UNIVERSITI TEKNIKAL MALAYSIA MELAKA

Faculty of Mechanical Engineering

SIMULATION OF PV SOLAR COCONUT DEHUSKING MACHINE

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SIMULATION OF PV SOLAR COCONUT DEHUSKING MACHINE

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A Master Project Report submitted
in fulfillment of the requirements for the degree of Master of Mechanical Engineering (Energy Engineering)

Faculty of Mechanical Engineering

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

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DECLARATION

I declare that this report entitled "Simulation of Solar PV Coconut Dehusking Machine" is the result of my own research except as cited in the references. The report has not been accepted for any degree and is not concurrently submitted in candidature of any other degree.

Signature : .....

Name : Bonny Jinggut anak Dominic Merikan

Date : 16/05/2016

APPROVAL

I hereby declare that I have read this report and in my opinion this report is sufficient in terms of scope and quality as a partial fulfillment of Master of Mechanical Engineering (Energy Engineering).

Signature : .....

Supervisor: Dr. Shamsul Anuar Bin Shamsudin

Date : 17/05/16

DEDICATION

To my beloved wife, mother and father

ABSTRACT

Solar PV coconut dehusking machine is one of the most important application of renewable energy especially in rural areas. It's not only improve the socio - economy in rural areas but reduce the risk of injuries while they dehusking the coconut manually. Thus the purpose of the study is to simulate the performance of the Solar PV coconut dehusking machine by circuit modeling in Simulink and PVsyst software. While the system is in a modeling and simulation of Simulink, simulation results show that it can match the rpm and torque of the dry coconut shear test. Furthermore, its offer better cost of ownership in the long term if compare to the fossil fuel dehusking dependable machine based on PVsyst analysis.

ABSTRAK

Mesin pengupas kelapa solar adalah salah satu aplikasi yang paling penting bagi tenaga boleh diperbaharui terutamanya di kawasan luar bandar. Ia bukan sahaja meningkatkan sosial ekonomi di kawasan luar bandar tetapi mengurangkan risiko kecederaan semasa mereka mengupas kelapa secara manual. Oleh itu, tujuan kajian ini adalah untuk mensimulasikan prestasi mesin pengupas kelapa solar sebagai model litar dalam perisian Simulink dan PVsyst. Walaupun sistem ini berada dalam pemodelan dan simulasi Simulink, hasil simulasi menunjukkan bahawa ia boleh menandingi rpm dan tork ricih kelapa keputusan ujian impak tekanan. Tambahan pula, ia menawarkan kos pemilikan yang lebih baik dalam jangka panjang jika dibandingkan dengan mesin pengupas kelapa yang bergantung pada bahan api fosil berdasarkan analisis yang dilakukan dengan menggunakan PVsyst.

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A	Ampere
AC	Alternate Current
B	friction coefficient
BLDC	Brushless Direct Current Motor
D	Diode
DC	Direct Current
DTC	Direct Torque Control
GHI	Solar Horizontal Irradiance
GUI	Graphical User Interface
Isc	Current Source
J	inertia
K	Kelvin
k	Boltzmann's constant
MPPT	Maximum Power Point Tracker
N	Motor speed
Nm	Newton Meter
P	Power
P&O	Perturb and Observe
PV	Photovoltaic
q	electron charge 1.602 x 10-19 C
rad/s	Radian per seconds
rpm	Revolutions per minute
Rs	Resistance
TL	Load Torque
V	Voltage

CHAPTER 1

OVERVIEW

1.1 Introduction

Chapter 1 outlines the importance of the project. This chapter includes the background of the study, problem statement, objectives, scope and outline of the project.

1.2 Background

Coconut dehusking machine capable to improve production and efficiently eliminate injuries to labour while perform coconut dehusking. These difficulties might change people mind to perform this job fulltime and as their core business. While government implement continuous drive to improve the rural economic, coconut production must not be neglected as it potentially generate consistent income. Thus, coconut dehusking machine is a critical element to successful production of coconut, yield better production and save time. The coconut husk waste is also required for both commercial value and environmental protection.

The recent increase in coconut milk demand for the past few years has contributing to a rapid growth in coconut dehusking activities. In 2009, coconut crops planted in 12.23 million hectare throughout various places in the world. Malaysia, among other coconut producers, yields about 400 million coconuts which is still short of the 143 million coconuts for domestic demand (Taufik et al. 2014). Thus, this is quite an impressive opportunity and handsome pay for some of the rural community especially in Malaysia.

Unfortunately, in Bintulu particularly, the quest for coconut milk is done manually by using hand tools such as knife, iron blade, iron spear or sharp hard blade. Modern dehusking machine is therefore a mandatory device to generate better income and improve production. Conventional ways to dehusk the coconut present many challenges. In particular, the labourers need to have good skills and endurance to perform the task and potentially injure themselves due to fatigue. On average, manual dehusking can produce almost 100 coconut/hr compared to 150 to 720 coconuts/hr produced by machine (Taufik et al. 2014).

Some type of dehusking machine was built a long time ago, about 1984 by Toh and Tan, whoincorporated electric powered circular saw to cut the coconut husk into halves before the spring loaded arms tear the husk out (Taufik et al. 2014). The problem for this machine is that the workers need to force their hand into the machine in event where the machine not properly met their needs. This action might expose them to hazard. Later, dehusking machine equipped with semi-automatic pneumatic system was developed (Taufik et al. 2014). This machine removes the husk by using a pneumatic force of the sharp blade edge toward the coconut. This design however still does not reduce the risk as the operator have to use their hands to force the coconut toward its sharp blades.

The safety of the operation is taken into consideration at this stage.Thus another version of the machine is developed to meet the challenge. In 1998, Kwangwaropas used a single phase, 1.5 kW electric motor to develop a new dimension of thedehusking machine (Taufik et al. 2014). It comprises of two revolving cylindrical rotors with six fins on each rotor. Like previous designs,the operator needs to force the coconut by pushing it toward the rotors, but this time it is done by using a cover. Another successful version of the dehusking machine is using double spike rollers with a hydraulic-actuated mechanism. It uses a 4.1 kW petrol-powered motor to generate the hydraulic pressure which is used to

drive the double spike rollers. The coconut is fed between the two rollers to remove it husk.

All the technologies and mechanisms of the dehusking machines available might be functional and efficient but they might not suit everyone's needs especially where the area lack basic facilities such as road access, electricity and petrol stations. Thus, this pavesthe way for a new innovation to develop a green energy dehusking machine for rural people of Bintulu division to equip them well and boost their economic capabilities. Renewable energy alternatives are also necessary for sustaining the environment, affording the basis for shrewd long-term rural production system.This would also minimize direct costs to producers for preserving good environmental quality and indirect costs caused by consumers when environmental quality declines.Furthermore, users may benefit greatly from the high environmental quality in air, soil and water.

The innovationin this work is driven by Photovoltaic source which is a renewable energy source. Auxiliaries such as alead acid battery to store electric charge and a charge controller are parts to improve both performance and economics of the system. The frame, its twin rollers and a DC motor are the main components of the dehusking machine as shown in Figure 1.1.

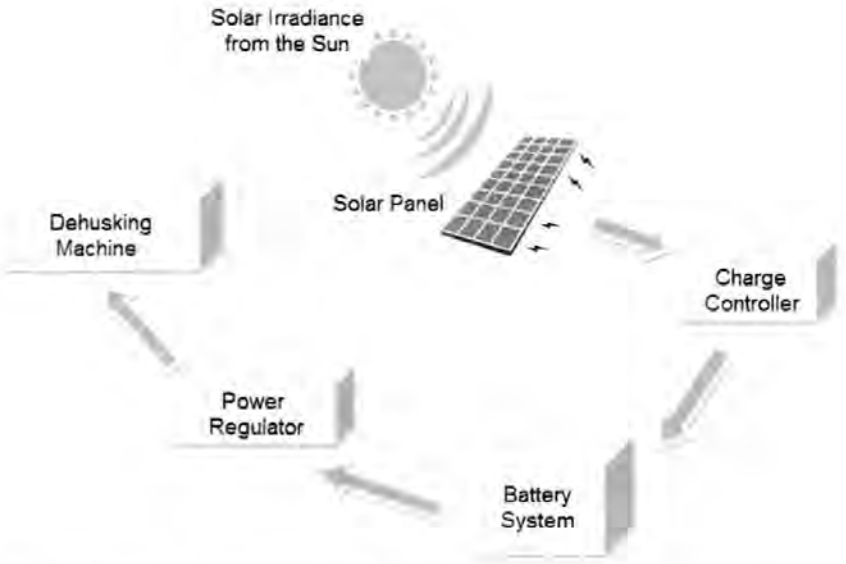

Figure 1.1: PV solar coconut dehusking machine modelling.

1.3 Problem Statement

A coconut is a well-known favourite fruit and can be found easily in the tropics. Young coconutsare harvested for it juice and flesh which bring sweet taste. The old coconut is a source for coconut milk which also an ingredient in consumer food. This basic crop is greatly in demand particularly in Bintulu, Sarawak. There, the coconut treescan be found widely in rural area such as Sebemban, Setulan, Serupai and other areas along the seaside. It becomes one of the main economic source of income beside the palm oil for people living in those areas.

Dealing with coconuts can be considered lucrative for the farmers. The current market price for husked coconut varies from RM 1.00 to RM 1.80 each. Normally, the farmer can easily sell up to 100 kernels daily as they do this by a conventional dehusking method. Most of the farmersare old as the young ones work in the cities.Thus, doing this daily could drain their energy, time and jeopardize their health. Unfortunately, they cannot

afford to stop doing their routine, as they also need some income to support their own living expenses.

A new techniques or a mechanical dehusking machine is what they might be craving for to support their production. Currently, they need something that is portable and not powered by electricity, at least not from the grid. Some areasareon grid while some are not. Even in the areas with electricity, their farmscan be far frompower socket points. Thus, electric-powereddehusking machines cannot be used directly. Another solution is probablyto introduce a petrol or diesel engine to power the dehusking machine.

In short term, this might be the best solution but the nearest filling station is around 80 km away in many areas. Another weakness is the regulation, which says no one can simply fill their empty drum or gallon canisters.Furthermore, according to that regulation,people are advised to fill their vehicle tanks. An alternative approach have some drawbacks, including their cost and long-term liability, a possible solar PV coconut dehusking machine should meet their need. It is portable, not need for fossil fuel or in-line grid hence able to come out with the same outcome.

1.4 Objectives

The objectives of this project are:

i. To modelling and simulate a Solar PV Coconut Dehusking Machine.

ii. To implement a renewable technology that able to reduce the dependable of fossil fuel for small-scale rural agricultural entrepreneur.

iii. To analyze the economic impact of Solar PV Coconut Dehusking Machine.

1.5 Scopes of Project

The scopes of this project are:

i. Perform simulation by using the Simulink software to determine the performance of PV solar coconut dehusking machine.

ii. Small PV systems that practically reduce the dependable of fossil fuel to operate the coconut dehusking machine and introduce the renewable energy for small-scale rural agricultural entrepreneur.

iii. Compare the simulation results with an existing machine.

1.6 Project Outline

This thesis consists of five chapters. The background of study, problem statement, objectives, scopes and outline of the thesis of this project will be discussed in Chapter 1. Next, Chapter 2 will review theories and related developments of the project including PV system, energy storage technology and food production technology. In Chapter 3, discussion is on the methodology to achieve the objective. Besides that, Chapter 4 will highlight the results and discussions. Finally, Chapter 5 outlines the conclusion of this project and recommendations that can be done to improve this work.

CHAPTER 2

LITERATURE REVIEW

2.1 Introduction

Chapter 2 discusses the theories and advancementsrelated to the project being studied. This chapter includes the studieson coconut dehusking techniques and an overview of the potential mechanisms. Coconut dehusking mechanisms can be driven manually (man power), by in-grid electricity, by fossil fuel generators or by renewable energy sources such as solar irradiance. The aim of this chapter is to describe the technologies that are currently available or under development.They may be suitable for the design and simulation of a Solar PV coconut dehusking machine.

2.2 Coconut

Coconut is well known favourite local snack and can be found easily in the tropics. Young coconutsare harvested for the juice and flesh which taste sweet. On the other hand,ripe coconut is a source for coconut milk which is also an ingredient in many consumer products. Coconuts are greatly in demand particularly in Bintulu, Sarawak where the coconut trees are widely planted in rural areas such as Sebemban, Setulan, Serupai and along the seaside. It becomes one of the main economic activities.

2.2.1 Coconut Dimensions

Coconut dimension is a critical element in designing the dehusking machine. The dimensions of the mature coconut vary depending on the area it is planted and its breed.

Anefficient machine has to meet a range of coconut sizes and able to increase productivity. Venkataramanan et al. had conducted a research to measure the dimensions of the coconut by using external callipers. Most of coconuts appeared to have identical dimensions in term of the Y and Z directions. However, the most similarity had been found in the Xdimension (Venkataramanan et al. 2014.). The dimensions of X, Y and Z are shown in Figure 2.1.

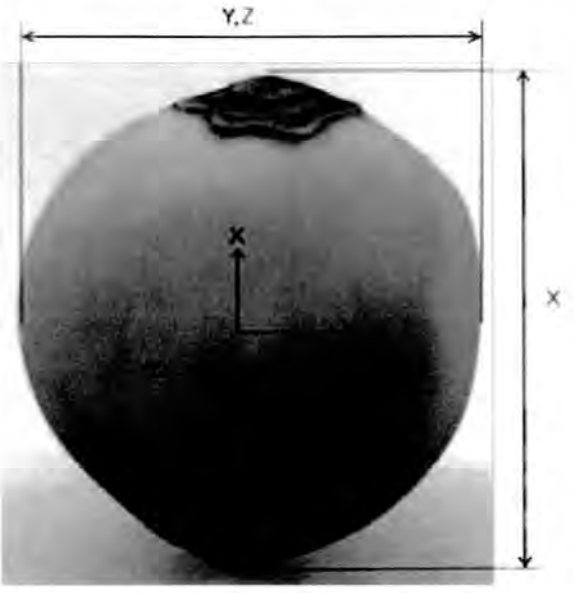

Figure 2.1: Mature coconut dimensional axes (Venkataramanan et al., 2014).

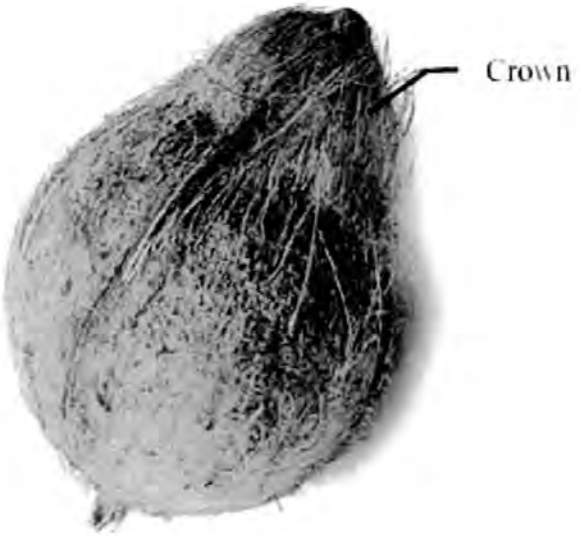

Figure 2.2: Coconut crown (Venkataramanan et al., 2014).

The data was collected from various places in order to get the average measurement of the coconut. Table 2.1 shows the dimension range of the coconut with husk. Meanwhile, Table 2.2 lists the dimension range of the husked coconut.

Table 2.1: Dimension of the coconut with husk (Venkataramanan et al. 2014).

No	X-axis (mm)	Y-axis (mm)	Z-axis (mm)
1	121	113	109
2	157	146	142
3	182	161	165
4	246	218	214
5	276	230	227
6	287	269	263

Table 2.2: Dimension of the husked coconut (Venkataramanan et al. 2014).

No	X-axis (mm)	Y-axis (mm)	Z-axis (mm)
1	97	86	86
2	114	98	96
3	125	115	109
4	147	129	125
5	162	135	134
6	132	124	122