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CONSTRUCTION AND DESIGN OF A PAPER CUTTER

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A RESEARCH REPORT SUBMITTED TO THE DEPARTMENT OF PHYSICS

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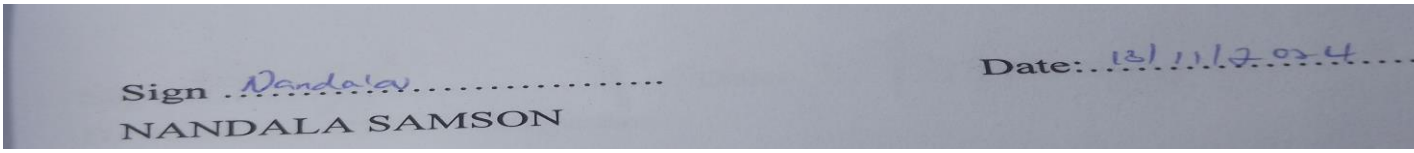
AUGUST 2024.

DECLARATION

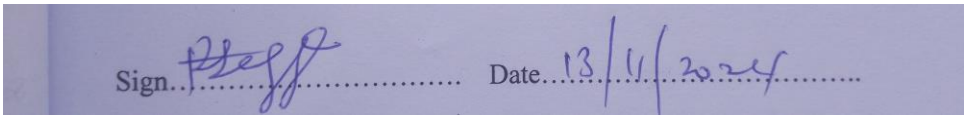
I ***Nandala Samson*** hereby declare this research is my original work and that it has not been submitted to any institution for academic award. I accept with proper acknowledgement and reference has been made for other people's work .



NANDALA SAMSON

APPROVAL

This research report entitled " Construction And Design Of A Paper Cutter" is submitted to the facultyof Education,Nagongera campus as a partial fullfilment for the award of degree of Bachelor of science with Education.



Dr Richard Cliffe Ssenyunzi

(Research supervisor)

DEDICATION

This research is dedicated to my parents Mr. Walekula Robert and Mrs. Nandutu Aidah. Thanks for the continous love , support and encouragement that they rendered to me during the whole of my life Journey. May the Almighty God bless you abundantly.

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I would like to start by thanking the almighty God for the gift of life, wisdom and knowledge that He has given me during my course at Busitema University.

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ABSTRUCT.

The primary aim of this project was to construct a paper cutter using a DC motor and double edged blade. This research report presents design, construct, and testing of a paper cutter powerd by a DC motor and featuring a double edged blade. The device aims to provide an efficient , safe and user friendly solution for cutting paperin various settings including offices, schools and print shops. The paper cutter’ s design involved a thorough analysis of existing paper cutting technologies, identification of design requirements and selection of appropriate materials and components.

The device design consists of a DC motor , double edged blade and control system. The DC motor provides the necessary torque and speed for cutting paper

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CHAPTER ONE

1 INTRODUCTION

1.1 BACK GROUND OF THE PROJECT

Paper is a thin material produced by pressing together moist Fibre of cellulose pulp derived from wood rags or grasses, and drying them into flexible sheets(Bajpai & Bajpai, 2015). It is a versatile material with many uses, including writing, printing packaging, cleaning, and a number of industrial and construction processes(Su & Song, 2021). The pulp papermaking process is said to have been developed during the early 2nd century AD, possibly as early as the year 105 A.D. by the Han court eunuch, in China although the earliest archaeological fragments of paper derive from the 2nd century BC in China. The modern pulp and paper industrial is now global, with China leading its production and the United States right behind it.

A paper cutter is a device used to cut sheets of paper into small pieces (sizes)(Gray, 1918) . There are various types of paper cutters available in the market, ranging from simple manual cutters to sophisticated electronic ones.

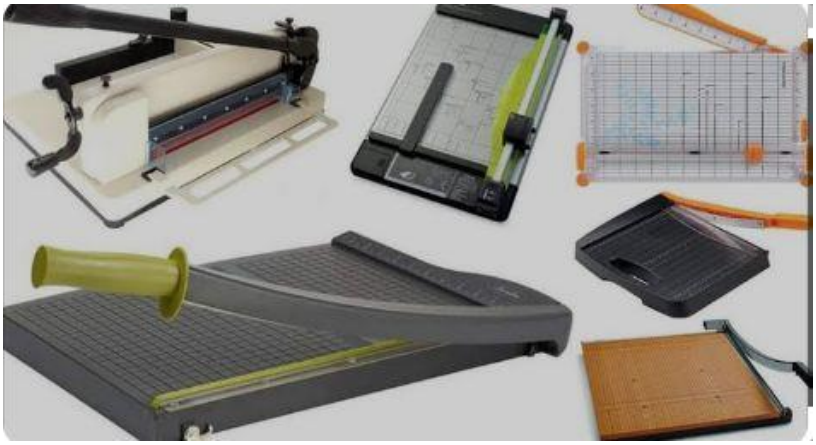

Figure 1.1Different types of sophisticated paper cutter

A paper cutter is an essential tool in schools, homes and offices used for accurately cutting paper, cardstock, and other materials(Mellis, 2011). By incorporating a DC motor into the design, we can create an automated paper cutter that enhances precision and efficiency.

A DC motor is an electric motor that operates with direct current (DC) as its power source(Popoola, Oladejo, & Odeyemi, 2015). These motors have various applications including industrial, automotive, and house hold devices like fans, DC motors are known for their ability to provide precise speed and torque control, making them suitable for various tasks (Gamazo-Real, Vázquez-Sánchez, & Gómez-Gil, 2010).

In this project, a DC motor was used as the primary driving force for the paper cutter. To the motor, a double edged durable blade will be attached. The paper cutter was capable of precise and consistent cuts, improving productivity and accuracy in cutting tasks.

1.2 PROBLEM STATEMENT

Traditional paper cutting methods often involve manual labour which can be time consuming and prone to errors. Additionally, the use of manual paper cutters may pose safety risks to

operators due to the sharpness of the cutting blades. Therefore, there was a need for a cheaper and user friendly paper cutter that can enhance productivity, accuracy, and safety in cutting processes.

1.3 AIM OF STUDY

The major aim of the study is to construct a paper cutter

1.4 OBJECTIVES

1.5 General Objective

To construct a paper cutter

1.6 Specific objectives

1. Design a stable and reliable frame for the paper cutter, capable of holding the DC motor, double edged blade, and paper in place during the cutting process.
2. Design a control system for the DC motor, including a power supply and a method for starting and stopping the motor

1.7 SIGNIFICANCE OF THE STUDY

This project has benefits which include the following:

1. **Faster cutting:** double edged blades allow for simultaneous cutting on both sides of the paper, resulting in faster cutting times. This can be particularly beneficial for individuals or businesses that need to cut large quantities of paper quickly.
2. **Energy efficiency**: DC motors are known for their energy efficiency, which can lead to cost saving in the long run.
3. **Torque**: DC motors provide a higher energy level of torque, allowing for smoother and more consistent cutting. This is particularly important when cutting thick materials or when working on projects that require a more powerful cutting force.
4. **Improved Precision:** With both edges of the blade cutting simultaneously, double edged blades can ensure a straighter and more accurate cut.
5. **Reduced wear and Tear**: Using a double edged blade can help reduce the wear and tear on the paper cutter as both sides of the blade are being used. This can lead toa longer lifespan for the paper cutter and reduce the need for replacements.

6. **Less expensive:** The paper will be less expensive as compared to other electronic paper cutters since the materials used to make it as cheape

CHAPTER TWO

2 LITERATURE REVIEW

2.1 INTRODUCTION

Paper cutting is an art with a long history, cutting paper began long before the making of the book of bound leaves, and the necessity of making a number of sheets of the same size called for some mechanical means of cutting and trimming(Hunter, 1978). The earliest cutting machine was no doubt a sharp stone or a stick; then a piece of metal, dragged across the parchment, with a guide to keep the cut in a straight line. The sheet was simply held by the hand, and later the straightedge formed a clamp also. Its first origins date back to the 4th century after the invention of the paper by the Chinese. Some of their earliest uses for paper cutting were for religious decorations or stencils used for patterns in embroidery (Bainbridge, 2023). For a long time, this art form was popular among high-society women, but it soon spread to other classes.

About the fifth century the important step of folding the vellum into leaves became the practice. The instrument which we know to-day as scissors or shears probably had a large part to do in these early operations. With the invention of printing and the multiplication of books larger and stronger means were necessary to cut the sheets(Georgi & Schubert, 1914). Although the book with the untrimmed sheets was the rule of this earlier time, and of a later time, for the smaller books and for divisions of the sheet a cutter was necessary.

For a time, the cutting of piles of paper was done by hand with a knife, a small pile being put upon a table and a weight laid upon it(Georgi & Schubert, 1914). (Grandjean & Kroemer, 1997). The earliest attempt to improve this consisted of a table, a framework of wood or metal above it, having a groove in which the knife could be worked, and a screw clamp to hold the pile(Mercer, 2000). The knife was originally short; then longer, until it became long enough to cut through the thickness of the book. The deckle-edge of the earlier and untrimmed books was improved upon and made easier to turn over and refer to rapidly by the improvement of trimming the leaves. The hand-plough cutter was probably the first successful machine intended to cut a number of sheets at a time(Gray, 1918).

Paper cutting practices ranged from the skilled craftsman to its evolution into the folk art world. People displayed paper cut designs in windows, as paper lanterns, and on furniture, just to name a few(Morris, 1903). Many other cultures began using paper cutting in a variety of different

techniques and as part of celebrations. A couple of the most popular cultural uses for paper cutting are *papel picado* banners in Mexico or *kirigami* in Japan. Paper cut silhouettes became popular in England during the middle Ages(Gildersleeve, 2014).

In the Haupt Halle at the great Graphic Arts Exhibition, Leipzig, 1914, were some illustrations showing the earliest German cutting machines and their evolution to date. The earliest among them is the lightly constructed hand-driven vertical cutter of 1855(Gray, 1918). This consisted of two side frames, the knife-bar guides in their slots and a large hand wheel at the right. The next stage was a cutter of 1876, a hand-driven wheel at the right turning gears above and outside the table. A crank and a rod connected to the center top of the knife-bar pulled the knife in the direction of the two slots in the knife-bar, giving it a shearing motion(AKINTUNDE). This model is the same as that used by most German manufacturers for both hand and power-driven cutters until within a few years, when the greatly improved, rapid, and more convenient American examples became known(Ristuccia & Tooze, 2004).

From simply pressing with the hand to hold the sheets the hand clamp was evolved; then the clamp was attached to a gear by which it could be held down on the sheets with greater and steadier pressure(Sclater & Chironis, 2001). To quicken this operation, the spring clamp was devised, with automatic pressure: fixed at first, then variable to suit varying requirements(Lin, Ni, Onyebuchi, & Rigby, 2016).

Perhaps the most signal advance in the art of paper-cutting machinery that has been made is the invention of Samuel R. Brown, who devised the fixed "throw" of the knife by means of two cranks at opposite ends of a shaft parallel with the knife(Gray, 1918). This control of the knife enables a hair to be cut through, or half through, or the knife edge to just touch it, with remarkable precision(Atkins, 2009). The various other mechanical connections for power-cutting machines between the pulley and the knife, consisting of rolls, slots, guides, cams, chains, levers, etc., all require a great number of parts between the pulley and the knife, with the consequent and necessary "looseness" of the mechanism(Gray, 1918). This allows, after short wear, a play or "chug" of the knife which quickly tends to destroy its best cutting abilities.

The evolution of the cutting machine has been rapid and distinctly marked in all its essential features, from the oscillating plough to the vertical stroke, to the shear stroke, to the doubleshear stroke; from a single-rod pull-down of the knife to the two-rod pull-down by cams, rolls, slots, slides, to the cranks which give a fixed dependable stroke(AKINTUNDE); to the cranks which give a fixed dependable stroke, and at the same time pull the knife endwise; from swinging-link

shear to a straight-line shear; from man-drive to power-drive; from driving by power fixtures in front and outside the frame to fixtures located back and underneath; from low piles to high piles; from hand clamp to power clamp, to self-clamp, to automatic clamp, finally to friction adjustable pressure clamp; from measuring by rule to the use of rapid automatic measuring and spacing devices(AKINTUNDE).

The best paper-cutting machine is designed with a knife motion operated by cranks which give an endwise pull to the knife; with the table of medium height; with quick and accurate adjustments for the knife; with a foot treadle for bringing the clamp down to the pile when desired to see exactly where the knife will strike; with an accurate and dependable device for moving the back gage and the pile and measuring quickly the widths to be cut; with starting handles easily reachable without bending; with a powerful clamping pressure automatic for all height piles and instantly adjustable for heavy or delicate work; with universal fine adjustments for squaring the back gage with the knife; with a simple change for the cutting stick; with the driving shaft running at a low speed; and with a powerful main driving clutch or friction material that will not cut or damage the parts under the heavy, constant thrusts.

Paper Cutting is the art form of cutting paper and it can be simple or intricate as the paper as the paper artist chooses (Ryan & Avella, 2011). It has definitely stood the test of time and will continue to be a popular art form amongst many cultures. Many famous paper artists still inspire current paper cutting practices. Also there have been progressive researches into different ways through which the cutting of papers can be achieved (Ryan & Avella, 2011);

2.2 Types of Paper cutters

1. **Guillotine cutters:** these are probably most familiar to general public. They use curved blade that lifts up and down, slicing through the paper.(cuts a maximum of 20 sheets at a go)

Figure 2.1 Guillotine cutter

2. **Rotary blade trimmer:** These are used for precise trimming of slim edges rather than cutting. They are available from small sizes of craft trimmers to extended lengths for posters.)
3. **Stack cutters** : they are designed for cutting large quantities of paper(up to full ream)

Fig 2.2 Stack cutter

4. **Board trimmers.** These are used to provide accurate trimming and are mostly used for small projects.

5. **Business card trimmers.** They are specifically used to cut business cards.

6. **Electronic paper cutters.** They are automated cutters that are powered by electricity (ac). They provide precise and accurate trimming but they are very expensive.

CHAPTER THREE

3 METHODOLOLOGY

3.1 INTRODUCTION

This chapter contains the materials that were used and the procedures that were followed to make the paper cutter

3.2 Materials And Tools Required

1. **DC Motor:** A DC motor with appropriate power and speed ratings for paper cutting was selected.

Figure 3.1 DC motor

2. **Double Edged blade:** A high-quality double-edged blade suitable for cutting paper cleanly and efficiently was considered

Figure 3.2 Double edged blade/ Razor blade

3. **Power supply:** A stable DC power supply to run the motor was selected

Figure 3.3 Tecno phone 4.2v DC battery

4. **Base Material**: A sturdy material such as wood was selected to act as the base foe the paper cutter

Figure 3.4 Strong timber

5. **Switch and wires:** A switch and wires that were connect from the power supply to the motor was selected.

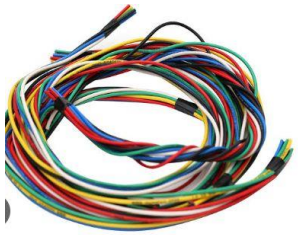

Figure 3.5Connecting wires

6. **Supporting Materials:** Nuts, nail and other hardware components were used to assemble the paper cutter.

Figure 3.6 nails

7. **Hammer.** This was used to fix the nails into the wood.

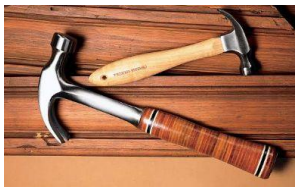

Figure 3.7 Hammer

8. **Super glue.** This was used to bind the motor to the base material and the blade to shaft of motor

Figure 3.8 Super glue

9. **Tape measure**. This was used to get the measurements/ length of the wood pieces.

Figure 3.9 Tape measure

10. **Planner.** This was used to smoothen the wood.

Figure 3.10 Planner

3.3 Step by step procedures that were followed to construct the paper cutter

Step one

The pieces of timber were smoothened using a planer and sand paper and cut into the required dimensions. (**18cm×18cm and 18cm×10cm)**

Figure 3.11 18cm×10cm wood piece

Figure 3.12 18cm×18cm wood piece

Step two.

The base material was selected and using nails and a hammer, the frame was made by joining the pieces of timber to form a cubic shaped frame.

Figure 3.13 Cubic Frame

Step three

A hole was drilled on the upper side of the frame. The hole allows movement of the double edged blade that is attached to the motor.

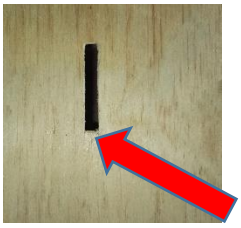

Figure 3.14 Blade hole

Another rectangular hole was drilled at one side of the frame. These hole was used to hole the switch.

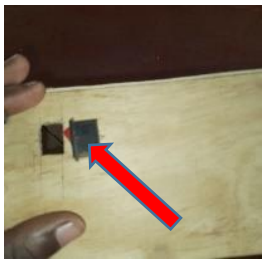

Figure 3.15 switch hole

Step four

The double edged blade was attached to the shaft of the dc motor using super glue and the combination was mounted to the frame and fastened using super glue.

Figure 3.16 Blade attached to shaft of the motor

Figure 3.17 motor fixed to the base

Step five

The switch was fixed in the drilled hole and fastened with super glue.

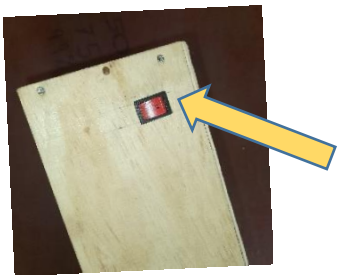

Figure 3.18 switch

Step six

The battery was fixed at one corner in the frame and was attached to the wall of the frame using super glue.

Figure 3.19 battery

3.4 Achievement of the objectives

3.5 Design a sturdy and reliable frame for the paper cutter, capable of holding the DC motor, double edged blade, and paper in place during the cutting process.

This was achieved by selecting the right materials ie the strong timber, nails essential for building a sturdy frame. For this project, wood was used for constructing frames due to is strength and easy to drill holes on it. Engineering principles such as box frame can enhance rigidity of the frame for good structural design. The box frames also provide inherent stability. Mounting points for the motor were integrated and were strategically positioned to evenly distribute the motors weight and minimize vibrations during cutting operation. Precise fastening methods like use of nails and nuts was used to assemble the frame.

3.6 Design a control system for the DC motor, including a power supply and a method for starting and stopping the motor

The paper cutter was have a control system for starting and stopping the DC motor. This was done by in cooperating control system component that' s to say a switch for allowing the starting and stopping power from reaching the motor

CHAPTER FOUR

4 RESULTS AND INTERPRETATION

4.1 DISCUSSION

The device was able to cut 15 sheets papers of 34cm×20cm into small pieces of 4cm×4cm in about 5 minutes, this was faster than using an ordinary cutter like a pair of scissors that takes about 7 minutes to do the same work. The device therefore is faster and more efficient.

CHAPTER FIVE

5 CONCLUSION AND RECCOMENDATION

5.1 CONCLUSION

In conclusion, the design and construction of a paper cutter using a DC motor and double edged blade have been a successfully achieved, demonstrating a significant improvement in the paper cutting technology. The device' s cutting efficiency, accuracy and safety features make it a valuable tool for various settings like office, schools and print shops enhancing productivity and reducing manual effort.

The device' s performance and safety features make it an attractive solution for different settings and individuals seeking to improve their paper cutting capabilities.

5.2 Recommendations

In this study, I recommend the improvement on safety enhancements, consider adding finger guides, emergency stops, and safety interlocks to prevent accidents.

I also recommend improvement in the power supply system, consider adding a charging system that can allow the device to charge and be used on ac supply.

REFERENCES

1. AKINTUNDE, A. O. (MEE/14/7987) A PROJECT SUBMITTED TO THE DEPARTMENT OF MECHANICAL ENGINEERING SCHOOL OF ENGINEERING AND EENGINEERING TECHNOLOGY.
2. Atkins, T. (2009). *The science and engineering of cutting: the mechanics and processes of separating, scratching and puncturing biomaterials, metals and non-metals*: Butterworth-Heinemann.
3. Bainbridge, A. (2023). Materials and Identification. In *Conservation of Books* (pp. 254-364): Routledge.
4. Bajpai, P., & Bajpai, P. (2015). Basic overview of pulp and paper manufacturing process. *Green chemistry and sustainability in pulp and paper industry*, 11-39.
5. Gamazo-Real, J. C., Vázquez-Sánchez, E., & Gómez-Gil, J. (2010). Position and speed control of brushless DC motors using sensorless techniques and application trends. *sensors*, *10*(7), 6901-6947.
6. Georgi, F., & Schubert, A. (1914). *Sheet Metal Working: Cutting, Punching, Bending, Folding, Pressing, Drawing, and Embossing Metals, and Machinery for Same*: Scott, Greenwood & son.
7. Gildersleeve, O. (2014). *Paper cut: an exploration into the contemporary world of papercraft art and illustration*: Rockport Publishers.
8. Grandjean, E., & Kroemer, K. H. (1997). *Fitting the task to the human: a textbook of occupational ergonomics*: CRC press.
9. Gray, N. (1918). *cutting Machines: A Primer of Information about Paper and Card Trimmers, Hand-lever Cutters, Power Cutters and Other Automatic Machines for Cutting Paper*: Committee on education, United typothetae of America.
10. Hunter, D. (1978). *Papermaking: the history and technique of an ancient craft*: Courier Corporation.

11. Lin, C., Ni, R., Onyebuchi, C., & Rigby, G. (2016). Hydraulic Cylinder Processing Workstation Automation.
12. Mellis, D. A. (2011). *Case studies in the digital fabrication of open-source consumer electronic products*. Citeseer,
13. Mercer, H. C. (2000). *Ancient Carpenters' Tools: Illustrated and Explained, Together with the Implements of the Lumberman, Joiner, and Cabinet-maker in Use in the Eighteenth Century*: Courier Corporation.
14. Morris, W. (1903). *Arts and crafts essays*: Longmans, Green and Company.
15. Popoola, J. J., Oladejo, O. J., & Odeyemi, C. S. (2015). Modelling and Simulation of ArmatureControlled Direct Current Motor using MATLAB. *Recuperado de* http://www. *internationaljournalssrg. org/IJEEE/2015/Volume2-Issue3/IJEEE-V2I3P105. pdf*.
16. Ristuccia, C. A., & Tooze, J. A. (2004). The Cutting Edge of Modernity: Machine Tools in the United States and Germany 1930-1945.
17. Ryan, R., & Avella, N. (2011). *Paper cutting book: contemporary artists, Timeless Craft*: Chronicle Books.
18. Sclater, N., & Chironis, N. P. (2001). *Mechanisms and mechanical devices sourcebook* (Vol. 3): Mcgraw-hill New York.
19. Su, M., & Song, Y. (2021). Printable smart materials and devices: strategies and applications. *Chemical reviews, 122*(5), 5144-5164.

APPENDICES

APPENDIX ONE: Defination Of Terms Used

Appendix two: Other relevate photos.

Figure 5.1 Top view of the cutter

Figure 5.2 27 Side view of the cutter