية والكهروميكانيك
كلية العلوم و التكنولوجيا