Design Model of Automated the Groundnut Threshing Machine

Benjamin Bello¹, A. Tokan², J. D. Jiya³, Abubakar Ibrahim Musa⁴

¹,³- Department of Mechatronics and System Engineering Abubakar Tafawa Balewa University Bauchi Nigeria
²- Department of Mechanical and Production Engineering Abubakar Tafawa Balewa University Bauchi Nigeria
⁴- NCPRD ATBU/Energy Commission of Nigeria

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ABSTRACT:

The groundnut threshing machine is an automatic device which removes groundnut seeds from their pods by stripping, impact action, and rubbing. In such machine, the main components are; the feeding hopper which contains the unshelled groundnuts, infrared sensor, the threshing unit which comprises of rotating pike (beater) and a fixed concave (screen) with a small gap space for threshing the groundnut, the separation unit which separate the threshed seeds from the chaffs with using a fan, and the collecting unit where the seeds will be stored and conveyed through a conveyor. An automation programming code in C language has developed and executed in an Arduino Uno which has enabled the automation process of the groundnut thresher, the materials which will be sourced locally. In this technique three motors are used as prime mover for thresher, blower, and conveyor. The performance of the proposed system is evaluated in terms of its throughput capacity, threshing efficiency, and mechanical damage.

Keywords: Groundnut, Design, Threshing, Separation, Automation, Arduino Uno

1. INTRODUCTION

Groundnut (Arachis hypogea) is originated from Brazil as far back as 350BC and was introduced into West Africa in the 16th century by Portuguese traders, groundnuts is the largest and most important member of the legumes family. This crop is best grown on loamy soil that is rich in Calcium, potassium, phosphorus (Ca, K, and P).

Over 100 countries worldwide grow groundnuts such as Nigeria, China, Sudan, India, Israel, USA, etc (Deshmukh et al., 2015). In Nigeria the product is predominantly farmed in the northern part of the country like Sokoto, Gombe, Kano, Borno, Bauchi and Kaduna state, etc. (Ani et al., 2013). Groundnut is the sixth most oiled in the world it contains approximately 49% of oil and 27% of protein and is a good source of vitamins, minerals and dietary fibre. The use of this crop cannot be neglected as a source of revenue generation for government, for commercial purpose, as food, as a source of employment and industrial purposes.

One of the important processes involve in the production of groundnut is threshing and separation. Threshing is the removal of the groundnut seed from its pod by stripping, by impact action, rubbing, compression and shearing etc. Threshing can generally be done by traditional method (hand) and machine method. Traditional method is the process in which the pod is pressed with thumb and the first finger so that the groundnut seed can be released, it could also be used by stick beating, animal trampling etc. The most popular method of groundnut threshing widely used in Nigeria is by pressing the pod with thumb and finger which has a very low percentage of groundnuts breakage, time wastage, high energy requirement, high labour intensive, fatigue also with sore thumb syndrome when large quantity are handled with low productivity Ajayi and Olassunkanmi (2013). The time require for an average man to produce at least 1kg to 1.5kg of a groundnut seeds from its pod is between 1 to 2 hours while a day’s work will be an average of 15kg. According to (Deshmukh et al., 2015), groundnut is grown by small scale farmers in developing countries like India, Nigeria. Lack of groundnut processing machines, especially groundnut Sheller, is a major problem of groundnut production. (Ashish and Handa, 2014).

1.1. Problem Statement

There are high rate of groundnut seed damage through the process of threshing, especially locally fabricated machines. In every 1kg of groundnut being threshed, approximately 0.83kg seeds are obtained, out of which 0.645kg are good while 0.185kg are damaged as reported by (Makoju 2010). Other threshing machine developed showed that after threshing the groundnuts
1.2. Objective

I. To design a model of groundnut threshing machine that will minimise the rate of groundnut seeds damage

II. To developed a automation code for automation

III. To simulate the circuit with proteus 8 professional

2. METHODOLOGY

I. Design Hopper

Upper hopper
Area = length x width (mm$^2$)  
Volume = $\frac{1}{3}$ (area x height) (mm$^3$)  

Lower hopper
Area = base x width (mm$^2$)  
Volume = $\frac{1}{3}$ (area x height) (mm$^3$)  

Volume of hopper = upper hopper – lower hopper (mm$^3$)

II. Design Concave

$rc = rd + hp + Cc$

Where:
$rc$ = Concave radius (mm)
$rd$ = Radius of cylinder drum (mm)
$hp$ = Peg height above the drum (mm)
$Cc$ = Concave clearance (mm)

III. Power required for threshing

$P = W \times F_R \times \log \left(\frac{L_1}{L_2}\right)$

$F_R$ = Rupture force of groundnut (N/mm)
$K$ = Kick’s constant
$W$ = Average weight of unshelled groundnut (kg)
$L_1$ = Average length of unshelled groundnut (m)
$L_2$ = Average length of shelled groundnut (m)

IV. Design Shaft, Pulley and Belt

The shaft for threshing has a diameter of 28mm with internal diameter of 25mm for bearing and was step down to 22mm for its pulley.

$N_1 \times D_1 = N_2 \times D_2$

Where:
$N_1$ = Speed of driving pulley (rpm)
$N_2$ = Speed of driven pulley (rpm)
$D_1$ = Diameter of driving pulley (mm)
$D_2$ = Diameter of driven pulley (mm)

V. Belt length:

$L_b = \frac{\pi}{2}(D_1 + D_2) + \frac{(D_1 - D_2)^2}{4x} + 2x$

Where:
$x$ = Centre distance between driving and driven pulley mm.

VI. Fan

The air discharge is given as:

$Q = (V \times A)$

$Q$=Air flow rate m$^3$/s
$A$=Outlet cross-section area m$^2$
$V$= Air velocity m/s

VII. Design of Drive system

Considering the pulley of radius, r in meter acted upon a circumferential force, F in Newton which causes it to rotate at N rpm and generate a torque, $\tau$ in Nm as shown in (9):

$\tau = F \times r$ (Nm)  

The work done, W by this force for one revolution can be shown in (10)

$W = F \times d = F \times 2\pi$ Joule

Therefore, for N- number of revolution, the work done can be expressed as

$W = F \times 2\pi \times N$ Joule

The power developed, P has been determined from

$P = \tau \times \omega$ Watt

Where $\omega$ = Angular velocity (rad/s)

But $\omega = \frac{2\pi N}{60}$ rad/s

Therefore $P = \tau \times \frac{2\pi N}{60}$ watt

VIII. Frame

$\text{Stress} = \frac{\text{Load}}{\text{Area}}$

IX. The power transmission of belt

$P = (T_1 - T_2) V$

Where $V$= Belt velocity (m/s)

$T_1$= Tension of the belt upper side (tighter side) (N)

$T_2$= Tension of the belt lower side (slacker side) (N)

X. Design procedure

CONCEPTUAL DESIGN

MATERIAL SELECTION

DESIGN ANALYSIS

PRODUCTION

ASSEMBLING

PROGRAMMING

FINAL PRODUCT
Automation code

//OUTPUT DECLARATION
const int PauseResetIndicatorRedPin = 13;
const int ProcessIndicatorGreenPin = 12;
const int ThreshingDCMotorPin = 9;
const int BlowerDCMotorPin = 8;
const int ConveyorDCMotorPin = 7;

//INPUT DECLARATION
const int HopperIRSensorPin = 6;
const int IRSensorPin = 5;
const int AutoManButtonPin = 4; // Flip-Type
const int LoadSensorPin = A1;
const int ThreshingMotorSpeedVariatorPin = A0;

// OTHER CONTROL VARIABLE DECLARATION
long hopperDelayTime = 10000;
long hopperDelayTimer = 0;
long processDelayTime = 20000;
long processDelayTimer = 0;
int hopperIR = 0;
int collectorIR = 0;
int loadValue = 0;

int autoMan; // 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X. Simulation Result

Plate 1. The circuit without program been uploaded.

Plate 2. Program uploaded Fan was ON automatic.

Plate 3. Fan and Thresher ware ON.

Plate 4. Fan, Thresher and Conveyor were ON.

XI. Propose automated threshing machine

Fig. 1. Concave (screen).

Fig. 2. Pike (beater).
Component: Hopper, Threshing cylinder (concave or screen, pike or beater), Blower (fan), collection unit, conveyor, Frame, Induction motor, DC motor, Shaft, Pulley, Belt, Printed Circuit Board (PCB), Microcontroller (ATmega 328p), Resistor, Transistor, Sensors, Diode, Jumpers wires, Liquid Crystal Display (LCD), Light Emitting Diode (LED),
3. CONCLUSION

The above propose design was conceive to provide solution to problem statement stated above through the implementation of an automated system where labour insensitive, time consuming, will be reduce to minimal and a better performance in term of threshing will be achieved. The rate at which mechanical damage of the groundnut seed is high, the automation operation will reduce the percentage to a very minimum value if not eliminated. The application of automation is now necessary to be employed in our today’s fabrication.

REFERENCE


Fig. 8. Assembling diagram.