Advanced Automated Collating and Stapling Mechanism for Office Efficiency in University of Santo Tomas-Legazpi

An Undergraduate Design Project Presented

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In Partial Fulfillment

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Bachelor of Science in Computer Engineering

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RECCOMENDATION FOR ORAL EXAMINATION

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ABSTRACT

The manual collation with stapling of documentation in the office setup has been found to lead to inefficiency, wastage of time, and human error. To ameliorate the aforementioned hindrance, the researchers have designed the Advanced Automated Collating and Stapling Mechanism for smooth processing of documents. The system is drawer-based paper feeding using no paper bin elevator, designed exclusively for short bond paper usage, with the aim of enhancing process efficiency by automating collation and stapling.

The prototype has incorporated nine servo motors and eleven DC motors, which would require an external 12V, 20A power source for functioning properly. Since the power loads of the motors are high, they are unable to be powered through Arduino Mega.

This study may be said to contribute to enhancing the office work resulting from the introduction of automation and reduced effort in compiling and stapling. The results describe the feasibility and problems of using automated solutions in establishing workflows for processing documents.

Keywords: Automation, Collating Machine, Stapling Mechanism, Arduino Mega, Office Efficiency, Paper Handling System, Servo Motor, DC Motor.

INTRODUCTION

Background of the Study

Since the very beginning of office automation, there has been a drive to perform better, pushing the development of technologies that take out tasks considered unproductive. The most recent review by Zhang et al. (2020) indicated an increasing interest in automation of document handling procedures and pointed to a surge in adoption of intelligent document processing systems. This directly aligned to the goals of the study because it proposes an innovative solution- an advanced automated collating and stapling mechanism. Many documents are going digital; however, there will always be a need for physical copies for various purposes. Hence, keeping these physical documents can become quite troublesome due to the sheer volume of collation and stapling involved.

Documents are a crucial part of any office environment and as a group of researchers, they noted the wide gap in the use of physical paperwork handling automations. The use of physical documents has not declined due to many administrative reasons, although other office procedures have been digitalized. In return, they came up with a n invention that resolves the hard arrangement and stapling work of massive volumes of paperwork. This helped us make such tasks much easier to handle, be more productive within the office, and reduce time and effort required to deal with manual document management.

With the latest advancements in automation technology, the researchers planned and built a system that keeps these continual challenges fully in focus. The project was developed and critically tested within the office of the university. The reason to the chosen environment is that it allowed a controlled environment in which the researchers simulated all types of document handling scenarios and observed them in the process. The system was tested with the help of administrative staff and students who regularly handle physical documents, providing valuable input that allowed researchers to fine-tune the system. The document processing needs at the university were diverse, which provided an outstanding testing ground for the machine in practical situations.

The researchers selected this project due to the continued, universal challenge of manual handling of documents in different offices. Administration, even with the advent and integration of digital developments, still requires a lot of paper. This addressed one of the most common areas of pain but is also in line with the prevailing technological trends toward office automation. The researchers aimed to contribute to the development of advanced automated collating and stapling mechanisms toward the improvement of the overall improvement in the office efficiency and reduction of administrative burden.

This study focused on the development and evaluation of the "Advanced Automated Collating and Stapling Mechanism for Office Efficiency in University of Santo Tomas-Legazpi " within the university environment. The primary scope of the study included designing, implementing, and testing the automated collating and stapling machine in real-world office settings at the university. The study involved office staff and administrators who regularly handled large volumes of paperwork, aimed to assess the efficiency, reliability, and user satisfaction of the automated mechanism.

The study limited its scope to the specific functions of collation and stapling of documents. It did not cover other document handling processes such as printing, scanning, or shredding. Additionally, the project was designed to handle standard office paper sizes and weights, and it may not perform optimally with non-standard paper types or unusually thick documents. The mechanism was tested and validated in controlled environments within university offices, and the findings may not be directly applicable to other types of organizations without further customization and testing.

Statement of the Problem

In office environments where large volumes of printed documents are processed on a daily basis, rendering manual collation and stapling a smattering of torturous processes. The most commonly practiced methods often result in misaligned pages and banned orders, thus wasting time and resources. Furthermore, the impacts of physically stapling bulky document sets can be tiresome: inconsistency and poor productivity.

The focus of this study is on solving various challenges through the design of an Advanced Automated Collation and Stapling System to increase office efficiency. More specifically, this study aims to establish (1) the feasibility of employing an automated system with a drawer-based paper feeding mechanism for the accurate collating and stapling of various documents and (2) the overall performance of this system, in terms of speed, accuracy, and reliability, as opposed to manual methods. This study aims at providing input into improving document processing workflows into the office business.

Objectives of the Study

The objectives of this study were: The main aim of the study was to develop and evaluate a more advanced automatic system with several objectives. (1) to design and construct a high efficiency automated system that integrated the functionalities of collating and stapling documents, aimed at improving office productivity and reducing manual labor; (2) Ensures the automated mechanism accurately collates and staples documents of varying sizes and thicknesses through rigorous testing under simulated office conditions, validating its reliability and performance; and (3) Compares the automated system's performance with traditional manual methods in terms of speed, accuracy, and error reduction. Quantifying improvements in workflow efficiency and document handling accuracy.

The device deals with developing a creative automated system that aimed to speed up the paperless office work. With the integration of functions such as collating and stapling facilities, the unit hoped that there will be a minimum need for workforce and so increasing productivity. By subjecting the new system to severe tests. The quantitative comparison of classic individual manual practices to methods with the new system provided empirical data on the system's efficiency, velocity, and error minimization, which are the reasons for its revolution in document management and the optimization of the process.

Scope and Limitations

The research study automobiles the development and evaluation of an Advanced Automated Collating and Stapling Mechanism for Office Efficiency at University of Santo Tomas-Legazpi. The study designed a way to automate the collation and stapling process in offices dealing with printed documents. It utilizes a drawer-based paper feeding system, sorting mechanism, IR sensor, and automated stapling system which place documents in proper sequence before binding. The study also conducts performance testing to determine whether the system meets how efficient it, namely, speed, accuracy, and user satisfaction.

The research scopes are limited to short bond papers and do not include long bond papers or other non-weighted bond paper sizes. Besides, the scope does not include testing for long-term extensive durability and reliability beyond the timeline of this study. The mechanism that handles different thicknesses of documents and multi-collation patterns is designed mechanically and at the software end to limit its use. This study does not concern network integration or wireless printing compatibility since the main focus of the study is the system for collation and stapling mechanism.

Significance of the Study

The significance of the "Advanced Automated Collating and Stapling Mechanism for Office Efficiency in University of Santo Tomas-Legazpi" project is rooted in its potential to benefit various stakeholders within the university and beyond. Office staff and administrators will experience a substantial reduction in the time and effort required for manual document handling, streamlining the collation and stapling of large volumes of paperwork and enhancing productivity. This automated system allows staff to focus on more strategic tasks, minimizes errors, and improves overall administrative efficiency. For the university and other educational institutions, the implementation of this mechanism serves as a model for improving administrative operations, showcasing how technology can address common challenges in document management. Researchers and innovators can build upon the project's findings to further enhance automated document handling systems, contributing to the growing body of research in office automation technologies. Additionally, by reducing physical labor and streamlining paper handling, the project indirectly promotes a more sustainable and environmentally friendly approach to office management, potentially lowering paper waste and supporting the university's sustainability goals. The project highlights the practical applications of automation technologies, demonstrating both technical innovation and the practical benefits of integrating such technologies into routine operations. Overall, the project is significant for its potential to transform administrative processes, benefit office staff and administrators, serve as a model for other institutions, contribute to research and innovation, and promote environmental sustainability.

Review of Related Literature & Past Studies

This section contains the articles, finished theses, ideas, findings, and methodologies that are similar to the study that is being researched. These helped present the theoretical, and conceptual frameworks of the study to further understand the research that is to be done.

The development of automated systems for document handling has evolved significantly, reflecting the ongoing pursuit of efficiency and productivity in office environments. The importance of printers cannot be overstated, as they remain integral to business operations worldwide, facilitating the creation and management of physical documents. Advances in automation have led to innovative solutions designed to alleviate the burden of administrative tasks associated with document collation and stapling.

The article "Advanced Applications of Industrial Robotics: New Trends and Possibilities" by Zakaria et al (2021) is the imperative aim of the engineering research which has the latest developments in the technology of industrial robots that are going to be employed for the purpose for example welding and painting. Looking at the most recent spheres including medicine, food, agriculture, and civil engineering, whereby the use of robots is becoming more and more prevalent, the study explores how robots have increasingly become the use in these new domains shown their investments. Moreover, discussions on highly advanced control systems, integrated sensors, data fusion, and intelligent learning algorithms are the main areas that are covered in the analysis of the function of the above-mentioned aspects to robot flexibility, environmental change for increasing precision and efficiency besides the places here they are used are also discussed.

The research relates to the proposed study since it has a very deep examination and a broad scope of application in industrial robotics. By investigating the force of breakthrough developments in control systems, sensors, and machine learning algorithms mentioned in the study, the proposed study aimed to relate them to the evolution of automated technologies in the machines used to sort and staple papers. The theoretical framework that the research provided the proper ways flexible solutions are shaped for automation in different sections of practice, then with the clear guidelines of the invention of innovative automation systems comes across.

The article “Automated Plastic Sorting Systems” by Sesotec's (2023) is focused on the automatic plastic sorting machines, which underscores the importance of recycling plastic by breaking it down by type and color to ensure the quality of the recycled materials and thus create an eco-friendlier recycling process. Opting for automated systems, Sesotec has put up systems that make use of the application of different types of technologies for sorting plastic materials, which in turn can be tailored to suit the demands of the respective plastic recycling units. Although no concrete technologies are mentioned, the main discussion is the solutions that Sesotec provides for automatic plastic sorting, which are the potential of automated document sorting systems. With both configurations involved, automation greatly increases efficient material handling and classification.

Through technological innovation, Sesotec provides a light on the automated plastic sorting systems and the researchers used the conclusion in the research and created an advanced and faithful collating and stappling of papers for office efficiency. In both the fields, the most important thing is the use of automation which leads to having a more effective and accurate performance in material handling and classification besides high productivity. It is noticeable that the practices of sorting by type and color used in plastic recycling are so much easier when you notice that documents are all arranged differently by different issues in the office. With the incorporation of the most current and ingenious technologies and methodologies in plastic sorting, the researchers project makes use of the tools accurately and efficiently in document management, and in the end, it will make a more straightforward and efficient working environment.

The research study titled, "Automated Sorting of Recycled Paper Using Smart Image Processing." by Van den Broek et al (2020) deals with the use of image processing methods along with machine learning in the automation of recycled materials sorting that is described in the title as they are suggested. The study gives priority to the use of computer vision techniques to take pictures of recycled paper, which are then analyzed by machine learning algorithms for distinguishing the types of the papers through color, texture, and the presence of contaminants. The key advantages are that the accuracy in sorting with the help of machines is better than with using human labor, recycling operations can be made more efficient, and the quality of recycled paper might be protected by lowering the quantity of pollutants in the streams.

This research is relevant to the proposed study because they both advocate the use of automation and advanced technologies to enhance accuracy and efficiency of the process. The image processing and AI technology applied to recycled paper sorting could be a proving ground for the smart technologies utilization in the automated system for the collating and stapling of documents. By knowing and capturing the functionality and advantages of smart image processing combined with machine learning in automatic sorting, the researchers considered integrating these techniques for the originating of the system and thus minimizing the effect of the problem. Moreover, the application of the mentioned techniques makes the system faster, energy-efficient and more reliable in the processing of documents.

The research “Automatic Waste Sorting Machine” by Instructables (2020) outlines the design of an automatic waste sorting machine which is very simple and can be made at a low cost. Sorting garbage items by the presence or absence of a drilled hole is the main function of the machine. The parts of the system are a vertical zig zag conveyor that makes use of gravity to feed the products for sorting, an LED and phototransistor sensor arrangement to detect the presence of holes by the light transmission, and a microcontroller (8051 microcontroller) that controls the sorting mechanism by using the sensor data and pre-programmed logic. This design lacked the complexity and employs many reused materials. Sorting done in particular to a certain trait may be the case of such a system, but the method can be applied to sort small items in small-scale industries or educational settings. One of the main ideas highlighted would be a fairly simple design compared to complex studies, the presence of only basic sorting tasks using components that are available and design examples of the use of sensor-based sorting systems in various fields such as document sorting beyond the usual.

The Smart Trash Management System project is part and parcel of the researcher’s study that has to do with inventing a state-of-the-art automated collator and stapler mechanism for office productivity through such virtues as simplicity, cost-saving, and sensor technology for the purposes of sorting out the tasks that need to be done. In both projects, the manual tasks become automated in order to enhance operational efficiency. The use of local materials and recyclables in the waste management system reveals some new ideas for proposed project, especially in the design of inexpensive and practical solutions. The idea of having a sensor-based sorting mechanism in the waste sorting machine has far-reaching implications for a similar approach to be taken, especially in the collating and stapling of the office documents, as the accuracy and reliability of this mechanism are improved. This is done by making the processes more effective and using technological innovations as the manual labor is reduced in the office, thereby bringing about productivity growth.

The research titled as “Design and Fabrication of Automated Sorting System” by Badwaik (2023) deals with the production of an automatic color-based sorting system which is loaded with materials. The authors, who are mainly focusing on industrial setting materials, draw attention to the drawbacks of the traditional way of sorting, such as cumbersome, expensive, and a major source of human error. As a consequence, it is therefore revealed that automatic systems should be provided to the industry to increase the speed of the whole process. Thus, the proposed system is set up with the help of a conveyor belt used to transport the objects and a light-dependent resistor (photodiode) sensor to identify the color of each object. The microcontroller (MCU) that has been used in this project is in charge of the sorting process concerning the color identified. Some advantages that arise are the reduction of human labor autonomously through the sorting of the goods, the existing upgraded operation with speed maintained better than hand sorting, and a decrease in the occurrence of injuries due to operators' need to bend and lift many times.

This study relates to the researcher’s study on "Advanced Automated Collating and Stapling Mechanism for Office Efficiency in University of Santo Tomas-Legazpi" in the sense that the IP provided key insights on the design and execution of automatic sorting systems. With implementing the new technology of sensors, microcontrollers, and conveyors to deal with the sorting process which was improved by the researcher's side as they provided us information on it. It is possible that with these new methods and programming technologies, the increased automation of color-based sorting systems and own office machinery will solidify the researcher's overall office efficiency, and at the same time decrease manual workload and related risks.

The research study with the name "Design and Development of a Low-Cost and User-Friendly 3D Printer for Educational Purposes" by Al-Hadidi et al (2022) is a project that concentrates on the establishment of a 3D printer that meets educational settings' requirements. To make 3D printing technology available to students and educators, the primary goals of the research was keeping the costs down and making the machine easy to use to students and teachers, respectively. The chief factors of the research include the design phase, accompanied by the possibility of a cost-effective component choice and user-friendly tools that meet educational expectations. The study examined the functions and real-life uses of the 3D printer built in educational settings, the main focus of the study being the new API's potential impact on learning and innovation.

The researchers have taken the study on "Design and Development of a Low-Cost and User-Friendly 3D Printer for Educational Purposes" in their literature review stage because it is an essential topic in the technological and educational side. The researchers looked for the results of the study on the steps required for producing an affordable and user-friendly 3D printer. The researcher's study was an attempt to verify how these need-of-the-hour concepts are also manifested in the invention of their merchandising product. The study has dealt with the theme of improvising student-friendly systems and the researchers aim is designing a practical and efficient system for this purpose. Furthermore, the educational 3D printing experiment provides great insights that would allow the technology integration into educational and organizational environments.

The study “Fully Automated Paper Document Sorting Robot Design” by Yang and Zhang (2023) published in Journal of Electronic Research and Application discusses designing a mobile robot for classifying documents and sorting them out. Although there is little information on this robot’s design in the available reference, it highlighted how robotics can be used to automate handling documents. Considering both static as well as mobile techniques for automating document sorting helped the researchers understand more about this field and even provided insight into coming up with creative solutions for researchers' own immobile machinery. Furthermore, adding lessons from mobile robotics assisted us to identify some features or functionalities suitable for making a good but fixed—positioned document collating equipment that may be efficient when used on large scale bases while reducing certain human tasks like walking around collecting papers unnecessarily.

The researchers study examined the construction of an automatic collating and stapling machine which improved the document processing speed. Such a system is expected to be stationary so as to optimize throughput and organization in a given work area. Nevertheless, the idea of mobile document sorting robots caught the researchers attention.

The research titled “Intelligent Document Processing -- Methods and Tools in the real world” by Cutting (2021) does a practical analysis of Intelligent Document Processing (IDP). The study was targeted at industrial users, executives or business owners who are interested in implementing IDP solutions for digitalization (Industry 4.0) purposes thereby focusing more on areas such as document classification, information extraction, and integration with business processes. Key components covered herein include an evaluation of current challenges faced in processing documents relevant to the real-world including forms and invoices, a review of existing OCRs, document classifiers, and data extractors as well as some thoughts concerning present limitations specifically around complicated document structures. Furthermore, the paper briefly explains how IDP has been enhanced using deep learning methods thus giving some insights into how IDP functions in today's context both operationally and technically.

The researchers had chosen the study for the literature report. The reason was its approach to practical solutions regarding IDP's applications in business and Industry 4.0. They discuss the techniques of document classification, challenges in the data extraction field, and the efficacy of the OCR tool in realworld conditions. By exploring the study's insights into document classification, data extraction challenges, and the effectiveness of OCR tools, the study research aims to draw parallels and derive lessons applicable to enhancing automation and efficiency in the development of an automated collating and stapling mechanism. The study's examination of IDP technologies and their real-world implementations provides a foundational understanding essential for evaluating and improving automated document handling systems in organizational environments.

The study "Mechanobiological considerations in colorectal stapling: Implications for technology development" by Cauk, et al (2023) was done to find information on which mechanical forces exerted by surgical staplers can be beneficial during colorectal anastomosis and which of them can be responsible for tissue healing problems and perfusion. Lately, the field of mechanobiology has gained significant attention, which focuses on the interaction between healthy tissues and mechanical forces they are subjected to. This paper deals with the effect of tissue responses to mechanical stimuli and their consequence to healing and perfusion during colorectal anastomosis. The paper would definitely cover the topics like how staple technology is currently being used as being one of the most challenging issues in the field and how innovative devices in the form of new stapling systems for colorectal surgeries can be used to not only improve the quality of the procedure and patient recovery but to reduce the limitations caused by the implementation of various hardware types.

The researchers preferred this paper on "Mechanobiological considerations in colorectal stapling: Implications for technology development" for their literature review as it provides insight on the mechanical impacts of surgical stapling in colorectal surgery. Their research strives to verify the effect of automation using the tissue findings, which compare the forces and their impact on the growth and perfusion during colorectal anastomosis, with the development of efficient and effective mechanisms in the researchers automated collating and stapling system. The study's contribution to better surgical practice through the improvement of the stapling technologies is a great one. It offers new perspectives on the optimization of the design and functionality of office automation, with an emphasis on the precision and reliability of automatic document processing.

In the article “What Automated Collating Options Are Available in Modern Copiers “by Electronic Office Systems (2023) the topic of the various modern copier collating options is tackled. Collating basically means the sorting and arranging of documents in a specific order. Automated collating in modern copiers provides many advantages, for instance, it saves businesses time and money. The article demonstrates several functions, such as booklet that is one of the functions, it arranges and assembles the pages into a booklet format, then multi-sheet saddle stitch, this one staple multiple sheet together at the fold line, and printing from multiple paper trays, which makes it possible to print from various sources of paper in a single collating job.

This article was carried over from the researchers study on the "Advanced Automated Collating and Stapling

Mechanism for University of Santo Tomas-Legazpi Efficiency" in which the limitations and benefits of the present automated collating systems are documented. With respect to such tools, the researchers can specify and approach the benchmarks and the efficiencies that they wanted to achieve with their mechanism. Moreover, advanced options such as booklet creation and multi-sheet saddle-stitching can inspire them to enhance the total utility and the user satisfaction of this system. It would then also align with their goal that the office efficiency improves.

Synthesis of the study

The review on related literature showed the application and importance of different studies in the development work of "Advanced Automated Collating and Stapling Mechanism for Office Efficiency" at the University of Santo Tomas - Legazpi. The primary goal of these studies, was to implement automation systems in different spheres, leading to the increase of efficiency and the reduction of manual labor. A number of studies looked at the significance of automation in material handling and sorting processes. For instance, the research conducted on the automatic sorting machines, such as the one that utilizes Programmable Logic Controllers (PLCs) and sensors, showed how automation can lead to quicker and more precise sorting of the materials. The core ideas promoted by the researchers' study, were designed to make documents go through queues.

Other studies, such as those in Intelligent Document Processing (IDP) and automated waste sorting systems, are examples of the advantages of integrating complex technologies, for example artificial intelligence and machine learning, in automatons. These tools can improve the accuracy and reliability of sorting equipment, thus building a state-of-the-art collating and stapling machine. The research on waste sorting utilizing smart image processing technology particularly complements the researchers aim of developing the correctness of document handling through cutting-edge technology, that is, image recognition.

The use of low-cost, user-friendly designs as the focus of such experiments as the development of automated sorting machines and 3D printers for educational purposes underlined the significance of affordability and ease of use. The end result was the same concept researchers aimed to fulfill which was to devise an economical and smart fixed solution for office facilities while guaranteeing that this proposed system is both low-cost and easy to use. Furthermore, the lifecycle assessments, such as the one on stapling machines, are a convenient tool for examining the ecological aspects of the production and utilization of automated gadgets. The above considerations were used to identify the most ecological materials and integrate ecofriendly features into the collating and stapling mechanism.

At long last, the paper about the automatic modern collating options in copiers turned the attention to the usefulness of systems in the real world through practical applications. The qualities of a system such as booklet creation, multi-sheet saddle-stitching, and the program's ability to print from several paper trays played an active role in the design and operation of their arrangement. That it could function the most appropriate way to satisfy the requirements of office operators. Technology is the technology-powered world, and literature, in general, it is already promoted the transformation of manual to increasingly automated technologies that can perform the tasks in a more efficient and productive manner. Booklet creation, multi-sheet saddle-stitching are some of the facilities that one and print from several paper trays often makes choices for the development and proper functioning of the researchers proposed mechanism, respectively, aside from the diversity of users. To summarize, all the associated literature is in accord with the advantages of automation in the workplace in terms of efficiency, accuracy, and environmentally friendly practices. Their wisdom gives technologies and methods that can be implemented in the researchers super-advanced systems for automatic collating and stapling technology that in turn is used to the final aim of the university staff to lay-off the root cause of inefficiency, which is manual labor use.

Gap to be bridged

While much of the past literature is rich with information about automatic machinery and the things that can be done with them, there seems to be a gap in the area of machines that can automatically collect and staple documents, which is typically found in academic places like the University of Santo Tomas Legazpi. Most of the studies that are being inquired into are the sorting and handling of materials in industrial areas, as well as waste management and documentation, however, the research in the field is rather shallow on the requisite and unusual situations that the office environment presents for document collation and stapling a daily task.

Besides, a small part of the research delves into the effectiveness and correctness of the AI and machine learning methods, but lacks the necessary studies that includes these technologies with the acumen of office document handling. The present automated options mostly focus on cheap and user-friendly designs, or, in contrast, high-tech and sophisticated systems, which are barely used in the office setting.

Furthermore, it is important to mention the lack of knowledge of these automated systems by many
people, thereby their interaction with the environment. In most of the cases lifecycle assessments and studies of sustainability are implemented to find out things on the general level and that is why big companies should first change. The highly required research should be a special one that tackles environmental aspects of office automation

components, such as material selection, energy consumption, and end-of-life management.

The researchers study sought to address the points mentioned above through building an improved
automated system for joining and stapling sheets that will be used in the office operations of the University of Santo Tomas-Legazpi. This elaborate examination employs a combination of technologies to grant high precision and fault-tolerance ahead of all other benefits in terms of low-cost and user-friendliness that might be there, and at the same time impose measures to take the sustainability of the environment into account.

Operational Terms

1. **Automated Collating Machine:** A machine designed to organize individual sheets of paper into a specific order, preparing them for subsequent stapling. This process involves sorting and arranging pages in sequence, typically from last to first, to ensure proper collation.

2. **Bond Paper:** The physical paper on which the document will be stapled.

3. **Collating Mechanism:** The part of the machine responsible for gathering sorted paper sheets into a single, organized stack. It ensures that all pages are properly aligned before they are stapled.

4. **Duplication Prevention:** The system's capability to avoid errors such as the inclusion of duplicate pages in the collated and stapled documents, ensuring each set of papers is correctly ordered and complete.

5. **IR Sensor:** An infrared sensor used to detect the presence of paper

sheets within the machine. It initiates a countdown timer for the stapling mechanism and resets the timer if new sheets are detected, ensuring no interruptions in the collating process.

6. **Paper Propeller/Ejector Function:** A feature of the modified printer that propels paper sheets out of the printer and into the paper bin elevator, facilitating the automated sorting and collation process.
7. **Paper Bin:** A container within the machine that holds paper sheets ensuring papers are sorted into the correct sequence.

8. **Stapling Mechanism:** A component of the machine that uses a stapler to bind together a stack of collated papers. It operates based on inputs from sensors and timers to ensure accurate and timely stapling.

9. **Sequence Control:** The method by which the machine manages the order and timing of its various functions, such as paper ejection, sorting, collation, and stapling, to prevent errors such as duplication or misordered documents.

10. **Sorting Mechanism:** The system within the machine that organizes individual sheets of paper into a designated order. This mechanism works in conjunction with the paper bin elevator to ensure papers are properly sorted before collation.

METHODOLOGY

Research Design

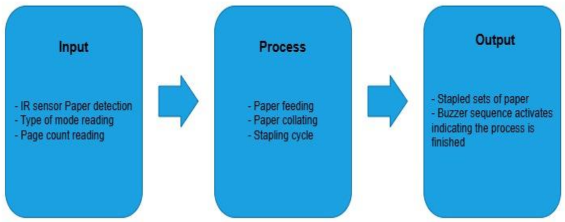

Figure 1. Conceptual Framework

Figure 1 shows the Input-Process-Output (IPO) framework of the Advanced Automated Collating and Stapling Mechanism for Office Efficiency project. Initially, the system detects paper from the tray, reading the selected mode (whether collated or uncollated) and counts the pages. After the input is processed, the tasking of the system consists three major tasks: paper feeding, where the sheets are automatically fed into the mechanism; paper collating, where the papers are arranged based on the selected mode; and the stapling cycle, where the stacked papers are securely stapled together. The entire process has been controlled using an Arduino Mega microcontroller to ensure automated accurate operation. The paper bin management system properly lifts and allocates paper based on the number of pages to be inserted for document handling. After the stapling process has been completed, there are sets of stapled documents, and a buzzer sounds to indicate that the process is finished.

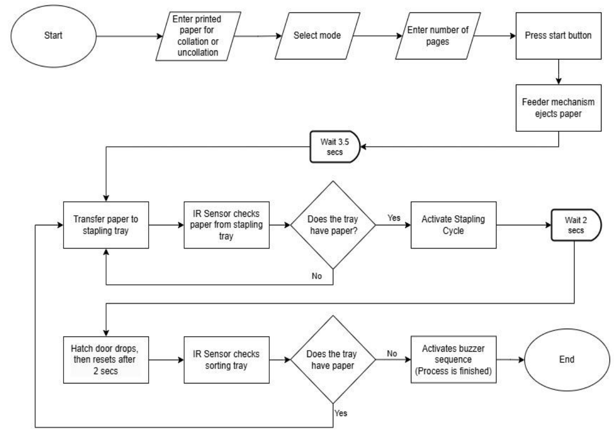

Figure 2. Flowchart of the Project

The flowchart illustrates the sequential processes of the "Advanced Automated Collating and Stapling Mechanism for Office Efficiency at the University of Santo Tomas Legazpi." The process begins with the user inputting the mode (collated or uncollated) and specifying the number of pages. Upon pressing the start button, an IR sensor checks whether the paper tray has paper. If no paper is detected, the process is aborted until paper is added. Once the paper is confirmed the feeder mechanism activates and ejects the paper to the stapling tray. Now it depends on the timing for the stapling cycle to be activated the given timing was calculated making sure that the paper are all set to be stapled. After the paper are stapled there is a delay of 2 seconds, the hatch door opens to release the stapled paper and returns to its original position. The process continues with IR sensor checking the sorting tray. If there is no paper detected the buzzer activates in sequence, indicating completion. Otherwise, the system loops back to adjust accordingly. This automated process ensures accuracy and efficiency in collating and stapling tasks.

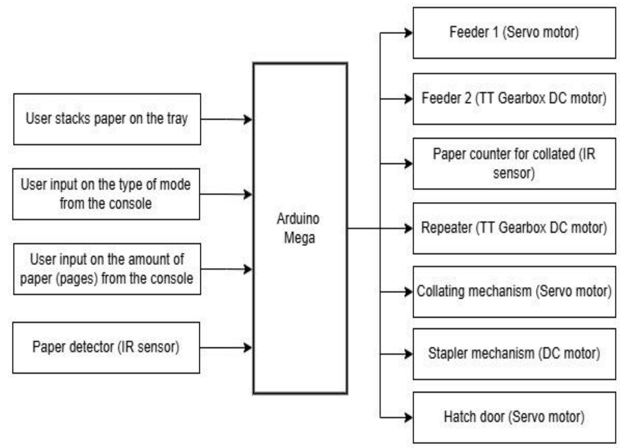

Figure 3. Block Diagram

Figure 3 clearly Illustrate how the system looks in the block diagram of the design. The block diagram shows how the components of automated collating and stapling mechanism comes to life. The Arduino Mega acts as the core of the system because it is where all the main processor occur. The user first arranges a stack of papers in the tray one by one by their page numbers (e.g., 1, 2, 3, etc.). Then, the user sets the number of pages of document from the console which are to be stapled. The processor reads this input and then executes the code based on the input which sends it to the motor feeder from the paper tray dispenser and allows it to dispense the required number of pages in the optimal sequence. After the paper has been discharged part of the processor is sending information to the stapler to make it start and close the set of documents like the stapler was on autopilot. After that, the stapled document shall be deposited into the finished tray. The very last stage is the system is in a ready state for the next following document to be stapled. This diagram is a step-by-step guide that explicitly outlines the impact of the user processor, paper tray dispenser, and stapler for having the efficient automatic collating and stapling.

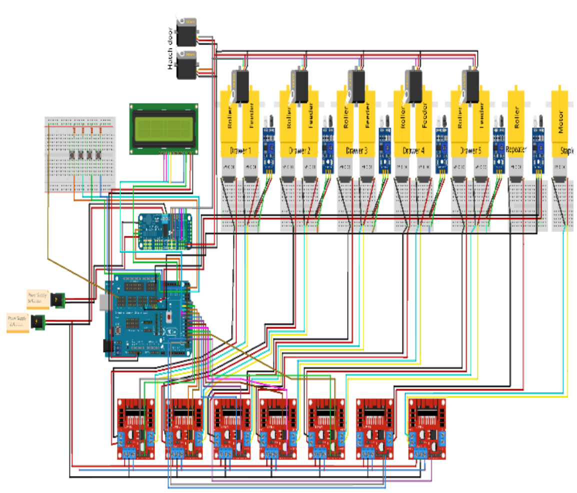

Figure 4. Schematic Diagram of the Project

Figure 4 represents the circuit diagram which depicts an Arduino-based automation system designed to control a feeder mechanism, a stapler mechanism, and an ejector mechanism, which are all managed by repetitive motors in the created system. For the Arduino, which is found on the left side of the figure, the connections are assigned to different pins such as 3.3V, 5V, and GND for the power supply, by which the device is operated.

In this setting, there are three driving motors that can be attached to the respective motor driver. The first motor driver run through the motor that moves the paper feeder and activates the motor. The second motor driver controls a torque motor to rotate the stapler mechanism. The third motor driver is responsible for paper ejection, and it makes the motor work. The motor driver trying to see if paper is there in the stapler tray also includes a sensor. The signal of the sensor goes back to the Arduino to make sure that the feeding, stapling, and ejecting processes are properly synchronized. The Arduino sends forward and backward signals to each motor driver to control the movement speed and operation, respectively, of the motors. This, in turn, facilitates the fine tuning of the automated tasks. The whole- entire system is designed to be seamlessly integrated and the whole thing, which is better than what is already in place, is very efficient when it comes to the drawing and use of the stapler. The process starts from the user when he inputs the printed paper to be used in the collating, indicating the number of pages that are to be piled up in one set and the number of sets that are to be collated and stapled. This feeder mechanism than starts up, and a paper that then comes out of the stapling tray is then added to it. The IR sensor is checking whether the amount of paper entered is correct or not. If not, the system will go back to the paper amount and correct it until it is satisfied. The system goes on the paper loop, sending the stapling process. Another IR sensor is working and if it reads the number of stapled sets equal to the user input the process ends; if not, the system reprograms accordingly. In this model, it can be noticeable how specifically ordered and automated the process is, which ultimately leads to not only accuracy but also efficiency in document collation and stapling procedures.

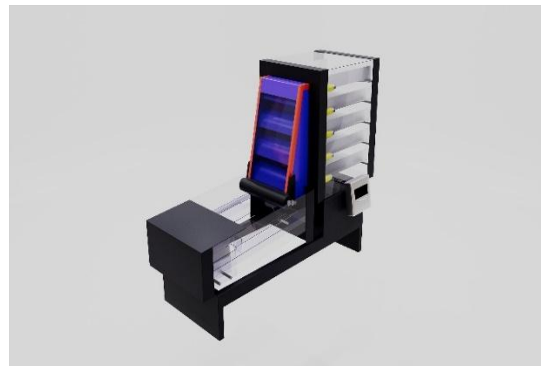

Figure 4. Prototype Blueprint

Figure 4 represents the prototype blueprint of the study which has a detailed design for the automation of document handling, it showcases the same. A paper feeding tray, a feeder mechanism with optical sensors, and a stapler mechanism are elements of the design. The paper feeding tray is on top and is the place where the paper stack to be collated is placed. The feeder mechanism, which is equipped with optical sensors, confirms that all paper movements are detected satisfactorily. Additionally, a stapler mechanism is placed to perform the accurate stapling of the collated papers. These components are essential for the document disassembly, yet the researchers focus on an enticing way of the description. As a result, they elaborate extensively on the previously presented parts, and at the same time, they present each one as the most effective of the options.

The blueprint also mentions the motor controller location, which is essential for controlling the machine's operation, and also for the use of rollers or conveyors to transport the paper to the finished tray. An LCD or OLED segment display is implemented for counting the number of pages on which stapling is needed, giving the user the correct feedback in real-time. The whole design was developed to showcase the seamless and very minimal time-consuming stapling concept with the neat output seen as papers firmly attached to the finished tray. The blueprint provides an understandable image of how the machine's layout and the involved components interact, important for coming up with an efficient and technical advanced design for the automated document handling system.

Materials/Components

Figure 5. Arduino Mega

The Arduino Uno is a versatile microcontroller board based on the ATmega328P, widely used in electronic projects and prototyping. This will serve as the controller for the collating device that will be overseeing the various parts and tasks of the system.

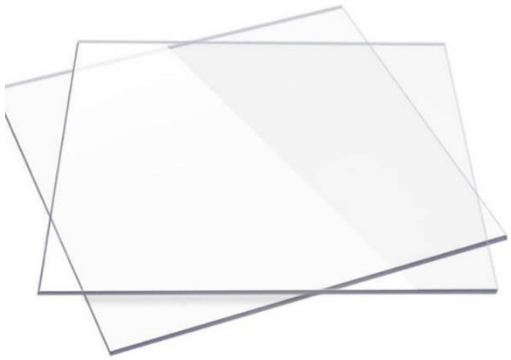

Figure 6. Clear Acrylic Sheet

Clear acrylic sheets are strong and lightweight materials made from transparent plastic. These sheets will serve as the main material for building the housing and structural frame of the device, providing durability and a sleek, modern appearance.

Figure 7. Aluminum pipe

An aluminum pipe is a lightweight and sturdy material often used for structural support. In this device, the aluminum pipe serves as the supporting foundation for the cabinet slots, ensuring stability and durability for holding the paper securely during operation.

Figure 8. Bolts and nuts

Bolts and nuts are essential fasteners used to securely join materials and components. In this device, bolts and nuts will be utilized to construct and reinforce the housing and structural framework, ensuring a durable and stable assembly for all its operational components.

Figure 9. TT Gearbox motor DC 9V

The 9V DC motor is a type of electric motor that runs on 9 volts of direct current (DC) power. The DC motor will have a crucial role in driving the mechanical components responsible for handling and processing paper documents.

Figure 10. Servo motor SG90

The SG90 servo motor is a compact and lightweight actuator known for its precise angular movement. In this device, the SG90 servo motor is used to control the hatch mechanism at the bottom compartment of the automated stapling system. This allows the stapled paper to be released efficiently and smoothly, ensuring the proper functioning of the system.

Figure 11. Rubber bands

Rubber bands are elastic loops commonly used for securing or transmitting force in simple mechanical systems. In this device, rubber bands will function as belts for the plastic pulley, providing a flexible and lightweight mechanism to drive the system efficiently and reliably.

Figure 12. Rubber sleeves

A rubber sleeve is a flexible covering often used to provide grip or protection in mechanical systems. In this device, the rubber sleeve will coat the idler roller, ensuring sufficient friction for feeding paper smoothly and preventing slippage during operation.

Figure 13. Idler Roller

An idler roller, normally used in conveyor systems and other machinery used in guiding and supporting the movements of materials or belts. The rollers will be used in handling the paper.

Figure 14. Plastic Toy Car Wheel

Plastic toy wheels are little, strong wheels made from plastic. These will be used in the paper handling mechanism to help aid in movement of paper sheets.

Figure 15. Electric Stapler

An electric stapler is a tool that has been made to automate stapling by using electric power to drive staples through sheets of paper with accuracy and consistency. The electric stapler will be the core component for the stapling mechanism of the device.

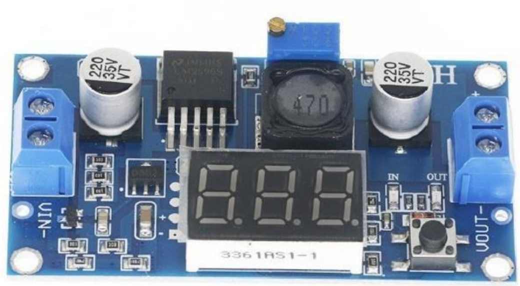

Figure 16. DC-DC Buck Step Down Converter LM2596S

A DC-DC Buck Step Down Converter LM2596S is a voltage regulator used to step down a higher voltage to a lower, stable output voltage. In this system, the LM2596S will be used to efficiently regulate the voltage to the necessary levels for the electronic components, ensuring proper power distribution and preventing damage from voltage fluctuations. This component will help ensure that each part of the system receives the correct voltage for its optimal operation, contributing to the overall stability and performance of the device.

Figure 17. IR emitter-detector sensor

An IR emitter-detector sensor includes an infrared (IR) light-emitting diode (LED) and a photodetector that is capable of detecting the IR light. The IR emitter-detector sensor will be used in the detection of the paper as it moves through the stages of the process.

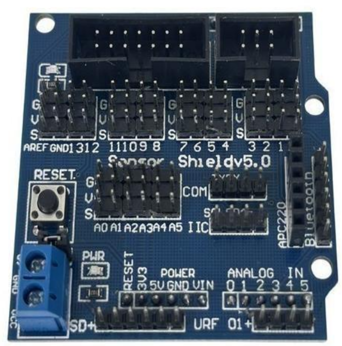

Figure 17. V5.0 Sensor shield

A V5.0 Sensor Shield is an extension board designed to make connecting sensors and modules to an Arduino easier by providing multiple ports and simplifying the wiring process. In this system, the V5.0 Sensor Shield will be used to facilitate the connection of various sensors and components, enabling smoother communication between the hardware and the controller. This will support efficient operation during the paper handling process by ensuring reliable connections and signal transmission between components.

Figure 18 Electrical Tape

Electrical tape is tape product used to insulate electrical wires and other materials that conduct electricity. This will be used to isolate exposed electrical connections preventing short circuits or electrocution.

Figure 19. Jumper wire

A jumper wire is a short electrical wire used to make connections between different points on a circuit board or prototype. It is often used for temporary connections during testing or prototyping. In this device, jumper wires will facilitate connections between electronic components such as sensors, motors, and microcontrollers, ensuring that the electrical signals can flow properly across the system for correct operation.

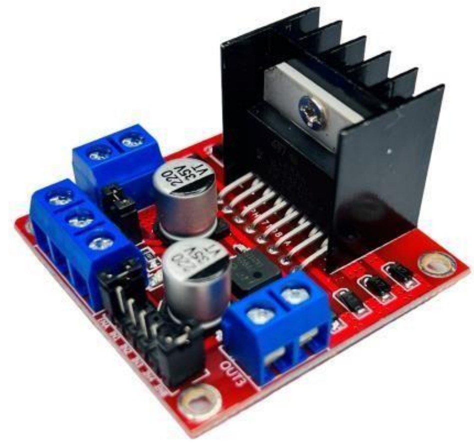

Figure 20. Motor Driver

A motor driver is a particular device enabling the regulation of two DC motors speed and direction at the same time. The motor driver will be used to allow the controller to interact with the motors in the device.

Figure 21. Buzzer

A buzzer when powered produces sound. The buzzer will be used in signaling the user when the process is done.

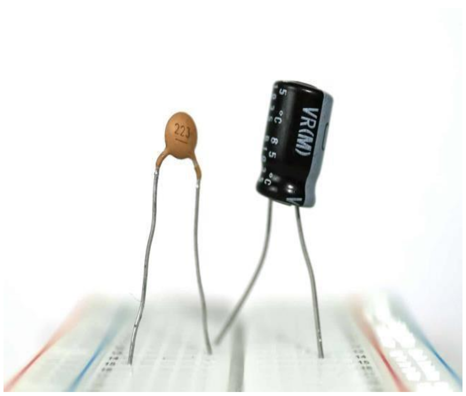

Figure 21. 100μF and 0.1μF ceramic capacitors

The 100μF and 0.1μF ceramic capacitors are used in this system to filter the power output from the DC-DC step-down converter, which converts the 24V, 6A input from the charger. The 100μF capacitor helps smooth out any low-frequency voltage fluctuations, providing stable power to the components. The 0.1μF ceramic capacitor, on the other hand, filters high-frequency noise, ensuring that the power supply is clean and stable for the sensitive electronics within the system, improving overall performance and reliability.

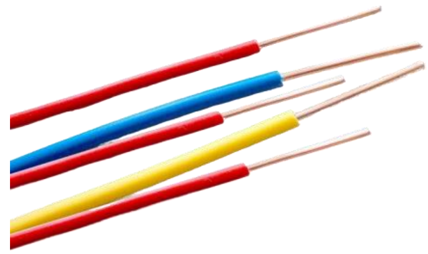

Figure 22. Solid wire

The solid wire is used for the final wiring in the system to ensure that it can handle the higher current from the power supply. Solid wire is more durable and capable of withstanding higher currents compared to stranded wire, making it ideal for the main power distribution circuits. It also provides more stable connections and reduces the risk of overheating, ensuring that the power is reliably delivered to all components in the system without any loss or interference.

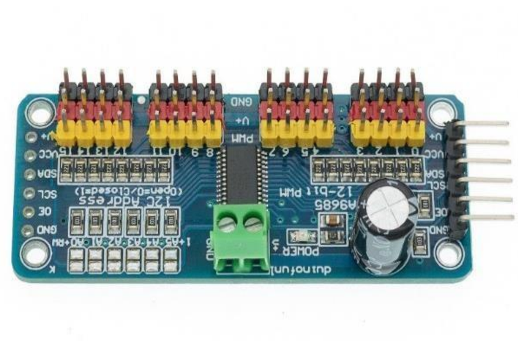

Figure 23. PCA9685

The 16-Channel 12-bit PWM Servo Driver – PCA9685 is used to control the SG90 servo motors in the system. This driver allows for precise control of up to 16 servo motors through a single I2C interface. With a 12-bit resolution, it ensures smooth and accurate movement of the motors, which is essential for the paper handling process. The PCA9685 driver is particularly effective in managing multiple servos simultaneously, reducing the complexity of wiring and improving the overall performance and flexibility of the system.

Figure 23. Tactile Button Switch

The Tactile Button Switch is a small, user-friendly switch that provides feedback when pressed. In this system, it is used for controlling functions such as starting, stopping, or adjusting settings. Its compact design and tactile response make it ideal for simple user interactions.

Figure 24. DC24V 6A Adapter

The DC24V 6A Adapter is a power supply transformer that converts AC voltage to a stable DC output of 24V with a current capacity of up to 6A, providing 150W of power. It is typically used for powering devices such as LED lamps and amplifiers, offering reliable performance for projects requiring a constant voltage supply. This adapter is available in both US and EU plug options, making it versatile for use in different regions. Its compact design makes it ideal for use in various electronic systems.

Implementation Plan

Table 1. Implementation Plan

Strategy	*Activities*	*Persons Involved*	*Duration*						
			Aug	Sep	Oct	Nov	Dec	Jan	Feb
Setting and preparing Components	- Installation of Arduino software and acquiring all necessary materials and components to be used in the design	Researchers							
Prototyping Phase	- Programming the software of the system - Building basic version of the device	Researchers							
Building the device	- Building the final version of the device - Connecting all the components needed by modifying the internal part of the device	Researchers							
Experimentation	- Doing test runs on the device to check possible faulty actions or see if it needs improvements	Researchers							

Table 1 represents the implementation plan of the researchers for the project. It consists of the strategies and activities on what the researchers are going to do in order for the project to be a success. It also shows the duration on how much time the activities are going to consume for the project.

Data Gathering Tools

For this study, the researchers have employed two primary data gathering tools: (1) First is the internet research which involves gathering the latest information in automation technologies, best practices in document handling, and that which are the already existing studies and implementations of the robotic systems. This is to help the researchers to know the technology that is being used at present and shows the points which might be improved in the prototype. (2) Device test runs setting sequences extend the prototype with the identification and error recovery of the functions. Over more test trials, the researchers may focus on its efficiency in the document's collation and stapling, its accuracy in handling various document sizes and thicknesses, and its overall reliability in an office environment. The researchers used these tools to gather data and in turn made their prototype techniques more practical to minimize manual transmissions of documents and to increase the efficiency of offices.

Ethical Considerations

One of the primary ethical aspects of the proposed research exists in the following key areas. First, the study should maintain the privacy and confidentiality of information that is collected freshly, especially if a user's information is engaged. Second, the protection and ergonomics of the machine must be the paramount concern to deter workplace accidents. Third, the environmental effect of the materials and procedures used in the prototype should be lessened. Lastly, the research should strive for unambiguity and credulousness in reporting information, thus not misinforming about the machine's capabilities or performance.

RESULTS & DISCUSSION

The purpose of the study is to provide an ease of collating and stapling documents for school and office staff allowing their time to be utilized in other tasks while documents are automatically collated and stapled. The proposed device will collate and staple the provided documents into a configurable page amount before it is processed and stapled by the machine.

Presentation of Data

Table 2. Data results of phase 1: Display interface

Trial Number	Results	Remarks
1	Without page input restrictions	Arduino Mega has been able to increment and decrement the pages through buttons but no with no number of limits.
2	With page input restrictions	Arduino Mega has been able to increment and decrement the pages with a limit

		of not greater than 5 and not less than.
3	With mode option	Arduino Mega has been able to increment and decrement the pages and select the type of mode either collated or uncollated mechanism.
4	With buzzer	Arduino Mega has been able to increment and decrement the pages and select the type of mode either collated or uncollated mechanism with a buzzer sound to alert the users that they have successfully pressed the button or the buttons are functional.
5	With IR sensor logic	Arduino Mega has been able display a message of no detected papers which will abort the process when there is no paper detected based on the inputs of paper.

Phase 1 of the project, as summarized in Table 2, focuses on the display interface functionality of the Arduino Mega. Initial trials demonstrated successful button-based page increments and decrements, which were later enhanced with page input restrictions (5 as the maximum, not less than 1). The interface also integrated mode selection (collated or uncollated) and user feedback mechanisms, including a buzzer to indicate button presses. Finally, IR sensor logic was implemented to detect paper presence, ensuring accurate functionality by halting operations when no paper was detected.

Table 3. Data results of phase 2: L298N motor driver and dc motors (Power supply)

Trial Number	Results	Remarks
1	Successful	The L298N motor driver has been able to run one 3V DC motor during the start process
2	Unsuccessful	The L298N motor driver has not been able to run the second 9V DC motor.
3	Successful	The L298N motor driver has been able to run the first and second DC motor with external power supply of 9V from the XL6009 dc stepdown converter converting the power supply of 24V and 6A charger

The data in Table 3 highlights the performance of the L298N motor driver during phase 1 of the experiment with DC motors. The results demonstrate varied outcomes under different conditions. In Trial 1, the driver successfully ran a 3V DC motor which was connected to the power source of Arduino Mega during the start process. Trial 2 was unsuccessful in powering a 9V DC motor. However, in Trial 3, success was achieved by integrating an external 9V power supply via an XL6009 step-down converter, showcasing the driver's capability to handle multiple motors with appropriate power management.

Table 4. Data results of phase 3: DC motor speed

Trial Number	Results	Remarks
1	Unsuccessful	The DC motors has been able to run without speed limit but way too fast which damages the bond paper during paper feeding
2	Unsuccessful	The DC motors has been able to run with the speed limit of 40 but is way to slow during the paper feeding
3	Successful	The DC motor has been able to run with the speed limit of 95 the

		researchers think that the speed fits for the machine
4	Successful	The DC motor was updated to speed limit of 225 which is the maximum speed of the dc motor because the roller was to heavy that is why the speed limit before was unfit

The table reflects iterative adjustments to the DC motor speed for optimized paper feeding. Initially, running the motor without a speed limit resulted in excessive speed, damaging bond paper (Trial 1). Trial 2 reduced the speed to 40, which proved too slow for effective feeding. In Trial 3, a speed limit of 95 was tested and deemed optimal by the researchers, ensuring smooth and efficient operation without compromising paper integrity, demonstrating the importance of balancing speed and functionality.

Table 5. Data results of phase 4: IR sensor's sensitivity

Trial Number	Results	Remarks
1	Successful	The IR sensors are able to detect the papers without range threshold limit
2	Successful	The IR sensors are able to detect the papers with a range threshold of 10 cm the researchers think this is the optimal choice of threshold

The results in Table 5 demonstrate the effectiveness of the IR sensors in detecting papers under different conditions. In the first trial, the sensors successfully detected papers without any range threshold limit, showcasing their inherent sensitivity. In the second trial, the sensors maintained accurate detection with a defined range threshold of 10 cm, illustrating their adaptability and reliability within a set distance. These findings confirm the IR sensors' consistent performance and suitability for applications requiring precise paper detection.

Table 6. Data results of phase 5: Hatch door Servo motor SG90 degree rotation

Trial Number	Results	Remarks
1	Unsuccessful	When the IR sensor detects the paper two servo motor has been able to run with a 30-degree rotation but are not in sync and the set degree are not enough.
2	Unsuccessful	When the IR sensor detects the paper two of servo motor has been able to run on sync with a 90-degree rotation and with same initialize closed position from the setup but did not meet the desired outcome due to having the same direction of the servo motors.
3	Successful	When the IR sensor detects the paper two of servo motors has been able to run on sync with 90-degree rotation and with different initialize closed position from the setup while on the setup the first servo was set to 180 degrees and the second one was set to 0 degree then when the IR sensor detected the paper two servo motor will adjust to 90 degrees.

The experiment in Phase 5 focused on testing the synchronization and angle adjustment of two SG90 servo motors using an IR sensor to detect a specific stimulus (paper). In the first trial, the servo motors rotated to 30 degrees upon detecting the paper. However, synchronization between the motors was not achieved, and the 30-degree rotation was insufficient for the desired outcome, making the trial unsuccessful. In the second trial, the servo motors rotated to 90 degrees in sync when the IR sensor detected the paper, but both motors were initialized to the same closed position during setup. This resulted in misalignment and failure to meet the desired outcome, as the motors moved in the same direction. The third trial was successful, as the motors were initialized to different closed positions-one at 180 degrees and the other at 0 degrees. Upon detecting the paper, the system adjusted correctly, achieving synchronized 90-degree rotations. These results highlight the importance of proper initialization and calibration of servo motors to ensure synchronization and desired angular adjustments.

Table 7. Data results of phase 6: Stapler mechanism dc motor speed threshold & timing

Trial Number	Results	Remarks
1	Unsuccessful	The speed threshold for forward and backward of stapler using dc motor was set to 80 and the delay was set to two seconds. It was too slow it did not meet the requirement to staple.
2	Successful	The speed threshold for forward and backward of stapler using dc motor was updated to 120 and the delay was set to two seconds. It manages to staple but not working efficiently. Thus, produces uncomfortable sound due to crashing in the end point barrier.
3	Successful	The speed threshold for forward and backward of stapler using dc motor was updated to 180 and the delay was set to 0.4 seconds. It successfully meets the staple mechanism eliminating the crash.

The three tests conducted on the DC motor speed threshold in the stapler mechanism and their time periods as shown in Table 7 were as follows. The first trial failed because the speed threshold for both forward and backward motions was set at 80, whereas the time delay was two seconds-thus such settings were too slow for stapling purposes. The second trial increased the speed threshold to 120; same delay and successfully stapled but inefficiently, giving an uncomfortable noise due to crashing at the endpoint barrier. The third trial succeeded by still increasing the speed threshold to 180 while changing the time delay to 0.4 seconds, thus fulfilling all requirements of the stapling mechanism while removing the crash issue of the periphery of the device. All these findings prove the necessities of both speed and timing for full operational efficiency of the stapler mechanism.

Discussion

The introduction of the Advanced Automated Collating and Stapling Mechanism has been designed to solve the inefficiencies found in office activities, especially in jobs that involve collating and stapling papers. This research has managed to automate these tasks to a great extent, through the integration of various components such as motors, sensors, and controlling systems. It was especially the complexity of integrating several systems that made things difficult to handle. For one, driving the motors in sequence and the proper paper routing delivered some pain.

Additionally, issues arose with the power and control systems, particularly in handling the 9V DC motor that powers the stapling mechanism. It brought about deeper reflection as to how the researchers chose the parts in ensuring durability and performance. However, there were challenges, the researchers managed to figure out the ways that allowed the system to operate as it was supposed to.

The final mockup is satisfying the goal of automating the stapling and collating processes and convincingly shows that such structures for pull-off arrangements can be built in office situations. Also, these experiences highlight the importance of iterative design and testing in overcoming unforeseen technical difficulties, and they offer valuable insights into the design of automated office tools for future applications.

Findings

After completing the coding and hardware connections of the prototype, the researchers found the following:

- The prototype requires a 12V, 20A external power supply to function properly. Multiple components, including motors and sensors, are connected to this power source. The Arduino Mega cannot directly power the nine Servo motors and Eleven DC because their combined current consumption exceeds its capacity.
- The system requires thick wires to handle the high current flow and prevent voltage drops.
- The prototype may restart due to overloading or overheating, especially when multiple motors are operating simultaneously. Proper heat dissipation and load management are necessary to ensure stability.

Recommendations

The study findings propose several measures to advance the functionality and reliability of the Advanced Automated Collating and Stapling Mechanism. To begin with, future iterations of the prototype should have more durable and high-torque engines for bigger and heavier pieces of paper. That would increase the system's capacity to run effectively in rigorous office settings. Moreover, attempting high-level sensors and algorithms can add precision to collation as well as stapling procedures.

The researchers in addition want to suggest that the use of a modular design is essential for easy maintenance and expandability. A modular scheme will provide each part (e.g. stapler or collator) to upgrade or replace without needing significant changes. Furthermore, implementing of wireless connectivity might enable remote tracking and control of the system, thus enhancing the usability of the system in the modern offices.

Finally, the study will be aiming at exploring some possible ways of the expansion of the functionality of the mechanism such as sorting of the document types or the design paradigm which will include non-standard paper formats. Addressing these improvements will confirm the system can meet the already present office requirements and also changes according to the needs of users in different places.

Conclusion

The installation of the Advanced Automated Collating and Stapling Mechanism for the administrative prosperity has effectively accomplished the priority goals of the research. The prototype can efficiently perform office tasks, this can be realized by the use of different hardware and control systems such as motors, sensors, a user-friendly interface. The operation of the system is proof of how much automation can help reduce the time and the energy that goes into manual office tasks, thus gateways to an environment where efficiency is the key.

During the project, the team faced many problems, one of the critical tasks was to manage the power requirements of the 9V DC motors and to ensure a precise coordination between the mechanical components. The unfamiliarity with this issue did not stop the researchers, who were able to make the relevant corrections to the design and to introduce the necessary solutions which in every way led the system to the performance desired. The adaptation to that direction made the researchers live through the whole issue of which the project was of course automation in practice and automation at the office but provided two frontline experiences one in the problems existence and two in their vision. Only having measured the pain can the beauty of a solution be truly known. The pronging of operations such as assembly and packaging, besides the hardware aspects was necessitating some reengineering through the software infrastructure of the controllers.

By finishing the development of the prototype, the researcher’s built the initial stage functional direction that automation also makes the most of the workspace, is a compact success. The prototype has proven that automated mechanisms, such as the collating and stapling system, can enhance office operations and open the door to further advancements in automation technology. Future research could explore improvements to the system's reliability, scalability, and integration with other office tools, marking the beginning of a new era in office automation.

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Appendix Programs

A. Prototype’s Code

Final prototype code using the C++ Language

```
// #include <Servo.h>
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <Adafruit_PWMServoDriver.h>

// Pin definitions
#define buttonStart 23
#define buttonDecrement 22
#define buttonIncrement 24
#define buttonSetMode 25

// IR sensor pins
const int irSensorPin1 = 36;  // 28
const int irSensorPin2 = 34;  // 30
const int irSensorPin3 = 32;  // 32
const int irSensorPin4 = 30;  // 34
const int irSensorPin5 = 28;  // 36
// const int irSensorPin6 = 40;  // Collating sensor

// Motors pins
#define motorPin1 49        // 31
#define motorPin2 47        // 33
#define motorPin3 45        // 35
#define motorPin4 43        // 37
#define motorPin5 41        // 39
#define StaplerMotorPinF 5     // for stapling mechanism forward
#define StaplerMotorPinB 4     // for stapling mechanism backward
#define motorPin7 39        // 41
#define motorPin8 37        // 43
#define motorPin9 35        // 45
#define motorPin10 33       // 47
#define motorPin11 31       // 49
#define motorPin12 52
// #define motorPin13 53

// Buzzer pin
#define buzzerPin 1

// Servo setup
// Servo servo1, servo2, servo3, servo4;

// LCD initialization
LiquidCrystal_I2C lcd(0x27, 20, 4);
Adafruit_PWMServoDriver pwm = Adafruit_PWMServoDriver();    // Initialize PCA9685

// Variables
int paperCount = 1;            // Paper count (1 to 5)
int feederMotorSpeed = 225;     // Set motor speed (0 to 255)
int feederMotorSpeed2 = 120;    // Set motor speed (0 to 255)
int staplerMotorF = 180;       // Set motor speed (0 to 255)
int staplerMotorB = 180;       // Set motor speed (0 to 255)
int irCount = 0;               // For collated mode stapling mechanism
```

```
bool mode = true;            // True = Collated, False = Uncollated

bool motorOff = 0;            // Default false | motor off

bool invalidStateFlag = false;  // Global flag to track invalid state


// Servo channels for drawers (channels 0 to 4)

const int drawerServos[5] = { 0, 1, 2, 3, 4 };


// Servo channels for hatch door (channels 13 to 16)

const int hatchServos[4] = { 12, 13, 14, 15 };


const int servoMin = 150;  // Minimum pulse length (adjust based on calibration)

const int servoMax = 600;  // Maximum pulse length (adjust based on calibration)


// Function to convert angle to pulse width

int angleToPulse(int angle) {

  return map(angle, 0, 180, servoMin, servoMax);

}


// Function to initialize servos to 0 degrees

void initializeServos() {

  // for (int i = 0; i < 5; i++) {

  // Set drawer servos to 0 degrees

  //         pwm.setPWM(drawerServos[1],         0, angleToPulse(5));  // servo 4

  //         pwm.setPWM(drawerServos[2],         0, angleToPulse(5));  // servo 3

  //         pwm.setPWM(drawerServos[3],         0, angleToPulse(5));  // servo 2

  //         pwm.setPWM(drawerServos[4],         0, angleToPulse(5));  // servo 1

  //         pwm.setPWM(drawerServos[5],         0, angleToPulse(5));  // servo 5

  pwm.setPWM(drawerServos[1],         0, angleToPulse(50));  // servo 4

  pwm.setPWM(drawerServos[2],         0, angleToPulse(65));  // servo 3

  pwm.setPWM(drawerServos[3],         0, angleToPulse(65));  // servo 2

  pwm.setPWM(drawerServos[4],         0, angleToPulse(60));  // servo 1

  pwm.setPWM(drawerServos[5],         0, angleToPulse(70));  // servo 5


  // Set hatch to close

  pwm.setPWM(hatchServos[0],         0, angleToPulse(88)); //

  pwm.setPWM(hatchServos[1],         0, angleToPulse(66));

  pwm.setPWM(hatchServos[2],         0, angleToPulse(50));

  pwm.setPWM(hatchServos[3],         0, angleToPulse(50));

  // }

}


// Function to activate drawer servos to 0 degrees

void activateFeederServos() {

  for (int i = 0; i < 5; i++) {

    pwm.setPWM(drawerServos[i],         0, angleToPulse(5));  // Set servos to 0 degrees

  }
```

```
}

// Function to activate hatch servos by opening them to 90 degrees
void activateHatchServos() {
  pwm.setPWM(hatchServos[2], 0, angleToPulse(10));  // Open hatch servo 3
  pwm.setPWM(hatchServos[3], 0, angleToPulse(0));   // Open hatch servo 4
  delay(1000);
  //   pwm.setPWM(hatchServos[0], 0, angleToPulse(0));  // Open hatch servo 1
  //   pwm.setPWM(hatchServos[1], 0, angleToPulse(120));  // Open hatch servo 2
}

// Function to update LCD
void updateLCD() {
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Paper/s: ");
  lcd.print(paperCount);
  lcd.setCursor(0, 1);
  lcd.print("Mode: ");
  lcd.print(mode ? "Collated" : "Uncollated");
}

void beepBuzzerRepeatedly(int times, int delayMs, int totalDurationMs) {
  unsigned long startTime = millis();
  while (millis() - startTime < totalDurationMs) {
    for (int i = 0; i < times; i++) {
      digitalWrite(buzzerPin, HIGH);
      delay(delayMs);
      digitalWrite(buzzerPin, LOW);
      delay(delayMs);
    }
  }
}

// No paper detected message
void InvalidState(int m1) {
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Slot " + String(m1) + " empty!");
  lcd.setCursor(0, 1);
  lcd.print("Check slot " + String(m1) + " or");
  lcd.setCursor(0, 2);
  lcd.print("adjust paper count");
  beepBuzzerRepeatedly(3, 200, 1500);
  updateLCD();

  // Set flag to indicate an error state
  invalidStateFlag = true;

  delay(500);  // Debounce delay
}

void MotorStop() {
  analogWrite(motorPin1, motorOff);     // Stop motor 1
  analogWrite(motorPin2, motorOff);     // Stop motor 2
```

```
  analogWrite(motorPin3,  motorOff);      //  Stop motor 3
  analogWrite(motorPin4,  motorOff);      //  Stop motor 4
  analogWrite(motorPin5,  motorOff);      //  Stop motor 5
  analogWrite(motorPin7,  motorOff);      //  Stop motor 7
  analogWrite(motorPin8,  motorOff);      //  Stop motor 8
  analogWrite(motorPin9,  motorOff);      //  Stop motor 9
  analogWrite(motorPin10,  motorOff);    //  Stop motor 10
  analogWrite(motorPin11,  motorOff);    //  Stop motor 11
}

void MotorTiming() {
  delay(5000);  // Motors run for 2 seconds
  initializeServos();
  delay(500);  // Short pause

  staplerFunction();
  activateHatchServos();
}

void Feeder1() {
  analogWrite(motorPin1,  feederMotorSpeed);   // ON motor 1
  analogWrite(motorPin2,  feederMotorSpeed);   // ON motor 2
  analogWrite(motorPin3, motorOff);          // OFF motor 3
  analogWrite(motorPin4, motorOff);          // OFF motor 4
  analogWrite(motorPin5, motorOff);          // OFF motor 5
  analogWrite(motorPin7, motorOff);          // OFF motor 7
  analogWrite(motorPin8, motorOff);          // OFF motor 8
  analogWrite(motorPin9, motorOff);          // OFF motor 9
  analogWrite(motorPin10, motorOff);        // OFF motor 10
  analogWrite(motorPin11, motorOff);        // OFF motor 11
}

void Feeder2() {
  analogWrite(motorPin1,  feederMotorSpeed);   // ON motor 1
  analogWrite(motorPin2,  feederMotorSpeed);   // ON motor 2
  analogWrite(motorPin3,  feederMotorSpeed);   // ON motor 3
  analogWrite(motorPin4,  feederMotorSpeed);   // ON motor 4
  analogWrite(motorPin5, motorOff);          // OFF motor 5
  analogWrite(motorPin7, motorOff);          // OFF motor 7
  analogWrite(motorPin8, motorOff);          // OFF motor 8
  analogWrite(motorPin9, motorOff);          // OFF motor 9
  analogWrite(motorPin10, motorOff);        // OFF motor 10
```

```
  analogWrite(motorPin11, motorOff);        // OFF motor 11
}

void Feeder3() {
  analogWrite(motorPin1,  feederMotorSpeed);   // ON motor 1
  analogWrite(motorPin2,  feederMotorSpeed);   // ON motor 2
  analogWrite(motorPin3,  feederMotorSpeed);   // ON motor 3
  analogWrite(motorPin4,  feederMotorSpeed);   // ON motor 4
  analogWrite(motorPin5,  feederMotorSpeed);   // ON motor 5
  analogWrite(motorPin7,  feederMotorSpeed);   // ON motor 7
  analogWrite(motorPin8, motorOff);          // OFF motor 8
  analogWrite(motorPin9, motorOff);          // OFF motor 9
  analogWrite(motorPin10, motorOff);        // OFF motor 10
  analogWrite(motorPin11, motorOff);        // OFF motor 11
}

void Feeder4() {
  analogWrite(motorPin1,  feederMotorSpeed);   // ON motor 1
  analogWrite(motorPin2,  feederMotorSpeed);   // ON motor 2
  analogWrite(motorPin3,  feederMotorSpeed);   // ON motor 3
  analogWrite(motorPin4,  feederMotorSpeed);   // ON motor 4
  analogWrite(motorPin5,  feederMotorSpeed);   // ON motor 5
  analogWrite(motorPin7,  feederMotorSpeed);   // ON motor 7
  analogWrite(motorPin8,  feederMotorSpeed);   // ON motor 8
  analogWrite(motorPin9,  feederMotorSpeed);   // ON motor 9
  analogWrite(motorPin10, motorOff);        // OFF motor 10
  analogWrite(motorPin11, motorOff);        // OFF motor 11
}

void Feeder5() {
  analogWrite(motorPin1, feederMotorSpeed);   // ON motor 1
  analogWrite(motorPin2, feederMotorSpeed);   // ON motor 2
  analogWrite(motorPin3, feederMotorSpeed);   // ON motor 3
  analogWrite(motorPin4, feederMotorSpeed);   // ON motor 4
  analogWrite(motorPin5, feederMotorSpeed);   // ON motor 5
  analogWrite(motorPin7, feederMotorSpeed);   // ON motor 7
  analogWrite(motorPin8, feederMotorSpeed);   // ON motor 8
  analogWrite(motorPin9, feederMotorSpeed);   // ON motor 9
  analogWrite(motorPin10, feederMotorSpeed); // ON motor 10
```

```
  analogWrite(motorPin11, feederMotorSpeed); // ON motor 11
}


void staplerFunction() {
  analogWrite(StaplerMotorPinF, staplerMotorF); // ON Motor stapler forward
  delay(400);
  analogWrite(StaplerMotorPinF, motorOff);   // OFF Motor stapler forward
  delay(2000);
  analogWrite(StaplerMotorPinB, staplerMotorF); // ON Motor stapler backward
  delay(400);
  analogWrite(StaplerMotorPinB, motorOff);   // OFF Motor stapler backward
}


void FeederState() {
  invalidStateFlag = false;  // Reset flag at the start of function
  activateFeederServos(); // Activate feeder


  // Set motor states based on paperCount and run motor/s
  if (paperCount == 1) {
    if (digitalRead(irSensorPin1) == LOW) {
      while (digitalRead(irSensorPin1) == LOW) {
        Feeder1();
        MotorTiming();
      }
    } else {
      InvalidState(1);
      return;
    }
  } else if (paperCount == 2) {
    if (digitalRead(irSensorPin1) == LOW && digitalRead(irSensorPin2) == LOW) {
      while (digitalRead(irSensorPin1) == LOW || digitalRead(irSensorPin2) == LOW) {
        Feeder2();
        MotorTiming();
      }
    } else {
      InvalidState(2);
      return;
    }
  } else if (paperCount == 3) {
    if (digitalRead(irSensorPin1) == LOW && digitalRead(irSensorPin2) == LOW && digitalRead(irSensorPin3) == LOW) {
      while (digitalRead(irSensorPin1) == LOW || digitalRead(irSensorPin2) == LOW || digitalRead(irSensorPin3) == LOW) {
        Feeder3();
        MotorTiming();
      }
    } else {
      InvalidState(3);
      return;
    }
  } else if (paperCount == 4) {
    if (digitalRead(irSensorPin1) == LOW && digitalRead(irSensorPin2) == LOW && digitalRead(irSensorPin3) == LOW && digitalRead(irSensorPin4) == LOW) {
```

```
      while (digitalRead(irSensorPin1) == LOW || digitalRead(irSensorPin2) == LOW || digitalRead(irSensorPin3) == LOW || digitalRead(irSensorPin4) == LOW) {
        Feeder4();
        MotorTiming();
      }
    } else {
      InvalidState(4);
    }
  } else if (paperCount == 5) {
    if (digitalRead(irSensorPin1) == LOW && digitalRead(irSensorPin2) == LOW && digitalRead(irSensorPin3) == LOW && digitalRead(irSensorPin4) == LOW && digitalRead(irSensorPin5) == LOW) {
      while (digitalRead(irSensorPin1) == LOW || digitalRead(irSensorPin2) == LOW || digitalRead(irSensorPin3) == LOW || digitalRead(irSensorPin4) == LOW || digitalRead(irSensorPin5) == LOW) {
        Feeder5();
        MotorTiming();
      }
    } else {
      InvalidState(5);
    }
  }
}

void noPaper() {
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("No paper detected");
  lcd.setCursor(0, 1);
  lcd.print("from the slot/s");
  lcd.setCursor(0, 3);
  lcd.print("Process Aborted!");
  beepBuzzerRepeatedly(3, 200, 1500);
}

void setup() {
  // Initialize LCD
  lcd.init();
  lcd.backlight();

  // Initialize PCA9685 Servo Driver
  pwm.begin();
  pwm.setPWMFreq(50);  // Set frequency to 50Hz for servos

  // Initialize servos to 0 degrees
  initializeServos();

  // Stapler forward reseter
  // analogWrite(StaplerMotorPinF, staplerMotorF);  // ON Motor stapler forward
  // delay(400);
  // analogWrite(StaplerMotorPinF, motorOff);

  // Stapler backward reseter
  // analogWrite(StaplerMotorPinB, staplerMotorB);  // ON motor stapler
  // delay(400);
```

```
  // analogWrite(StaplerMotorPinB, motorOff);  // OFF motor stapler


  //         pwm.setPWM(drawerServos[0],         0, angleToPulse(60));  // Move servo to 90 degrees


  // Buzzer Setup
  pinMode(buzzerPin, OUTPUT);
  digitalWrite(buzzerPin, LOW);   // Initially turn off the buzzer



  // Initialize pins
  pinMode(buttonIncrement,  INPUT);    //  Using external resistors
  pinMode(buttonDecrement,  INPUT);   //  Using external resistors
  pinMode(buttonSetMode,  INPUT);      //  Using external resistors
  pinMode(buttonStart,  INPUT);           //  Using external resistors
  pinMode(irSensorPin1, INPUT);
  pinMode(irSensorPin2, INPUT);
  pinMode(irSensorPin3, INPUT);
  pinMode(irSensorPin4, INPUT);
  pinMode(irSensorPin5, INPUT);
  // pinMode(irSensorPin6, INPUT);
  pinMode(motorPin1, OUTPUT);
  pinMode(motorPin2, OUTPUT);
  pinMode(motorPin3, OUTPUT);
  pinMode(motorPin4, OUTPUT);
  pinMode(motorPin5, OUTPUT);
  pinMode(motorPin7, OUTPUT);
  pinMode(motorPin8, OUTPUT);
  pinMode(motorPin9, OUTPUT);
  pinMode(motorPin10, OUTPUT);
  pinMode(motorPin11, OUTPUT);
  pinMode(motorPin12, OUTPUT);
  // pinMode(motorPin13, OUTPUT);


  // Initialize all motors to off
  analogWrite(motorPin1, motorOff);
  analogWrite(motorPin2, motorOff);
  analogWrite(motorPin3, motorOff);
  analogWrite(motorPin4, motorOff);
  analogWrite(motorPin5, motorOff);
  analogWrite(motorPin7, motorOff);
  analogWrite(motorPin8, motorOff);
  analogWrite(motorPin9, motorOff);
  analogWrite(motorPin10, motorOff);
  analogWrite(motorPin11, motorOff);
  analogWrite(motorPin12, motorOff);
  // analogWrite(motorPin13, motorOff);


  // analogWrite(motorPin12, feederMotorSpeed);


  // Initial LCD display
  updateLCD();
}


void loop() {
  // Read state of each IR sensor
  int irState1 = digitalRead(irSensorPin1);
  int irState2 = digitalRead(irSensorPin2);
```

```
  int irState3 = digitalRead(irSensorPin3);
  int irState4 = digitalRead(irSensorPin4);
  int irState5 = digitalRead(irSensorPin5);
  // int irState6 = digitalRead(irSensorPin6);

  // Hatch door (servo)
  // if (irState6 == LOW) { // Object detected
  //    servo1.write(90); // Open hatch door with servo 1
  //    servo2.write(90); // Open hatch door with servo 2
  //   delay(1000);

  // } else { // No object detected
  //  servo1.write(0); // Close hatch door with servo 1
  //  servo2.write(0); // Close hatch door with servo 2
  // }

  // if (irState5 == LOW) {
  //   lcd.clear();
  //   lcd.setCursor(0, 0);
  //   lcd.print("Sensor 2 detected:");
  //   delay(1000);
  //   updateLCD();

  //   // activateHatchServos();
  //   // staplerFunction();
  //   // delay(1000);
  //   // initializeServos();
  // }

  // // Test irSensor
  // if (irState2 == LOW) {
  //   lcd.clear();
  //   lcd.setCursor(0, 0);
  //   lcd.print("Sensor 2 detected:");
  //   delay(1000);
  //   updateLCD();
  // }

  // Increment button
  if (digitalRead(buttonIncrement) == HIGH) {
    if (mode) {  // Collated mode
      if (paperCount < 5) {
        beepBuzzerRepeatedly(1, 50, 50);
        paperCount++;
      } else {
        lcd.clear();
        lcd.setCursor(0, 0);
        lcd.print("Warning:");
        lcd.setCursor(0, 1);
        lcd.print("Collated mode only");
        lcd.setCursor(0, 2);
        lcd.print("has 5 max slot");
        beepBuzzerRepeatedly(2, 200, 1000);
      }
    } else {  // Uncollated mode
      if (paperCount < 5) {
        beepBuzzerRepeatedly(1, 50, 50);
```

```
      paperCount++;
    } else {
      lcd.clear();
      lcd.setCursor(0, 0);
      lcd.print("Warning:");
      lcd.setCursor(0, 1);
      lcd.print("Only 5 slots available");
      beepBuzzerRepeatedly(2, 200, 1000);
    }
  }
  updateLCD();
  delay(200);  // Debounce delay
}

// Decrement button
if (digitalRead(buttonDecrement) == HIGH) {
  if (paperCount > 1) {
    beepBuzzerRepeatedly(1, 50, 50);
    paperCount--;
  } else {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Warning:");
    lcd.setCursor(0, 1);
    lcd.print("Cannot go below 1");
    beepBuzzerRepeatedly(2, 200, 1000);
  }
  updateLCD();
  delay(200);  // Debounce delay
}

 // Set mode button
 if (digitalRead(buttonSetMode) == HIGH) {
   mode = !mode;    // Toggle mode
   paperCount = 1;  // Reset paper count
   beepBuzzerRepeatedly(1, 50, 50);
   updateLCD();
   delay(200);  // Debounce delay
 }

 // Start button
 if (digitalRead(buttonStart) == HIGH) {
   activateFeederServos();
   delay(5000);
   analogWrite(motorPin12,   feederMotorSpeed);
// Run motor Repeater
   if  (digitalRead(irSensorPin1)  ==  LOW)  {   //
Check if primary paper is detected
     // Process starts
     beepBuzzerRepeatedly(1, 100, 100);
     lcd.clear();
     lcd.setCursor(0, 0);
     lcd.print("Processing Papers");
     if (mode) {  // Collated mode
       if (digitalRead(irSensorPin1) == LOW) {
         while (digitalRead(irSensorPin1) == LOW)
{
           Feeder1();  // activate feeder 1 based on
paperCount and run
           MotorTiming();
         }
```

```
    } else {
     noPaper();              // No detected paper
     invalidStateFlag = true;   // Set flag to indicate an error state
    }
   } else {  // Uncollated mode
    FeederState();  // Update motor states based on paperCount and run
   }

   // Check if an invalid state was encountered
   if (invalidStateFlag) {
    invalidStateFlag = false;  // Reset flag at the start of function
    return;                    // Exit function early if invalid state occurred
   }
  delay(500);  // Debounce delay
 }
}
```

```
 // Process finished
 MotorStop();        // stop all motors
 initializeServos();  // Reset servo
 lcd.clear();
 lcd.setCursor(0, 0);
 lcd.print("Process Complete!");
 beepBuzzerRepeatedly(2, 500, 10000);
 paperCount = 1;  // Reset paper count
 updateLCD();

} else {
 noPaper();  // Error for no paper
}
updateLCD();
```

B. Cost of Materials

Table 8: Cost of Materials

Component	Price
Arduino Mega	₱ 915
Clear Acrylic Sheet	₱ 2,500
Aluminum pipe	₱ 252
Bolts and nuts	₱ 190
TT Gearbox motor DC 9V	₱ 715
Servo Motor SG90	₱ 801
Rubber bands	₱ 65
Rubber sleeves	₱ 71
Idler Roller	₱ 1,260
Plastic toy car wheel	₱ 369
Electric Stapler	₱ 767
DC-DC Buck Step Down Converter	₱ 168
IR emitter-detector sensor	₱ 150
Sensor shield V5.0	₱ 200
Electrical Tape	₱ 75
Jumper wires	₱ 265
L298N Motor Driver	₱ 450
Buzzer	₱ 65
Capacitors	₱ 89
Resistors	₱ 185
Solid wire	₱ 417
PCA9685	₱ 249
Tactile Button Switch	₱ 70
DC24V 6A adapter	₱ 269
	Total ₱ 10,557

C. Documentation

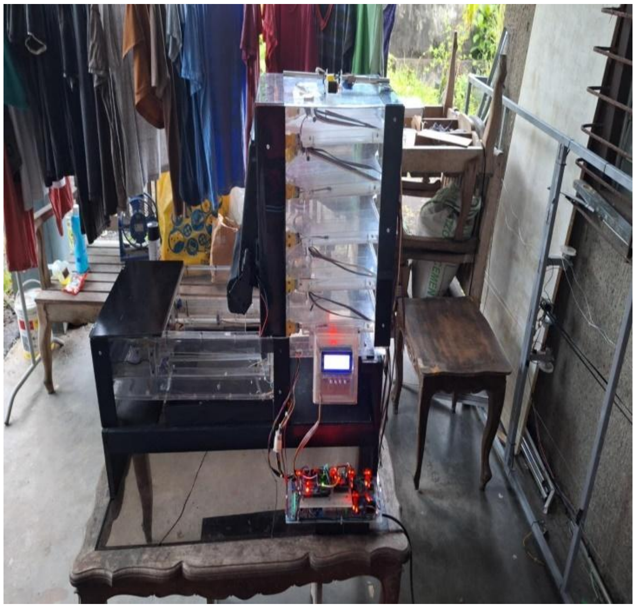

Figure 25. Prototype Model (Original)

Figure 27. Drawer Base

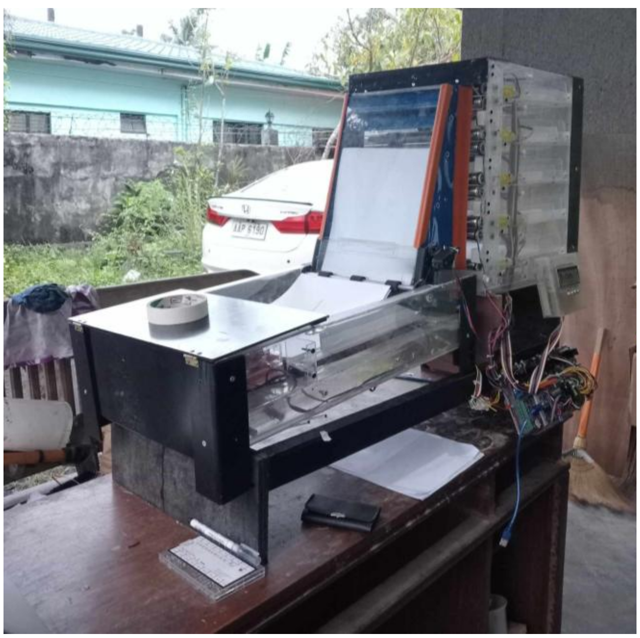

Figure 26. Prototype Model (Final)

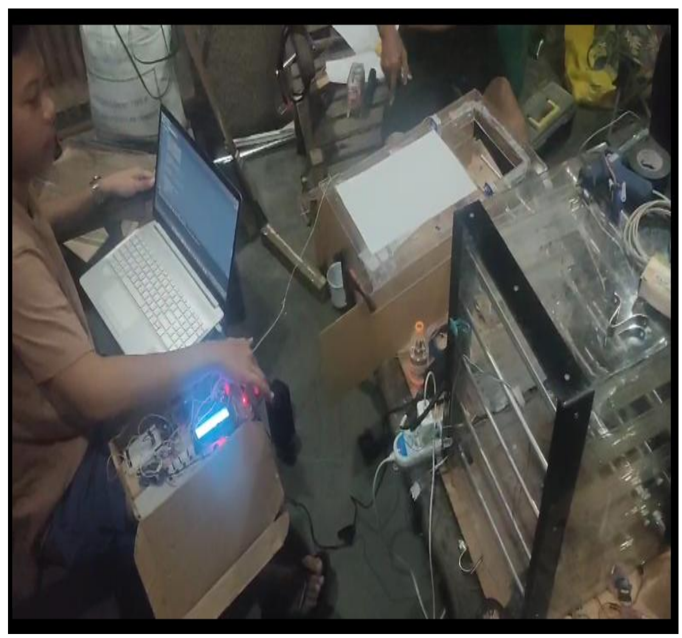

Figure 28. Hatch door testing

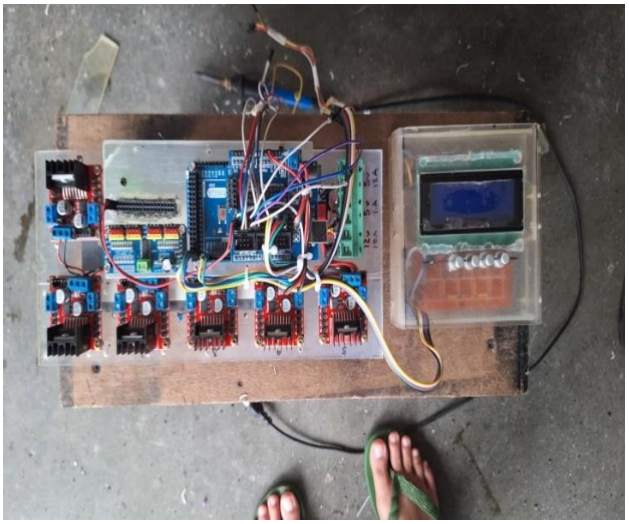

Figure 29. Organizing setup of the components

Figure 31. Testing the prototype

Figure 30. Prototype Model Development

ABOUT THE AUTHORS

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CAREER OBJECTIVE

- To work in a dynamic environment where I can apply and expand my knowledge and skills in software development, embedded systems, and automation. I aim to contribute to the advancement of innovative technologies while continuously learning about emerging trends in hardware integration, networking, and system optimization

TECHNICAL SKILLS

- Programming (Pascal, Python, Java)
- Network knowledge
- Computer Hardware and Software Troubleshooting
- Automation

PERSONAL SKILLS

- Good Listener
- Teamwork
- Adaptability
- Critical Thinking

EDUCATION

Bachelor of Science in Computer Engineering
University of Santo Tomas – Legazpi
2020 – 2025

CERTIFICATIONS

- **Course Certificate,** Introduction to SQL April 4, 2024 by Sololearn
- **Course Certificate,** Introduction to Artificial Intelligence June 30, 2023 by DICT Region 3
- **Certificate of Participation,** Data Visualization Workshop April 6, 2024 by ZUIT Coding BootCamp

REFERENCES

Engr Darwin B. Darca, MIT
College Instructor, UST – Legazpi
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MAR JOEFREY M. CALLEJA

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Phone: 09474181283
Email: marjoefreyc@gmail.com
Birthday: January 13, 2003

CAREER OBJECTIVE

- To work in an environment where I can apply my skills, passion for computer and contribute to the developments of cutting-edge software solutions.

TECHNICAL SKILLS

- Programming (Python, Java)
- Computer Circuitry
- Network knowledge

PERSONAL SKILLS

- Problem Solving
- Critical Thinking
- Teamwork

EDUCATION

Bachelor of Science in Computer Engineering
University of Santo Tomas – Legazpi
2021 – 2025

CERTIFICATIONS

- **Certificate of Participation,** AIvolution Webinar June 15, 2024 by Institute of Computer Engineers of the Philippines
- **Certificate of Completion,** Installing and Configuring Computer Systems July 7, 2024 by TESDA

REFERENCES

Engr Darwin B. Darca, MIT
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