

Design and Fabrication of Surgical Masks and Gloves Destroyer Machine

Akhil Sharma¹, Ashish Kumar²

¹Mechanical Engineering Department, Yogananda College of Engineering and Technology, Jammu, India

Abstract: *This paper deals with a detailed study & design procedure of a Surgical masks and gloves destroyer machine. A detailed study of various parts of machine like stand (frame), transmission system and cutting system are made and designed separately. Surgical masks and gloves destroyer machine is a mechanical device which is used to cut the Surgical mask and gloves into chad, typically either strips or fine particles for decomposition of used Surgical masks and gloves. So our intension behind this project is to process the waste as cheap as possible by shredding and further vanishing it completely. The objective of this machine is to get rid of these used masks and gloves. So we are going to design this for shred the Surgical masks and gloves waste, with the help of blades and further decomposition of the leftover of shredded particles. People across the world are doing the research for the vaccine, but right now the problem of masks is not considerable as that much big, but it will create worst condition in the atmosphere, that we will see only masks around us on the roads, fields. So our concept of making this machine is to get rid of these used masks and gloves.*

Keywords: Surgical masks and gloves destroyer machine, servo motor, cutting blades AUTOCAD 2020.

1. Introduction

A Surgical masks and gloves destroyer machine is a mechanical device used to cut Surgical masks and gloves into small strip in order to completely destroy the waste. Covid-19 pandemic is possessing huge global health threat. Wearing mask nowadays has not just been the precaution towards the covid-19 rather has become necessity. One of the most commonly used mask around the world is surgical masks. Surgical mask are one time use product which possess a issue in its recycling process as it is made up of polypropylene. While PP is easily among the most popular plastic packaging materials in the world, only around 1% is recycled, which means most PP is headed for the landfill. These decompose slowly over 20-30 years.

Protective personal equipment (PPE) such as gloves and masks should not be recycled for health and safety reasons, and should go into the general rubbish container, because “as soon as PPE is considered waste, it should not be subject to any human interaction, in order to avoid possible infection of sanitation workers. So the concept of making machine that will use to deform masks and gloves which are used in the current scenario as a precaution for the covid-19. The method of making the machine by using blade/cutters that should be capable of cutting the all kind of masks and gloves into smaller pieces and then the further process is to decompose it by spraying acid on it. The machine is smaller in size that it can be installed anywhere. It can be installed on the poles, outside any village or house, and of course if we use some acid to deform it we have to be very care full and store it in such a manner that it will not get in touch with human body and cause any kind of injury. Best material for containing sulphuric acid is HDPE (high density polyethylene), carbon steel, XLPE (cross linked polyethylene), FRP (Fiber-reinforced plastic) is a composite material made of a polymer matrix reinforced with fibers. The fibers are usually glass, carbon, wood, or asbestos have been used. Considering all the materials and parts for making the machine, cost would be around Rs. 3000.

The machine is equipped by using all necessary items and method such as aluminium sheet metal, rivet, and skills in manufacturing machine to cut and bend the parts and etc. The process of development is started from designing the shape of the machine by considering the function as well. In order to produce user friendly product that is suitable to the consumer, consideration to the ergonomic factor is taken into account. It involves the measurement process before the materials are cut into pieces before assemble together by using cutting and bending processes. The machine is needed to test to check whether its mechanism is properly work or not work.

This project title is “Design and fabrication of Surgical masks and gloves destroyer machine”. The project includes small analysis and fabrication of the machine itself with concerns regarding strength, portability, durability, ergonomic factor and convenience. Test need to be done to verify the strength of the machine before the fabrication process started. It is require more knowledge and skill of analysis.

2. Literature Review

Fauzia et.al, (2017) in their study presented a design and procedure of a paper shredder machine. In their study they presented the cutting system of shredder machine also they described the definition, objectives, procedure of design with the detailed design of each component of the cutting and transmission system i.e. designing a blade and making certain modifications in it and the frame. Further in their study they depicts the design of 3D model of various parts on Dassult Systems “SOLIDWORKS 2014” and its motion study and the analysis of the stand in ANSYS 15.

Ming- Hui Ho.(2003) presented a paper cutter with two rotary cutters each with multiple blades. Each blade had a first cutting blade with multiple first cutting edges and a second cutting blade with multiple cutting edges. Both the first and the second cutting blades were distributed in a non-equianular manner and each of the first cutting edges was

offset to each one of the second cutting edges, so that there was only one cutting edge that engaged with the paper to be shredded. When the amount of shredded paper increased, the paper shredder did not function normally because multiple cutting edges simultaneously engaged with the paper to be shredded paper stuck in the shredder. This problem was sorted out by using rotary cutter with multiple blades with numbers cutting edges. With the arrangement described here, the noise of the shredding was also greatly reduced.

Joseph Y. Ko (2000) presented a machine with automatic feeding mechanism capable of shredding 20 sheets with approx. 9 inches width. The machine had a three way switch i.e. On, Off and Auto. The blades were knife rollers which cut paper strips, but can be occasionally configured to have confetti-cuts of paper. Feeding mechanism contained a pair of roller to direct the paper. The rollers and the knife blades were driven by a single AC Motor and a belt drive.

Frank Chang (2000) presented the blade assembly for paper shredder is in a juxtaposed manner. Conventional assembly consists of long and short partition rings. The disadvantage was that even if one part malfunctioned, the whole assembly gets loosened. Instead of having partition rings it had long and short plates casted with the blade ring. The blades were arranged on the rotary shaft to form a bladed shaft such that long and short projecting about the long and short projecting plates of adjacent blades. This arrangement eliminated use of partition rings, reducing cost and enhancing assembly efficiency.

Kumar (2015) presented a project on the design and development of paper Shredder machine aimed for chopping of coconut leaves, areca leaves in order to convert the waste in to vermin compost. A concept was developed with reference of four different shredder machine and operating processes. Concept was developed considering the safety factor users operating environment and maintenance. Considering the users' needs and buying capacity, a prototype was fabricated. The machine consists of single-phase motor, spur gear, bearings, structural frame, cutter and dual shaft. The machine frame is built using mild steel and tungsten carbide is used for cutter tip preparation. Eight cutters are mounted on two shafts, which rotate parallel driven by a spur gear. The power from the electrical motor is transmitted to cutter shaft through a belt drive. Cut is made inside the chopping house because of the effect of tensile, friction, and impact effect in chopping process.

3. Methodology

The proposed system that we are going to make will consist of 2 servo motors used for the movement of blades (round in shape) which will cut masks and gloves into smaller pieces before the deformation due to this it will get deform easily. With the help of Arduino UNO R3 we can

control the motors motion and also it consist of a battery which will run the motor and whole system.

The container consist of two blocks, one is for cutting masks into smaller pieces and another one is for the deformation with the help of sulphuric acid.

- 1) The main components of machine includes blades and disposal of sulphuric acid. Thus our more focus is on the research and study of shredder blades which will use for the shredding of surgical masks and gloves, and also for the container which will use for storing sulphuric acid for solving our purpose.
- 2) Once the blade type is fixed with motors along with the sulphuric acid container, the next step is to design the machine. The design has been framed in software AUTOCAD 2020.
- 3) The machine also contains different components which are designed along with the blades which includes frames, display, buttons, sprayer jets, servo motors, battery.
- 4) Hence the design phase is briefly classified as machine construction, cutting system and decomposition system.
- 5) One of the primary objective was to take into consideration the space factor regarding pollution. So the machine was aimed to be space friendly which was designed in rectangular shape that will be easy for installation by occupying 3x2 feet of space in length and breadth respectively.
- 6) After the completion of design our next step is material selection that would resistible in nature with a long period.
- 7) The more emphasis was put on the decomposition process which includes shredder material of surgical masks and gloves. The next step is to take out the burnt material which was leftover there.
- 8) The analysis is done by manufacturing prototype of the machine. If outcomes are satisfied, then the actual manufacturing will start. If there is any error, then the modification will be done in existing model.

Machine Construction

- 1) Construction machine consists of servo motors, blades, shafts, battery, sprayer jets, display, buttons, wires, wood, plastic, HDPE sheet, Arduino UNO R3, sulphuric acid.
- 2) The machine frame is made of wood with plastic as outer layer and HDPE sheet as inner layer of the frame with a size of 91.44 x 60.96 x 60 cm, which are connected through nut and bolts.

Cutting Blades

Fig1. shows the actual manufactured sample. The cutting blade is round-shaped blade with 3 (three) cutting edges, given a hexagon-shaped hole in the middle, mounted on the main shaft and main shaft move together. This blade is used to cut the paper in vertical direction. Cutting blades are designed with Mild Steel material with the specification are 18 blades, 10 mm thick and 51-degree of cutting angle.



Figure 1: Blade Model

Figure 2: Shows the modifications in the blade design. Thus few modifications were 1st design. The stress concentration problem was solved by creating a tangent in a side edge. Though this problem was solved, the weight of this blade

came out to be 722 grams which was more than the 1st design.

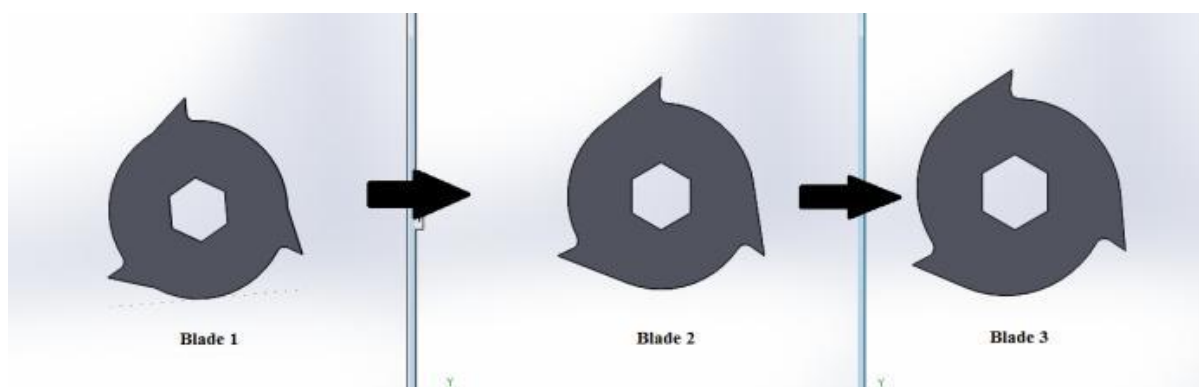


Figure 2: Modifications in Blade Design

In the 3rd modification, the weight was reduced. The first two blades had a perfect circle of dia. 110mm with a single centre. In this design, the size was reduced. Instead of radius 55mm which had a common centre, this blade was designed in such a way that a 55mm arc would develop and all the three arcs had three different centres such that these three centres would form an equilateral triangle. The weight was 648 grams.

Procedure followed in manufacturing a blade:-

- Hand Drawing (with the dimension lesser than the actual required ones).
- Template Making.
- Gas Cutting
- Surface Grinding.
- Curve Filling.

Main Shaft

The main shaft serves as the cutting blade holder. The main shaft has a hexagon shape in the position of cutting blade holder and has a round shape at both ends in the position of the holder main bearings and gears. The main shaft is made of EN8 AISI 1040 material with a minimum distance between two parallel sides of 38 mm.

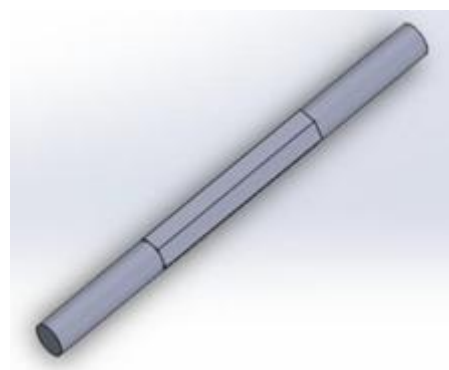


Figure 3: Shaft Model

Shaft Assembly

Fig 4 shows the shaft assembly. The shaft assembly consists of blades washers and the gears. The blade part is as discussed above. The washers are again made of MS. The shape of the washer is normal ring form and its only function is to align and lock the blades such that they do not move during operation. They are total 20 in number with 2 of them with a lock nut. The main shaft gear consists of two spur gears paired with the size (number of teeth 25 and modules 4).

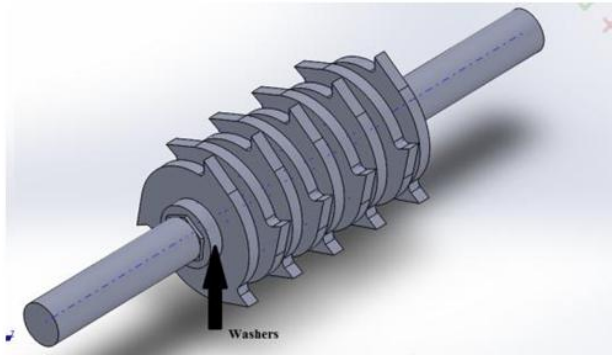


Figure 4: Shaft Assembly

Transmission System

It includes the movement of blades with the help of servo motors placed alternatively.

Servo Motors: A servomotor is a rotary actuator or linear actuator that allows for precise control of angular or linear position, velocity and acceleration.^[1] It consists of a suitable motor coupled to a sensor for position feedback. It also requires a relatively sophisticated controller, often a dedicated module designed specifically for use with servomotors.

Servomotors are not a specific class of motor, although the term servomotor is often used to refer to a motor suitable for use in a closed-loop control system.

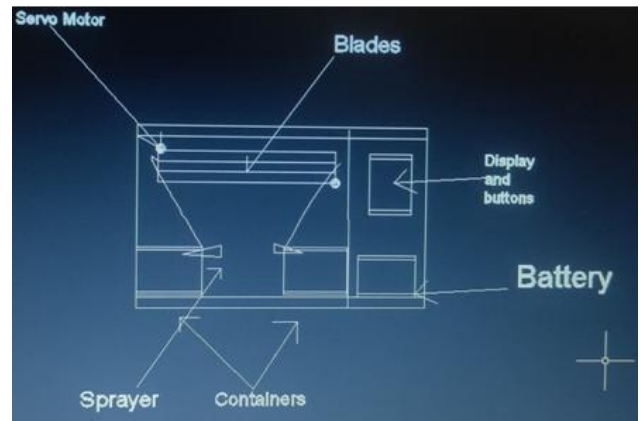
Servomotors are used in applications such as robotics, CNC machinery or automated manufacturing.



List of Parts and Their Functions

Name of Part	Function
Wood	For making the outer block
Plastic	For coating
HDPE sheet	For inside coating to resist the acid
Blades	For cutting the mask
Servo motors of 5v	For running the blades
Battery of 6-8v	For running the whole system
Wires	For connections
Sulphuric acid	For the deformation of masks
Arduino UNO R3	For controlling motors

Design of the Machine



Machine Dimension

91.44 cm length

60.96 cm height

60 cm width

Working of the machine

A mask is supposed to be put in the box and it will go through the blades firstly, that will cut it into smaller pieces, then it will go into the second chamber where the acid will sprayed on it eventually and decompose it.

Step-1:- Mask to be inserted in the machine.

Step-2:- Start the servo motors through the controller buttons, when the servo motors starts blades also starts moving that are attached with the motors both the blades moves in opposite direction. Then mask will go through the blades and shear into smaller pieces.

Step-3:- Sheared pieces of masks will pass through second chamber where the acid will be sprayed on the pieces of mask controlled through the control panel that will deform the mask completely and the leftover burn out material can be removed from the machine.

4. Conclusion

Although technical standards are the main reference that should be used as a guide to the manufacture and use of personal protective equipment such as disposable surgical masks and gloves, in situations of extreme scarcity caused by epidemics, and in this particular case, the COVID-19 pandemic, other strategies should be considered. We also know that there are different types of masks made by different fabric materials like cotton, as all are these made by cloths material, we can easily use it for a long time as these are washable and reusable. But the surgical masks and gloves should not be reused as instructed by WHO and we also know that it took over 20-30 years to deforms itself naturally. So the purpose of making this machine is to destroy these surgical masks and gloves manually in seconds.

References

[1] B.L. Theraja, A.K. Theraja, (2015), A Textbook of Electrical Technology: AC and DC Machines, twenty third revised multicolored edition, Volume II, New Delhi,1562-1565.

- [2] Chen, 2010, Shanghai (CN), “Cutter Structure Of Shredder Blade”, 7641136B2.
- [3] Frank Chang, Taipei (TW), 2005, “Linkage Mechanism Of Paper Cut And Antiblock Of Double Duty Shredder”, 6966513B2.
- [4] I.M.Sanjay Kumar, DR. T.R. Hemant Kumar, 2015, Design and Development of Agricultural Waste Shredder Machine, IJSET, Vol. 2 Issue 10.
- [5] Joseph Y. Ko, 2002, “Paper Shredding Device”, US 6390397 B1.
- [6] Ming-Hui Ho, Taipei Shein, 2003, “Blade Of Paper Shredder”, 6513740B2.
- [7] P. Viitanen, T. Yli-Pietila, P. Yli-Paunu, and R. Suoranta, 1992, “Modelling and simulation of mechatronical devices,” *Mechatronics*, vol. 2, no. 3, pp. 231–238.
- [8] Richa Choudhary, April 2020, COVID-19 Pandemic: Impact and strategies for education sector in India. <https://government.economictimes.indiatimes.com/agency/88675781/ETGovernment>
- [9] Siddiqui . Fauzia et.al, 2017, Design and Fabrication of Paper Shredder Machine, *International Journal of Scientific & Engineering Research*, Volume 8, Issue 3, March-2017 ISSN 2229-5518.
- [10] S. Morimoto, K. Hatanaka et.al 1993, “Servo drive system and control characteristics of salient pole permanent magnet synchronous motor,” *IEEE Transactions on Industry Applications*, vol. 29, no. 2, pp. 338–343.
- [11] S. N. Vukosavic and M. R. Stojic, 1998, “Suppression of torsional oscillations in a high-performance speed servo drive,” *IEEE Transactions on Industrial Electronics*, vol. 45, no. 1, pp. 108–117.