Tea Leaf Harvester Using Solar Power

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ABSTRACT - Our project deals with the design and the fabrication of the solar tea leaf cutting machine. Hilly areas are a great source of tea as the plantation of the tea leafs is sustainable in such areas. The cutting of the tea leafs is usually done manually with more number of labours. This consumes a lot of time and also an extensive labour charge is there. The leaves that are being cut also are not even and hence the consistency of the tea production may be affected. In order to eliminate these types of disadvantages, we propose a simple solar tea leaf cutting machine. Our machine is portable and can be easily carried in bare hands. More number of leaves is cut within a short due to the automated process and also there is no need of any external power source for the successful operation of our machine. The solar panel that is provided with a backpack setup helps to convert the solar energy into the electrical energy and thus the entire system can be powered up. The parts of our project and designed and assembled using the Solid Works software and finally the fabrication part has been carried out.

***Key Words*: Tea leaf, Solar, Labour, Cutting machine, Production.**

INTRODUCTION

Tea has been the most popular and low cost beverage around the world. The goal of solar powered tea leaf harvester is to overcome agricultural challenges. An agricultural robot must deal with an unstructured, unknown, uncertain and varying environment. Tea leaves are randomly located on tea plant, and it is difficult to detect different categories in tea leaf (such as bud, fresh leaf, active leaf, mother leaf, etc.) I have found that Tea cutting machines are designed in many countries but they are designed only for cutting with any selective method and these machines are very large and expensive. Therefore quality is being reduced. So in order to improve the quality it is necessary to improve the cutting methodology with more available resources which are less expensive and are renewable. This project is carried out to design and fabricate a simple solar powered tea leaf harvester that can be operated even by layman with solar power system.

These types of solar powered tea leaf cutting machines have a wide range of applications in the fields like,

- Tea estates,
- Agricultural purposes,
- Highly suitable for tea plantations,
- Garden cleaning purposes.

The following points reveals why we have to make use of this type of machine,

- Solar Leaf cutting machine reduces the manual work.
- This type of machine reduces working time.
- This is non-conventional solar power mechanism

A. Description of the tea leaf harvester

The machine generally comprises a battery, motor, solar panel, frame, crank mechanism, blower and cutting jaw. In this example, the frame is formed of mild steel. The metal frame comprises a plurality of tubular sections that are bolted, welded or fastened together via typical means to form the shape. Preferring to the device more specifically, the solar powered

tea leaf harvester generally comprises a frame assembly, solar panel, battery, motor, Cutting jaw where one is fixed and the other one is movable and other mechanisms.

B. Problem description

Nowadays people are facing difficulties in maintenance of labour, labour wage and the time consumption for harvesting the tea leaf. This project is aimed at solving these complexities and develops a machine that is compact and portable.

C. Objectives

The main objective of the project is to design and develop a unique, cost-effective, purpose serving solar tea leaf harvester.

MATERIALS AND METHODS

This paper aims to design and develop a solar powered tea leaf harvester for using with easy accessibility in the hill areas. This chapter deals with the design and analysis of the product and also the methodology of making the product. The materials and properties of the selected components are also discussed in this chapter.

A. Conceptual design

Initially, the rough drawing and dimensions were drawn. After the drawing, the three-dimensional model of the solar tea leaf harvester was drawn in solid works. Each part has been separately drawn and assembled.

While designing the tea leaf cutter, some assumptions are considered which is standard for their parts. Safe design for this machine by calculating the dimensions of each part and considering formulations. Material selection of the product is based on the availability, durability, cost and ease of fabrication were also considered. The conceptual design of the product is shown in the Fig 1.

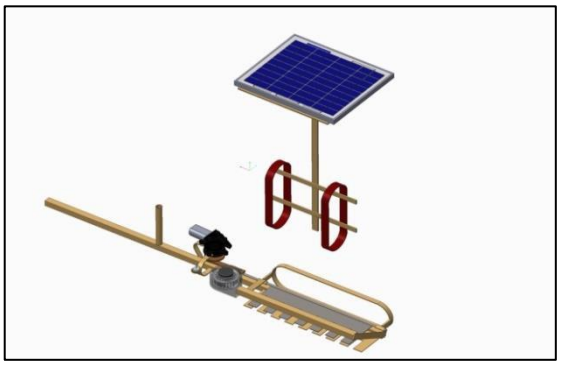


FIGURE 1 Conceptual design

B. Methodology

The methodology of the project is explaining the materials and methods which are used for designing the components of a solar powered tea lead harvester. The solar tea leaf harvesting machine consists of a frame, solar panel, motor, battery, crank mechanism, blower, cutting jaw and other mechanisms. The frame is made up of mild steel materials and all the other components are welded with it. There is another separate frame for solar panel which is to be carried on your shoulders. The tools are the cutting jaws made from the mild steel which is easily available and lesser in cost in the market. We use Lead acid battery(12v) for storing the electrical energy from the solar panel. Where high values of load current are necessary, the lead acid cell is the type most commonly used. An electric motor is a machine which converts electrical energy into mechanical energy. A DC electric motor of 12 volts in which the crank plate has been connected. Crank rod is connected to the movable cutting jaw where the other cutting jaw has been fixed by which cutting mechanism is done. Solar Panel reefers either to a photovoltaic module, a solar thermal energy panel, or to a set of solar photovoltaic (PV) modules electrically connected and mounted on a supporting structure. The slider crank mechanism is a typical mechanical linkage that converts rotational motion into linear motion which actuates the movable jaw to cut the leaves. The leaves that stuck in between the jaws are blown by a blower that is attached to the frame. The leaves are then collected in the collecting bag.

C. Working principle

The experimental setup of our project consists of a frame on which the fixed jaw and the movable jaw are mounted. The motion to the movable jaw is delivered with the help of the crank mechanism and the motor. The motor is powered up by a battery. A blower is provided at the side of the machine which helps to blow the leaves which are stuck between the jaws. Another backpack setup is arranged which consists of a solar panel and a backpack. The backpack can be used to wear the solar arrangement in order to carry with the operator.

The operator carries the backpack along with the solar panel. The solar panel helps to convert the solar energy directly into

electrical energy which is stored up in the battery. The battery supplies power to the motor. The power from the motor is transmitted to the cutting jaw through a crank mechanism. The crank mechanism is used to convert the rotary motion into the linear motion. The movable jaws moves and the leaves are stuck between the fixed and the movable jaw and the leaves are cut.

D. Sequence of operation

The flow of the solar powered tea leaf harvester is shown in Fig. 2

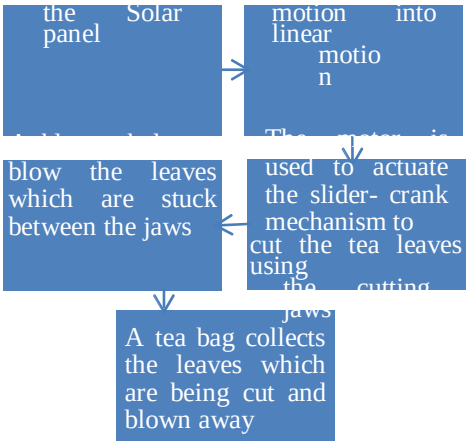


FIGURE 2 Sequence of operation

E. Design calculation

The solar tea leaf harvesting machine consists of a frame, solar panel, motor, battery, crank mechanism, blower, cutting jaw and other mechanisms.

P_a – Pressure of air
ϒ – Specific weight
Θ – Angle of inclination
h_w – Height difference
ρ_a – Density of air
R – Universal gas constant

H_a – Air head
Q – Discharge
A – Area of cross section
C_d – coefficient of discharge
V – Critical velocity of tea leaves

$P_a = \Upsilon \sin \Theta h_w / 100$

$= 1000*9.81*\sin30*1 / 100$

$= 49.05\ P_a.$

$\rho_a = P_a + P_{atm} / R\ T_o$

$=49.05+101.32/287+(273+30)=0.255 kg/m^3$

$\Upsilon = \rho_a * g = 0.255 * 9.81 = 2.5 kg/m^2s^2$

$H_a = \rho_a / \Upsilon = 49.05 / 2.5 = 19.2m$

$V = Q/A = C_d * ¶ 2*g* H_a$

$= 0.6 * ¶ 2 * 9.81 * 19.62 = 11.722$ m/s

AIR FLOW CALCULATION

The critical air flow rate required for properly conveying the leaves through the conveying pipe is 1180cm/s. For properly accommodating the tea leaves inside the leaf conveyor pipe, the minimum inlet diameter is

$d_{inlet} = 8cm$

$A_{inlet} = d^2 /4 = *8^2 /4 = 50\ cm^2$

for proper conveying of leaves at the inlet,

Critical velocity of tea leaves

assuming the air velocity at the inlet is double the critical velocity.

Then the flow rate required for the blower is: V =

$Q_{blower} / N = 7.08 * 10^6 / 5000 = 1416 cm^3$

For preventing the leaves entering the outlet, assume the air velocity at the outlet is half of the critical velocity,

$Q_{blower} = A_{outlet} * V / 2$

$A_{outlet} = 2Q_{blower} / V = 2 * 1.18 */1180\ 10^5$

$= 200 cm^2$

RESULTS AND DISCUSSION A.

Methods of study

This project is involved cutting the tea leaves with the help of the solar power tea leaf harvester. This solar powered tea leaf harvester has been explained in the last chapter. The time, study and cost estimation in the project are explained in this chapter.

B. Final fabricated prototype of Solar powered tea leaf harvester

The following Fig. 3 is shown us the final fabricated prototype of a solar powered tea leaf harvester.

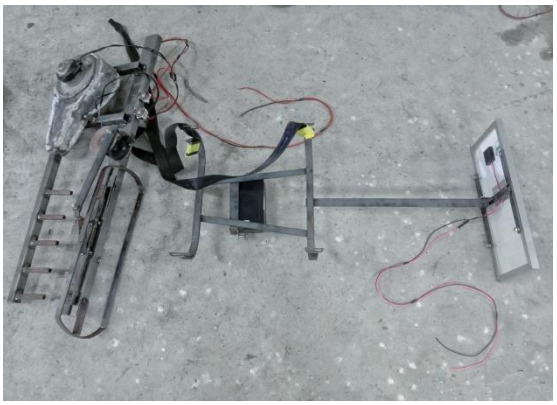


FIGURE 3 Final prototype

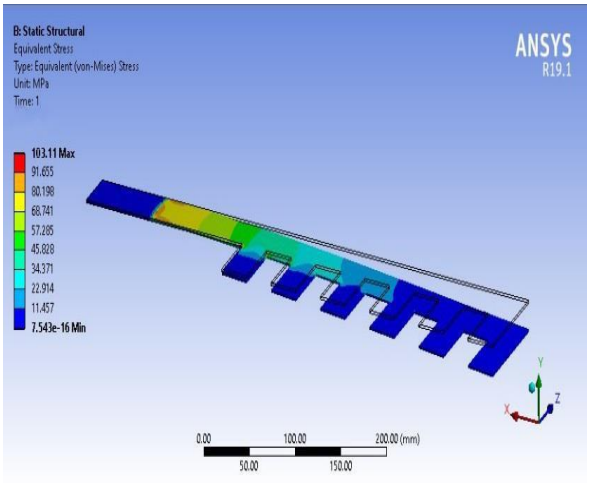
C. Fabrication process

The material selected must possess the necessary properties for the proposed application. The various necessities to be satisfied are weight, surface finish, rigidity, ability to withstand environmental attack from chemical reactions, service life, reliability etc.

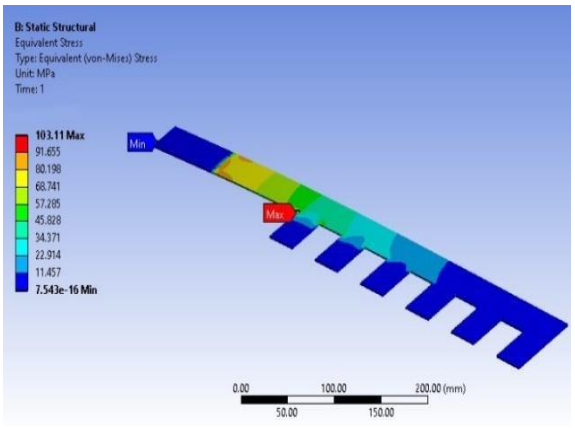
D. Analysis report

The machine has been designed and analysed, Analysis like Stress analysis, the factor of safety and total deformation has been carried out and discussed.

Stress Analysis



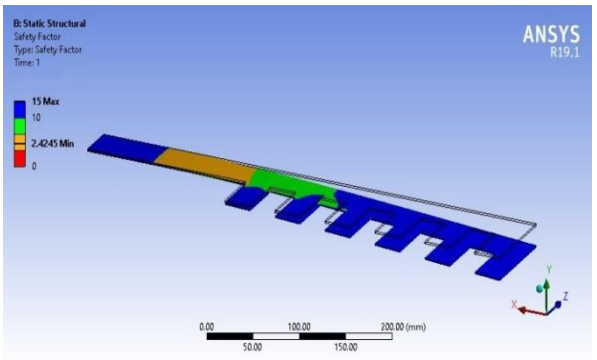
The maximum stress induced in the blade due to the gravitational constant of force 9.8N (self-weight) that is acted on the body is 103 Mpa which is less than the yield strength of the material. So, it is completely safe to manufacture the blade unless and until the blade is acted upon by any other external load.



Stress Analysis - Factor of safety

The factor of safety developed during analysis when the gravitational force is taken into account is 2.42. The maximum stress develops uniformly on the blade, the design is safe. So, the blade can withstand Gravitational force without damage.

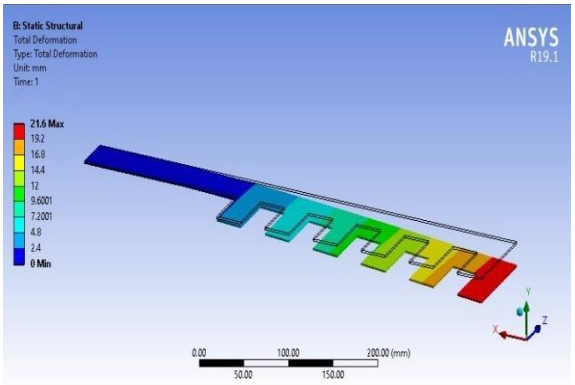
In Industrial machine manufacturing, most FOS values range anywhere between 1.5 to 2.5. As our material



has 2.4 FOS, it is completely safe to manufacture.

Stress Analysis - Total Deformation

The total deformation of the blade is 21.6mm. Even though it is slightly higher. It can be managed by reducing the length of the blade or by changing the material of the blade.



E. Important findings

These types of solar powered tea leaf harvesters will have a wide range of applications in areas like,

- It has a vital role to be performed in the tea estates.
- This innovation is highly suitable for the purpose of tea plantations.
- It is also very helpful in the garden cleaning purposes and as well as agricultural purposes.
- This kind of innovation reduces the manual work and the working time.
- This is non-conventional solar power mechanism.
- It can be operated even by layman with solar power system.

CONCLUSIONS

This project work has provided us an excellent opportunity and experience, to use our limited knowledge. We gained a lot of practical knowledge regarding, planning, purchasing, assembling and machining while doing this project work. We feel that the project work is a good solution to bridge the gates between the institution and the industries.

We are proud that we have completed the work with the limited time successfully. The "DESIGN AND FABRICATION OF TEA LEAF HARVESTING MACHINE USING SOLAR ENERGY" is working with satisfactory conditions.

We can able to understand the difficulties in maintaining the tolerances and also the quality. We have done to our ability and skill making maximum use of available facilities. By using more techniques, they can be modified and developed according to the applications.

This project can be modified in the future in the following ways:-

- To automate tea leaf cutting in unconditioned farms.
- Employs innovative cutting-edge technology with blades made of ferrous metal.
- Plucking of side shoots.
- Operate the machine in hilly-terrain areas.

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