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RESEARCH AND DEVELOPMENT OF CASHEW-NUT DESHELLING MACHINE

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ABSTRACT

Cashew nut farming is one of the prime occupations in Goa. However, due to lack of laborforce, it is getting tough for the farmers involved in this occupation. The major risk involved being spilling of fluid from theshell that can lead to partial/permanent blindness. The machinery involved with processing are bulky, costly, imported as well as needs regular maintenance.

The intention is to build a smart machine that can fulfill requirements of the farmer as well as provide additional function such as Deshelling and online monitoring (using the internet). The online control and monitoring save the time needed to travel and also the need for an operator is removed. This saves time and resources. This is important as Transportation network in remote areas is weak.

Introduction

1.1 Cashew nut

The cashew tree is evergreen. It grows up to 12 meters high and has a spread of 25 meters. Its extensive root system allows it to tolerate a wide range of moisture levels and soil types, although, commercial production is advisable only in well-drained, sandy loam or red soils. Annual rainfall needs to be at least 889mm (35 inches) and not more than 3048mm (120 inches). Cashew trees are most frequently found in coastal areas.

The main commercial product of the cashew tree is the nut. In the main producing areas of East Africa and India, 95% or more of the apple crop is not eaten, as the taste is not popular.

However, in some parts of South America and West Africa, local inhabitants regard the apple, rather than the nut kernel, as a delicacy. In Brazil, the Apple is used to manufacture jams and soft and alcoholic drinks. In Goa, in India, it is used to distil cashew liquor called "feni".

The cashew fruit is unusual in comparison with other tree nuts since the nut is outside the fruit. The cashew apple is an edible false fruit, attached to the externally born nut by a stem. In its raw state, the shell of the nut is leathery, not brittle. It contains the thick vesicant oil, CNSL, within a sponge-like interior. A thin test skin surrounds the kernel and keeps it separated from the inside of the shell. The primary products of cashew nuts are the kernels which have value as confectionery nuts.

1.2 Problem

Cashew nut farmers are the real producers of Cashew nuts. However, Cashew-nut farmers don't earn enough profits in spite of being a producer of dry fruits due to lack of facilities in technical as well as themanagerial side. The requirements were thus studied and a solution was developed. Thus, Smart Deshelling Machine was the solution founded.

1.3 Cashew Nut Processing

Cashew Nut Processing includes stages such as:

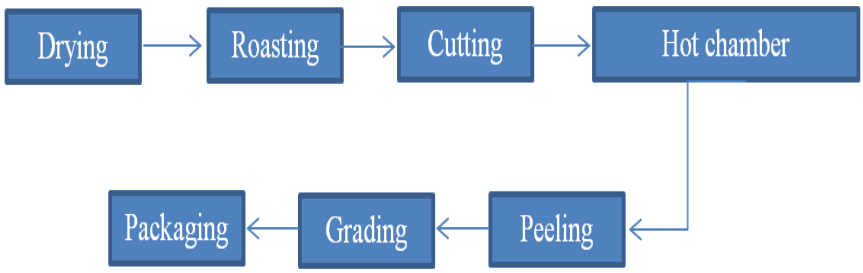

Figure 1 cashew nut processing.

Traditionally, extraction of the kernel from the shell of the cashew nut has been a manual operation. The nut is roasted which makes the shell brittle and loosens the kernel from the inside of the shell. By soaking the nuts in water, the moisture content of the kernel is raised, reducing the risk of it being scorched during roasting and making it more flexible so it is less likely to crack. The CNSL is released when the nuts are roasted. Its value makes acollection in sufficient quantities economically advantageous. However, for very small-scale

processors, this stage is unlikely to take place due to the high cost of the special roasting equipment required for the CNSL collection. If the nuts are being manually shelled, gloves need to be used or alternatively, the nuts should be tumbled in sawdust or ashes to absorb the liquid coating which has a harmful effect on the skin the high cost of the special roasting equipment required for the CNSL collection. If the nuts are being manually shelled, gloves need to be used or alternatively, the nuts should be tumbled in sawdust or ashes to absorb the liquid coating which has a harmful effect on the skin.

1.4 Solution Identified

To execute the task the first and foremost work was that, if there is a need to perform Deshelling in a machine then a platform is needed, which is suitable to do programming, controlling and simulating the concept within a safe environment. Matlab (simulation), SolidWorks (3D model)&Atmel Arduino compatible microcontroller board turned out to be the best platforms for implementing the solution. Mechatronics approach was chosen to solve this problem. The first step was to think of the mechanism required to implement such system. Thus, a 3D model was created after confirming the mechanism. Thus, thefirst step is accomplished.

The structure was supposed to be robust as well as cheap. The C type channel seemed anideal choice for chassis. Thus, after manufacturing the chassis the toughest part was to select actuators. The single phase AC motors with high rpm were capable enough to produce required force as well as capable of being controlled by the microcontroller using an Ethernet Shield and Relay board. The selection of microcontroller was done on the basis of certain requirements such as wireless control and Data logging on Android Smartphone.

The intention was to add an online control and monitoring of thesystem for which the intended sensors are proximity sensors, counters, timers, encoders, etc. The major hardware used in the project:-

Electronics: Arduino Uno (microcontroller), Ethernet Shield, Motor Driver, AC Motors, Relay, etc.

Mechanical: C- Channel, Scotch Yoke Mechanism,Inverse Slider Crank Mechanism, Linear shaft, ball bearing etc.

Coding: Arduino IDE software used.

Electronics Integration

4.1 Principle

The integration of Android app with Arduino was a challenge it needed to be solved in such a way that, the machine maintenance can be done by any person with sound knowledge on Electronics. Thus, the flow of information was decided.

The sensor selected for the purpose of counting input number of cashew nuts was a proximity switch. The switch is located vertically to make the count of cashew nuts taken as input. This leads to therecording of an input signal whenever the scrapper is near the proximity switch. Information is collected and the number of cashew nut taken so far is counted. This information is measured using a counter which is already inbuilt in the Arduino uno board. This leads the program to send this information through Transmitter. The transmitter uses the Ethernet Shield for communication using Network Time Protocol and Web Server. This leads to information transfer to the website. This data is received at thewebsite and taken as an input for Approximate Weight indication bar.

Average weight of one cashew nut = 3.7g

The no. of cashew nut shelled = 20

Weight on bar = 20 x 3.7 = 74 g

The information from thewebsite is transferred to mobile using HTTP and Android Application protocol. This leads to information transfer and Data Logging and Display at the remote device, which is a Smartphone. Thus, the device is able to display data on the weight so far shelled and thus, can be used for bidding in themarket directly to the Government or Consumers. This adds up a transparency and Money flow towards the producers.
The list of major electronic components used is mentioned below:

- ARDUINO UNO
- ETHERNET SHIELD
- LDR MODULE

- RELAY MODULE
- JUMPERS
- POWER SUPPLY

Circuit Description

The value of LDR sensor is taken as a digital output. LDR sensor is an analog device. But, the LDR module from Veerobot has an additional pin to take digital output. The user needs to set a point above which reading is expected to be one. Thus, the LDR senses the cashew nut, when the light falling on it is blocked by the cashew nut. The sensor thus gives us a binary data in terms of HIGH & LOW state.

The circuit diagrams for counting and measurement of theweight of cashew nuts deshelled so far is given as follows:

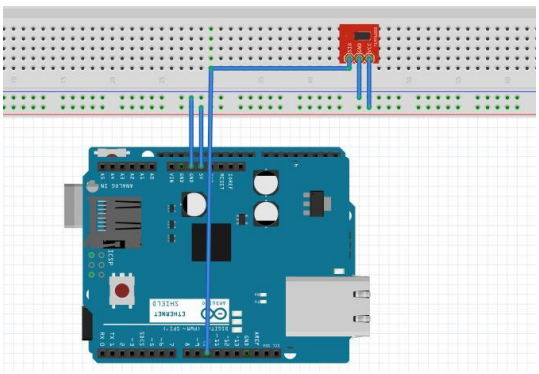

Figure 2 Monitoring circuit.

The value read by the Arduino at the pin connected to the LDR module helps in taking actions. Thus, a variable is created in the program which updates its value by +1 whenever there is a HIGH signal recorded at the LDR pin.

This reading is updated every time and stored in a buffer in thetransmitter. The transmitter backs up this data on the SD card present in the shield. The recorded data is sent to thewebserver. The webserver updates this value on the webpage. This leads to the indication of theapproximate weight of cashewnut as per the logic explained above.

Thus, reading on the web is available. This helps in monitoring the machine from remote areas. The location of LDR module is near the feeder.

Now, the circuit of controlling needs to be taken into consideration. Since the Arduino UNO is incapable of handling large memory. The control and monitoring circuits are different. This is also due to drop in potential recorded when the size of wires increases. The circuit below shows the elements involved in controlling and their wiring.

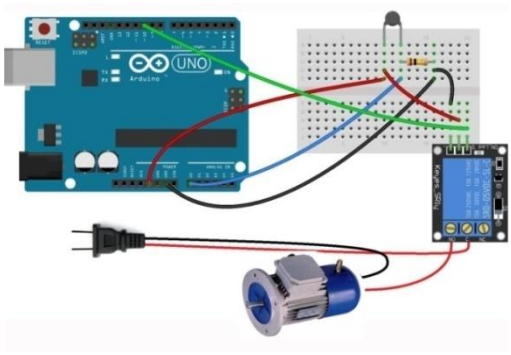

Figure 3 Control circuit for machine.

When the webpage is showing the weight of cashewnuts. The readings are dynamic in nature i.e. it constantly changes with respect to time. But, it becomes after a time. That stage is achieved when the machine finishes the shelling of the cashewnuts loaded in it. This is observed on the webpage by the person responsible for monitoring the machine. This leads to an indication of work done. The machine can now be stopped. This needs the machine to be given an off signal.

The webpage contains a submit button to turn on/off the motor. The webserver gets this value and updates the state. This state is taken as an input to the arduinouno R3through means of Ethernet Shield connected to it. This received command activates a task in the program to run. This program is responsible for making an input to thedigital pin connected to the relay to change its state from HIGH to LOW & vice versa.

The signal is received on the relay board. Depending on the type of connection i.e. NO/NC the load is supplied or deprived of the power. The relay is a controlled switch. The load, in this case, is a 220V, 50 Hz single phase AC motor.

Technical Specification of Electronic components:

- Arduino UNO
- Ethernet shield
- Relay
- LDR module
- Jumper

4.3.1 Arduino UNO

Figure 4 Arduino UNO R3.

Table 1 Specification of ARDUINO UNO.

Microcontroller	ATMEGA328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 Ma
DC Current for 3.3V Pin	50 Ma
Flash Memory	32 KB (ATmega328P) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
Length	68.6 mm
Width	53.4 mm
Weight	25 g

4.3.2 Ethernet Shield

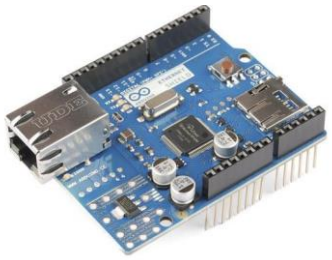

Figure 5 Ethernet Shield.

Table 2 Specification of Ethernet Shield.

Microcontroller	ATmega328
Operating Voltage	5V
Input Voltage Plug (recommended)	7-12V
Input Voltage Plug (limits)	6-20V
Input Voltage PoE (limits)	36-57V
Digital I/O Pins	14 (of which 4 provide PWM output)
Arduino Pins reserved:	
	10 to 13 used for SPI
	4 used for SD card
	2 W5100 interrupt (when bridged)
Analog Input Pins	6
DC Current per I/O Pin	40 Ma
DC Current for 3.3V Pin	50 Ma
Flash Memory	32 KB (ATmega328) of which 0.5 KB used by bootloader
SRAM	2 KB (ATmega328)
EEPROM	1 KB (ATmega328)
Clock Speed	16 MHz
W5100 TCP/IP Embedded Ethernet Controller	
Power Over Ethernet ready Magnetic Jack	
Micro SD card, with active voltage Translators	
Length	68.6 mm
Width	53.3 mm
Weight	28 g

4.3.3 Relay switch 5.0V

Figure 6 Relay Switch.

Table 3 Specification of Relay Switch.

Type	5V DC SPDT Relay
Current limit	Rated up to 5A
Casing	Fully Sealed

4.3.4 LDR module

Figure 7 LDR module.

Table 4 Specifications of LDR.

Operating Voltage	**3.3V to 5V DC.**
Operating Current	15mA.
Output Digital	0V to 5V, Adjustable trigger level from preset.
Output Analog	0V to 5V based on light falling on the LDR.
LEDs indicating output and power.	PCB Size: 3.2cm x 1.4cm.

4.3.5 JumpersWires

Figure 8 Jumper Wires (male to female).

Programming Approach & Logic

The program for the Machine is not specified in a single programming language. The interfacing through a server needed some aspects of System Integration. The logic was to update sensor reading to the Arduino and then send this information over a TCP/IP protocol. This establishes communication between the webpage and ARDUINO. This webpage could have been used to control the Motor. However, the limited memory of an ARDUINO UNO board makes it impossible to create a single page update and control. Thus, separate boards and separate codes were used to do monitoring and control operations.

5.1 Program logic for Mass Indication

The code for the Mass of Cashew nut follows the below-mentioned logic:

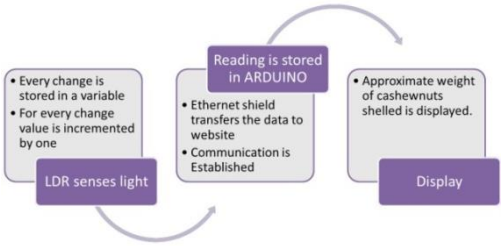

Figure 9 Programming logic for mass indication.

5.2 Program logic for Motor Control.

The display of weight indicates a remote operator to turn off the machine. This means that a control circuit is needed in order to turn off the motor. The DC motors can be turned off using a PWM signal. In thecase of AC motor, a different idea was needed. So,a Relay switch controlled through awebpage using ARDUINO board was an ideal choice. The logic for the same is explained:

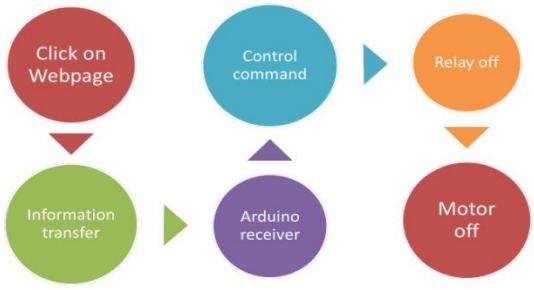

Figure 10 Program logic for Motor Control.

When the webpage is updated through the LDR module, the machine feeds cashew nuts inside the Deshelling unit. This indication on the webpage displays the mass of cashew nuts shelled by the machine. By checking this indication, the machine can be turned off by means of off button present on the webpage. This button on webpage sends a request to turn off the relay. Thus, the integrated system is explained.

Conclusion and Scope for Future Work

This work is focused on providing better solutions to the farmer community by offering solutions through mechatronics. This approach utilizes aminimum number of iterations to obtain the result. Smart methods for fabrication, calculation, and prototyping were followed. The machine was fabricated at a minimum market cost, redesigned to be a machine which follows the principles of Mechatronics. Thus, features such as data logging, wireless control, monitoring, etc. were incorporated to increase its functionality.

The data can be used for better bidding which leads to theelimination of a mediator between the groverment and farmers. It will improve the life of a farmer. In turn, cashew nuts of high quality will be available at cheaper rates.

In near future, this machine can be upgraded and further developed to make it more convenient. Custom made actuators for the scrapper can make the machine even more compact. This machine can have furthermorefeatured such as alerts, decision making, etc. which can make it a smart product. Integrating Artificial intelligent will give it more flexibility in terms of power utilization and productivity.

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