DESIGN AND IMPLENTATION OF A REMOTE CONTROL FOR A RICE DESTONER SYSTEM

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APPROVAL

THIS PROJECT REPORT HAS BEEN APPROVED FOR ACCEPTANCE BY THE MECHATRONICS ENGINEERING DEPARTMENT, FEDERAL UNIVERSITY OYE-EKITI, EKITI AND MEETS THE REGULATIONS GOVERNING THE AWARD OF BACHELOR OF ENGINEERING OF FUOYE.

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DEDICATION

This research work is dedicated to God Almighty, the Alpha and Omega of my life.

ABSTRACT

This project reveals design of a remote control for a rice de-stoner for separating stones from rice based on their different properties. The remote control is made up of Encoder, Decoder, RF transmitter and RF receiver, push buttons, resistors, arduiono and IC sockets. The remote control is used in automating a rice destoner that has a sieve with opening based on the size of rice grain to separate the rice from the stones larger than it and also a second sieve which allows sands and stones smaller than the rice only. Both sieves are vibrated, powered by a 0.50kW DC and rotational speed of 700rpm electric motor. The de-stoner has the efficiency of 80% and mass flow rate of 2.10 kg/s which is equivalent to 7.50t/hr capacity. The design of the remote control was carried out economically and it can be controlled from 10metres from the machine A machine of this nature can be manufactured for small entrepreneurs and rural level applications in the developing countries. due to its low cost of and easy production and maintenance. where rice is locally produced for better quality and quantity

CHAPTER ONE

1.0 INTRODUCTION

1.0.1 BACKGROUND TO THE STUDY

Rice in Nigeria is primarily an urban middleclass product, but is also increasingly becoming a more widely consumed staple food. The total market is an estimated 5 million ton (2007), approximately two-third of which is urban and the rest rural. Estimated annual production is 3.4 million and rest is imported. Again approximately two-third of urban demand is met by imports. Rice in Nigeria is distributed through five channels - rural household consumptions (8%), small scale processing for rural and urban markets (33%), medium commercial processing for urban markets (16%) and large scale industrial processing (10%) and the fifth channel is the imported rice market (33%). Half of local rice is channeled through the small-scale processors and medium commercial processors, which have direct connection with poor parboilers and farmers. National rice production growth is 15% per annum (FAO Stat) and growth of national demand is 20% per annum. Imported rice sets the standard in the market in terms of price and quality (in terms of cleanliness, whiteness, consistency, breakage and being free of stones). In principle locally produced and processed rice can compete with imports at an estimated sales price of NGN 400/mudu (vs. NGN 450/mudu for imports) by improving the quality of local rice. To improve local quality, incentives for maintaining quality need to be passed on better through the value chain (instead of each player trying to corner the premium for better quality, passing little incentive on the next player upstream), processing equipment requires upgrading and linkages between urban demand and rural production needs to be strengthened. Incentives to improve quality are better secured if processors (parboilers and millers) integrate more steps in their processing and own the rice they process (parboilers or millers controlling the entire processing steps from buying from farmers to selling to the traders). Changing the business model for the parboilers also implies that their social status is improved, better recognition is achieved (going out to buy paddy, collecting the loan amount, getting into trading, participating in the meetings and so on).

Equipment to improve quality is partially available (such as small scale milling equipment), but millers and traders are by and large not aware of these. Market channels that can guarantee local rice of a good and consistent quality are virtually absent. The quality of local rice is also influenced by agricultural practices, seed varieties in particular. For last couple of years numbers of other projects are working in rice sector in northern Nigerian states, which have resulted in increased production and productivity. Kano being the hub of local rice processing and trading, this increased production becomes a good opportunity for increased income and employment. It is observed that paddy rice from different states are getting into Kano for processing and then being distributed almost all over the Nigeria, which means effectively working in Kano processing has an working in Kano processing has an effect on entire North Nigerian rice sector. With this backdrop, it is imperative to channelize the additional volume of rice through processing. Due to the increase of production, quality and quantity of processing are the most crucial constraints for the growth of the Kano rice sector. Thus, priority is given to the key constraints downstream: processing volume and marketing.

1.0.2 BACKGROUND TO THE INTERVENTION

Stones in locally produced rice are the main quality constraint. The only form of destoning presently available is picking by hand. However, the female labor to do this is not always available and it is an inefficient, expensive process (four females take 4 days to pick only 75 kg). Traders and millers are unaware of the opportunities of mechanized de-stoning, both in technical and economic terms. If millers and traders invest in mechanized de-stoning, this could open up the urban market for local produced rice. Higher quality, de-stoned rice has a much stronger demand in the market.

Another issue for the millers is investment required to install small scale milling equipment for mechanized de-stoning. Lease finance by the financial institutes could solve the problem but the FIs are not completely aware of the necessity, market size and demand of this service. Therefore, if the FIs could be informed about how many potential millers would avail the said financial arrangement and how well they can repay the loan amount, then they will be willing to finance the millers to install small scale milling equipment. Finally, millers will be required to prepare a strong business proposal articulating how efficiently they will utilize the fund to make their business successful where their capacity will require development.

1.1 Aim and Objective

1.1.1 AIM

The aim of this study is to develop automated rice De-Stoner Machine to separate rice from stones, sands and chaffs

1.1.2 Objectives

In order to achieve the above aim, the following objectives are to be pursued: To design a destoner machine in order to:

a) Achieve quality separation of rice from stone
b) Be of high Capacity and Compact size
c) Require minimal maintenance and ease of operation

1.2 JUSTIFICATION

The design and implementation of the remote controlled rice destoner system was done in a way that it can be used in domestic situations like:

- In a rice producing company where rice is being handpicked or where the rice de-stoner is being controlled mechanically
- On a rice farm, to separate the chaffs and stones from the rice.
- In homes to separate rice from chaffs and stones, especially in Nigeria homes, to separate ofada rice from stones and chaffs

1.3 SCOPE OF THE PROJECT

The scope of this project covers the simulation of the model of the rice de-stoner using Autodesk inventor with the specified dimensions, then proceeding to the physical model of the work, which is construction of the remote control, programming of the software that the microcontroller will use and then designing of the power circuit, transmitter and receiver circuits.

1.3.1 LIMITATION OF THE PROJECT

- Due to the factor of environment and availability of materials there was delay in the time of completion of the project.
- Material selection was one of the limitations experienced during the design because the material properties of different engineering material was compared in other to use the one less expensive, light weight, durable and highly efficient.

CHAPTER TWO

2.0 LITERATURE REVIEW

The removal of impurities in rice has led to different landmarks in the invention and method of separating rice from its impurities. Rice de-stoning is old just as the as the history of man. Prior to the beginning of machines for de-stoning, farmers had to hand pick or sieve manually. Many works has been done and documented in the area of rice and stones separation in Nigeria.

In 1976, Henderson & Perry (Henderson, et al, 1976) designed a separator based on gravity and floating effect. It is made of a triangular shaped perforated table which has reciprocating motion that moves any material on it in the direction of conveyance as a result of the angle of gravity flow.

Rice is known and recognized as a short, narrow white or brown grain grown on wetland in hot countries as food. The design that has the capability of de-stoning at two separation stages thereby ensuring that stone-free rice is produced has been done (Osueke, 2010). Rice of 6.25-6.99 mm long, 2.10-2.87 mm wide and 1.74-2.00 mm thick is separated from tiny stones (sand) at screening unit with screen holes of 2.10mm thereafter it is separated at the separating cylinder with cylinder grooves of 2 mm deep and 2 mm wide rotating at a speed of 6.3 rpm while the prime mover has this rating of 0.5hp and speed of 24rpm. Moreover, the rice de-stoning machine that will de-stone rice effectively is achieved using two stages of de-stoning process, at the screen with holes of 2.10 mm whereby little stones (sand) are removed and also at the grooves of the cylinder with groove dimensions of 2 mm deep-2 mm wide which ensures perfect de-stoning.

In addition, a rice mill plant with a capacity of 3t/hr was constructed with automated facilities at Chonnam National University in Korea (Chung, et al, 2003). A simulation model was developed with the simulation language for alternative modeling (SLAM) for evaluating and improving the rice mill process. The developed model was validated in relation to hulling efficiency, milling efficiency, milled rice recovery, other materials produced, and flow restrictions in the processes. The hulling efficiency, milling efficiency and milled rice recovery in the simulation were, respectively, 81.1, 89.5, and 73.1%, while those of the actual mill plant were, respectively, 81.5, 90.2 and 73.5%.

The simulation results include the contents of other materials (chaff, bran, broken rice and stone) produced in the processes were almost similar with those of the actual process. In the simulation, the flow restrictions were found in the processes for separating brown rice and for sorting colored rice and needed an increase in the hourly capacities of the brown rice separator and the rice color sorter. As the automated rice mill plant was described by the developed model, it could be used for designing and improving rice mill plants.

Moreover, the rice milling plant is developed to solve the problem associated with the manual processing of locally produced rice (Ofada Rice), particularly the removal of pebbles and other impurities from the rice (Adegun, et al, 2012). The machine consists majorly of two stages: de-hulling and sieving. The de-huller consists of rotary cylindrical sieve which separates the chaff from the rice grains via the shaft and blade. Impact method was adopted for the removal of husk from the rice paddy. After milling the paddy rice, it passes through a vibrating sieve machine where a crank mechanism converts rotary motion into a reciprocating movement of the sieve bed. The vibrating sieve removes the chaffs and the pebbles from the rice grains. The performance tests conducted on the machine showed that the de-huller effectiveness reduced with increase in number of paddy rice fed into it, while the sieve shaker optimum yield occurs at a maxim um stroke of 40. It was discovered that a minimum output shaft speed of 900 rpm transmitted by a v-belt drove by an electric motor of 3.5 hp which was required for the effective performance of the vibrating sieve. Mild steel was used majorly for the fabrication of component parts for ease of machining, assembling, maintenance and affordability. The plant would reduce the hazardous health implication currently experienced when eating locally produced rice. It would reduce the cost of labor and also enhance the economic status of the peasant farmers in Nigeria.

Furthermore, in the recent research work, physical and mechanical properties of rice are necessary for the design of equipment to handle, transport, and process and store the crop. These properties were evaluated as a function of moisture content of grain. The objective of this work was to determine the physical and mechanical properties of rice. The grain was tested for bulk density, true density, sphericity, porosity, angle of internal friction and coefficient of friction with various materials at 12% moisture content (dry basis, db.). The average length, width, thickness and the average thousand grain weight of the rye grains were, 7.43mm, 2.75mm, 2.53mm and 26.91 g, respectively. The static coefficient of friction 0.4835, 0.4061, and 0.3670 for wood, galvanized iron and glass surfaces respectively. The higher friction coefficient values were observed on wood surface and the lowest on steel surface.

According to Mohammad et al (Mohammad, et al, 2012), knowing the grain's bulk density, true density and porosity can be useful in sizing grain hoppers and storage facilities. They can affect the rate of heat and mass transfer of moisture during the aeration and drying processes. A grain bed with low porosity will have greater resistance to water -vapor escape during the drying process, which may lead to the need for higher power to drive the aeration fans. Cereal-grain kernel densities have been of interest in breakage susceptibility and hardness studies. The static coefficient of friction is used to determine the angle at which chutes must be positioned to achieve consistent flow of materials through the chute. Such information is useful in sizing motor requirements for grain transportation and handling (Chang, 1988) (Ghasemi et al, 2008).

Literature has shown the existence of rice-stone specific gravity separator which works on a principle that makes use of the densities variation between sand and rice (Chang J. , 1997). There is another specific gravity separation method adopted (Adekoya & Koya, 1994). The system involves movement of grains on an oscillating conveyor and the application of aerodynamic force. Another machine for the separation of dust and stone from rice is the stoner separator (Chackravery, 1981). Multi crop cleaner has been developed (Ademosun, 1993). Rice de-stoner was described as a machine, which takes advantage of the difference in axial velocities of rice and stone (Ozormba, 1997). The rice is fed via a hopper into a rotating cylindrical sieve, which separate the rice from the stone. The rice passes through the sieve and leaves the stone in the cylinder to roll down to the stone collector while rice is being collected in the rice collector (Adegun I. K., 2006). Sieve shaker to separate guinea corn from rice had been used (About Us: An engineering Fundamental, 1999).

2.1 RELATED WORKS

A rice destoner machine was developed to solve the problem associated with the manual processing of locally produced rice (OFADA RICE), particularly the removal of pebbles and other impurities from the rice. Lots of works has been done and documented in the area of rice and stones separation in Nigeria,

A rice destoning machine was developed by (Adegun, et al, 2012). The machine consists majorly of two stages: dehulling and sieving. The dehuller consists of rotary cylindrical sieve which separates the chaff from the rice grains via the shaft and blade. Impact method was adopted for the removal of husk from the rice paddy. After milling the paddy rice, it passes through a vibrating sieve machine where a crank mechanism converts rotary motion into a reciprocating movement of the sieve bed. The vibrating sieve removes the chaffs and the pebbles from the rice grains. The performance tests conducted on the machine showed that the dehuller effectiveness reduced with increase in number of paddy rice fed into it, while the sieve shaker optimum yield occurs at a maximum stroke of 40. It was discovered that a minimum output shaft speed of 900 rpm transmitted by a v-belt drove by an electric motor of 3.5 hp which is required for the effective performance of the vibrating sieve. Mild steel was used majorly for the fabrication of component parts for ease of machining, assembling, maintenance and affordability.

The criteria for design of the machine component parts were adopted from (Osborne, 1977) (Khurmi & Gupta, 2005) (Keter, 1980) (Ryder, 1977)). The factors that determined the selected materials for this work were involved in the mechanical properties such as toughness, strength and hardness. Surface finish, density, interaction with environment, fabrication cost, maintenance cost and availability of materials; ease of fabrication and safety of materials were also considered. Mild steel with carbon content 0.15% to 0.3% and of various thicknesses were used. However, galvanized steel was used for the blades of the blower and for the hopper.

The physical properties such as density, specific gravity, weight, size of the impurities and rice grains were considered in the design of the machine. These properties form the basic information for the design of the machine. Parameters such as capacity (quantity of feed), axial dimension of rice grain, coefficient of friction and sphericity of the rice were also determined in other to have a comprehensive and effective design of the machine (Adegun, et al, 2012). For the sample of rice considered the dynamic coefficient of friction μ and angle of inclination of the sieve bed θ were determined experimentally to be 0.414 and 23^0 respectively. The moisture content for effective milling was 12.8% wet basis while the density of the Ofada rice was 1336 kg/m^3.
A Rice destoner machine was developed by (Olugboji,et al 2014) the work was aimed at producing Rice de-stoning machine with vibrating screens on two stages using simplified exciters. Mild steel was used in the construction of the machine. Standard equations were used to determine the dimension of the parts. The machine was driven by a 1Hp electric motor with 688.17W required power. The machine had a capacity of 47.39 Kg/hr. and an efficiency of 82.47 % (Olugboji et al, 2014)

The rice de-stoning machine was made up of two sets of carriage each comprising of three screens. The first in each working deck serves to separate the stones slightly bigger than the grain; the second screen serves to separate the stones smaller in size than the grains while the third screen serves to convey the stones down to the stone chutes. The screens one and two are special wire gauze designed for separation purposes. The two working decks are designed to be slanted in opposing angles of 7^0 to 14^0 to the horizontal. The angle can be varied in relation to the speed and efficiency required. The two decks are held in position by four flexible suspension reeds by means of belts and nuts on the upper part of the machine frame. The two decks are connected together and are mounted on the frame work which connects them to the shaft rotating. The shaft has two exciters on which are meant to excite the system, the offset angle can be arranged to obtain high or low vibration. Also, on the shaft are two bearings giving support to the shaft and pulley which receives drive from an electric motor via a belt. The hopper is fixed on the upper frame to receive charge for the first deck. Rough rice (rice with impurities) when charged through the hopper, gradually passes through the throat of the hopper and falls on the first screen with angle of inclination 7 o to 14 o as convenient and effective. The rate of floe from hopper is controlled manually. (Olugboji,et al, 2014)

By this time, the prime mover drives the shaft carrying the exciters, thus the whole working deck is vibrated. As the working deck is vibrated, the rough rice is caused to move on the first screen thereby the bigger stone and impurities move down while smaller materials including rice dropped off on the second screen. Now the cleaner rice falls on the second working deck where the process is repeated. The second working deck will improve on the efficiency of the first separation. There are two outlets, the first, to collect the impurities and the second to collect the clean rice.

2.2 REMOTE CONTROL

The following components are used for the remote control

- Encoder
- Decoder
- RF transmitter and RF receiver 433MHz
- Push Buttons
- IC socket
- Resistor (1kilo-Ohms and 1Mega-Ohms)

2.2.1 Encoder

An encoder is a device, circuit, transducer, software program, algorithm or person that converts information from one format or code to another, for the purposes of standardization, speed or compression.

Encoders are used to translate rotary or linear motion into a digital signal. Usually this is for the purpose of monitoring or controlling motion parameters such as speed, rate, direction, distance or position. When applying encoders, selecting the optimum model and specifying the appropriate configuration are critical for success. Proper encoder selection begins by understanding the role of the encoder in the motion control system (Watt, 2017).

These application examples represent a significant portion of encoders used throughout the industrial marketplace.

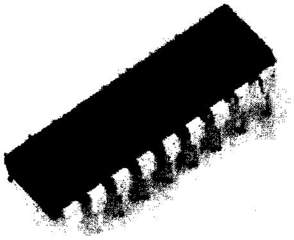


Fig 2.1 An Encoder

2.2.2 Decoder

In digital electronics, a binary decoder is a combinational logic circuit that converts binary information from the n coded inputs to a maximum of 2n unique outputs. They are used in a wide variety of applications, including data demultiplexing, seven segment displays, and memory address decoding.

There are several types of binary decoders, but in all cases a decoder is an electronic circuit with multiple input and multiple output signals, which converts every unique combination of input states to a specific combination of output states. In addition to integer data inputs, some decoders also have one or more "enable" inputs. When the enable input is negated (disabled), all decoder outputs are forced to their inactive states.

Depending on its function, a binary decoder will convert binary information from n input signals to as many as 2n unique output signals. Some decoders have less than 2n output lines; in such cases, at least one output pattern will be repeated for different input values.

A binary decoder is usually implemented as either a stand-alone integrated circuit (IC) or as part of a more complex IC. In the latter case the decoder may be synthesized by means of a hardware description language such as VHDL or Verilog. Widely used decoders are often available in the form of standardized ICs.

2.2.2.1 Types of decoder

1-of-n decoder

A 1-of-n binary decoder has n output bits. This type of decoder asserts exactly one of its n output bits, or none of them, for every integer input value. The "address" (bit number) of the activated output is specified by the integer input value. For example, output bit number 0 is selected when the integer value 0 is applied to the inputs.

Examples of this type of decoder include:

A 3-to-8 line decoder activates one of eight output bits for each input value from 0 to 7 — the range of integer values that can be expressed in three bits. Similarly, a 4-to-16 line decoder activates one of 16 outputs for each 4-bit input in the integer range [0,15].

A BCD to decimal decoder has ten output bits. It accepts an input value consisting of a binary-coded decimal integer value and activates one specific, unique output for every input value in the range [0,9]. All outputs are held inactive when a non-decimal value is applied to the inputs.

A demultiplexer is a 1-of-n binary decoder that is used to route a data bit to one of its n outputs while all other outputs remain inactive.

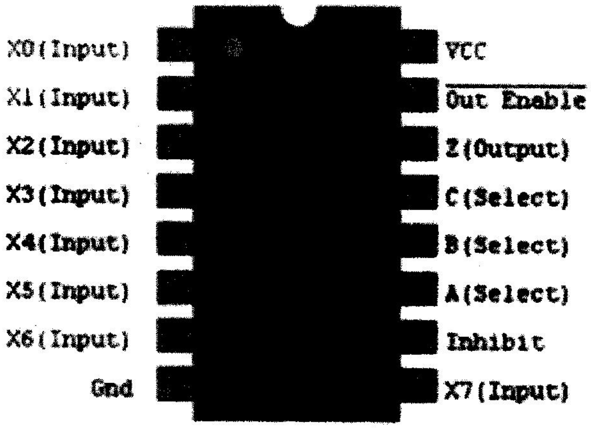


Fig 2.2 Pin Diagram of a decoder

Code translator

Code translators differ from 1-of-n decoders in that multiple output bits may be active at the same time. An example of this is a seven-segment decoder, which converts an integer into the combination of segment control signals needed to display the integer's value on a seven-segment display digit.

One variant of seven-segment decoder is the BCD to seven-segment decoder, which translates a binary-coded decimal value into the corresponding segment control signals for input integer values 0 to 9. This decoder function is available in standard ICs such as the CMOS 4511.

2.2.3 RF transmitter and RF receivers 433MHz

The RF module, as the name suggests, operates at Radio Frequency. The corresponding frequency range varies between 30 kHz & 300 GHz. In this RF system, the digital data is represented as variations in the amplitude of carrier wave. This kind of modulation is known as Amplitude Shift Keying (ASK).

Transmission through RF is better than IR (infrared) because of many reasons. Firstly, signals through RF can travel through larger distances making it suitable for long range applications. Also, while IR mostly operates in line-of-sight mode, RF signals can travel even when there is an obstruction between transmitter & receiver. Next, RF transmission is more strong and reliable than IR transmission. RF communication uses a specific frequency unlike IR signals which are affected by other IR emitting sources.

This RF module comprises of an RF Transmitter and an RF Receiver. The transmitter/receiver pair operates at a frequency of 434 MHz. An RF transmitter receives serial data and transmits it wirelessly through RF through its antenna connected at pin4. The transmission occurs at the rate of 1Kbps - 10Kbps. The transmitted data is received by an RF receiver operating at the same frequency as that of the transmitter.

The RF module is often used along with a pair of encoder/decoder. The encoder is used for encoding parallel data for transmission feed while reception is decoded by a decoder. HT12E-HT12D, HT640-HT648, etc. are some commonly used encoder/decoder pair ICs.

Fig 2.3 RF Modules (Transmitter and Receiver)

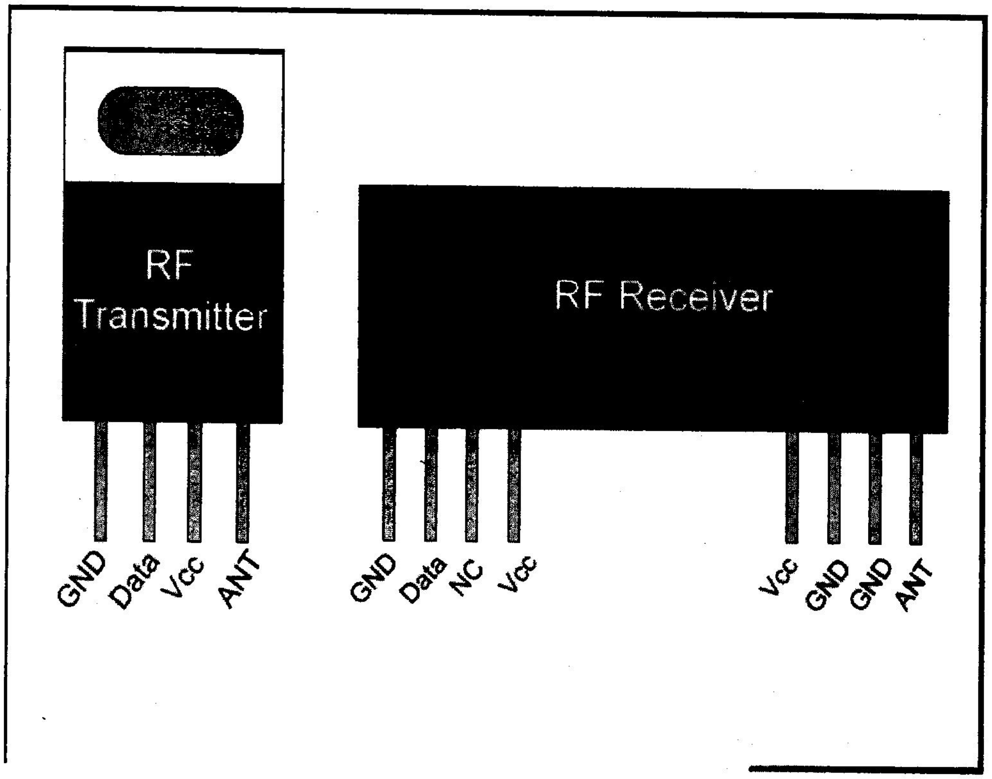


Fig 2.4 Pin Diagram of the RF Transmitter and RF Receiver

PIN NO	FUNCTION	NAME
1	Ground (0V)	Ground
2	Serial data input pin	Data
3	Supply Voltage Input	Vcc
4	Antenna output pin	ANT

Table 2.1 Pin Description for RF Transmitter

Pin No	Function	Name
1	Ground (0V)	Ground
2	Serial data output pin	Data
3	Linear output pin; not connected	NC
4	Supply voltage; 5V	Vcc
5	Supply voltage; 5V	Vcc
6	Ground (0V)	Ground
7	Ground (0V)	Ground
8	Antenna input pin	ANT

Table 2.2 Pin Description for RF Receiver

2.2.3.1 Typical Applications

- Vehicle monitoring
- Remote control
- Telemetry
- Small-range wireless network
- Wireless meter reading
- Access control systems
- Wireless home security systems
- Area paging
- Industrial data acquisition system
- Radio tags reading
- RF contactless smart cards
- Wireless data terminals
- Wireless fire protection systems
- Biological signal acquisition
- Hydrological and meteorological monitoring
- Robot remote control

- Wireless data transmissions
- Digital video/audio transmission
- Digital home automation, such as remote light/switch
- Industrial remote control, telemetry and remote sensing
- Alarm systems and wireless transmission for various types of low-rate digital signal
- Remote control for various types of household appliances and electronics projects
- Many other applications field related to RF wireless controlling
- Mobile web server for elderly people monitoring

2.2.4 Push Buttons

A push button is a simple switch mechanism for controlling some aspect of a machine or a process. Buttons are typically made out of hard material, usually plastic or metal (Kabai, 2013). The surface is usually flat or shaped to accommodate the human finger or hand, so as to be easily depressed or pushed. Buttons are most often biased switches, although many un-biased buttons (due to their physical nature) still require a spring to return to their un-pushed state. Different people use different terms for the "pushing" of the button, such as press, depress, mash, hit, and punch.

2.2.4.1 Uses

The "push-button" has been utilized in calculators, push-button telephones, kitchen appliances, and various other mechanical and electronic devices, home and commercial. In industrial and commercial applications, push buttons can be connected together by a mechanical linkage so that the act of pushing one button causes the other button to be released. In this way, a stop button can "force" a start button to be released. This method of linkage is used in simple manual operations in which the machine or process has no electrical circuits for control.

In popular culture, the phrase "the button" (sometimes capitalized) refers to a (usually fictional) button that a military or government leader could press to launch nuclear weapons.

To avoid the operator from pushing the wrong button in error, pushbuttons are often color-coded to associate them with their function. Commonly used colors are red for stopping the machine or process and green for starting the machine or process.

Red pushbuttons can also have large heads (called mushroom heads) for easy operation and to facilitate the stopping of a machine. These pushbuttons are called emergency stop buttons and for increased safety are mandated by the electrical code in many jurisdictions. This large mushroom shape can also be found in buttons for use with operators who need to wear gloves for their work and could not actuate a regular flush-mounted push button. As an aid for operators and users in industrial or commercial applications, a pilot light is commonly added to draw the attention of the user and to provide feedback if the button is pushed. Typically this light is included into the center of the pushbutton and a lens replaces the pushbutton hard center disk. The source of the energy to illuminate the light is not directly tied to the contacts on the back of the pushbutton but to the action the pushbutton controls. In this way a start button when pushed will cause the process or machine operation to be started and a secondary contact designed into the operation or process will close to turn on the pilot light and signify the action of pushing the button caused the resultant process or action to start.

2.2.4.2 Scram and Scramble Switches

Akin to fire alarm switches, some big red buttons, when deployed with suitable visual and audible warnings such as flashing lights and sirens for extreme exigent emergencies, are known as scram switches (as in evacuate, vamoose, "get the hell out"). Generally, such buttons have extended large scale functions, beyond a "mere" fire alarm, such as automated shutdown procedures, complete facility power cut, fire suppression like halogen release, etc. A variant of this is the scramble switch which triggers an alarm to activate emergent personnel to proactively attend to and go to such disasters. An air raid siren at an air base initiates such action, where the fighter pilots are alerted and "scrambled" to their planes to defend the base.

2.2.5 IC Socket

An IC socket, or integrated circuit socket, is used in devices that contain an integrated circuit. An IC socket is used as a placeholder for IC chips and is used in order to allow safe removal and insertion of IC chips because IC chips may become damaged from heat due to soldering..

There is a wide range of IC sockets from several manufacturers that can be used for integrated circuits. IC socket of any pin size (8 pin, 14 pin, 16 pin, 18 pin, 20 pin, 28 pin, 40 pin, etc

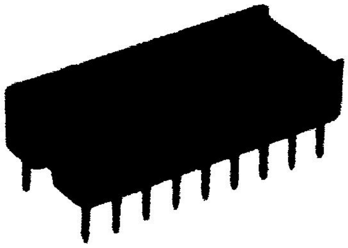


Fig 2.5 IC Socket 18pins

2.2.5.1 Applications for IC Sockets:

IC sockets are used in applications where integrated circuit devices have short lead pins. They help in providing safe removal and insertion of IC chips. They are often found in desktop and server computers. They are also used for prototyping new circuits because they allow easy component swapping.

2.2.6 Resistors

A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element. In electronic circuits, resistors are used to reduce current flow, adjust signal levels, to divide voltages, bias active elements, and terminate transmission lines, among other uses. High-power resistors that can dissipate many watts of electrical power as heat may be used as part of motor controls, in power distribution systems, or as test loads for generators. Fixed resistors have resistances that only change slightly with temperature, time or operating voltage. Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity.

Resistors are common elements of electrical networks and electronic circuits and are ubiquitous in electronic equipment. Practical resistors as discrete components can be composed of various compounds and forms. Resistors are also implemented within integrated circuits.

The electrical function of a resistor is specified by its resistance: common commercial resistors are manufactured over a range of more than nine orders of magnitude. The nominal value of the resistance falls within the manufacturing tolerance, indicated on the component.

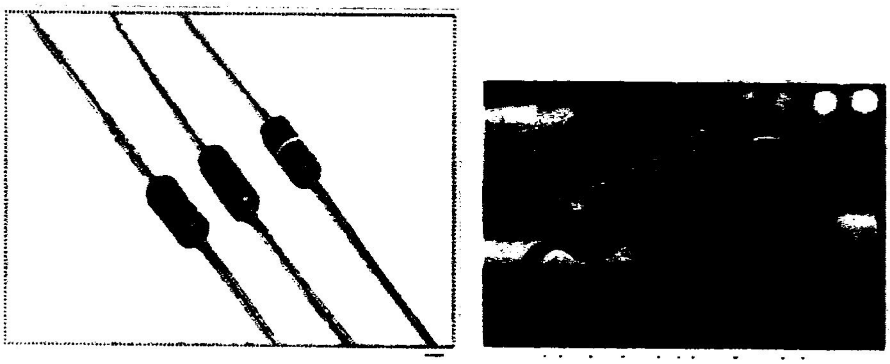


Fig 2.6 Resistors

CHAPTER 3

METHODS AND MATERIAL SELECTION

3.1 Method

In this design, the rice to be de-stoned is fed into the vibrating sieves through the hopper which is fixed at an elevation higher than the rest of the separation bed. The combination of the rice and stones flows from the hopper to the first separation bed. The rice grains and smaller stones of same size fall through the sieve on the first separation bed, while the stones are collected at the end of the bed. This is achieved due to the vibration of the motor which is being controlled by a remote control and also inclined at an angle and is supported by six springs; as the mixture moves along the sieve. The rice and stones of similar size fall into the second screening chamber with finer holes that allow only the passage of sand particles that are smaller than the rice. At the end of this channel, there is also another collector that receives the cleansed rice grains.

3.2 Machine Components

The design consideration is based on the machine component:

- Hopper
- Sieve A (rice size)
- Sieve B (sand size)
- Springs (six) and
- Vibratory Motor

3.3 Description of Equipment

The de-stoner as shown in the figure below consists mainly of two inclined meshes which are each held by six springs. The meshes are rectangular in shape with guides along the lengths to prevent the mixture of sand and stone from falling off. At the left end of the upper mesh/screen is the hopper, the means by which the mixture is fed into the separating chamber, while at the right end of the separating chamber is situated a collector for the large stones.

The separation chambers are each attached to the frame by means of springs of varying lengths, causing the rectangular chamber to be inclined along the frame of the setup. These springs provide transmit vibration to the chamber thus causing the mixture to move along the separation chamber. At the end of each mesh is a collector; the collector for the upper chamber collects the large stones, while the collector for the lower chamber collects the fully destoned rice grains. The setup also consist of an electric motor; when turned on, this motor provides the motion that causes the vibration of the separating chambers by aid of the attached springs. The vibratory motor is then been controlled by a wireless remote control.

The isometric drawing of the machine with parts labeled is shown in Figure 1 below.

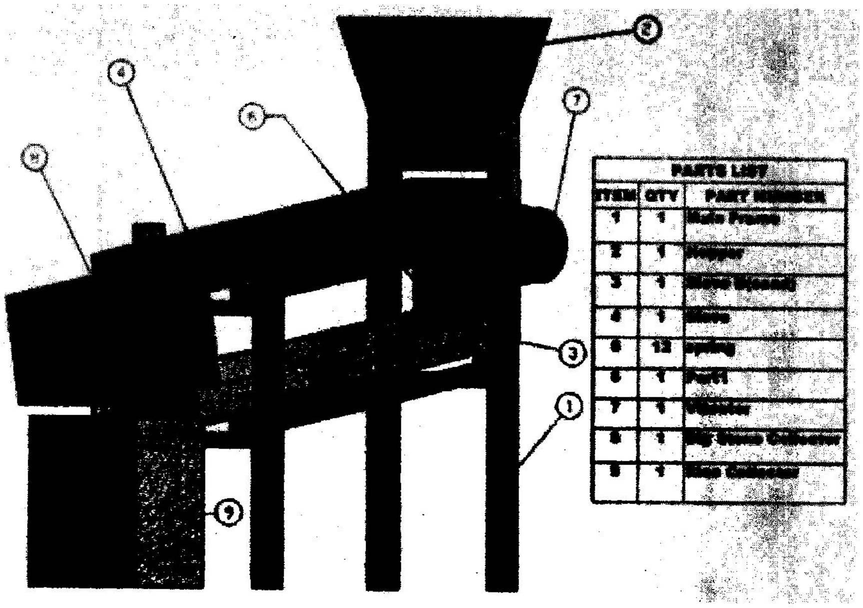


Figure 3.1: Isometric drawing of assembled rice de-stoner machine

Source: (Oluwarotimi et al, 2013)

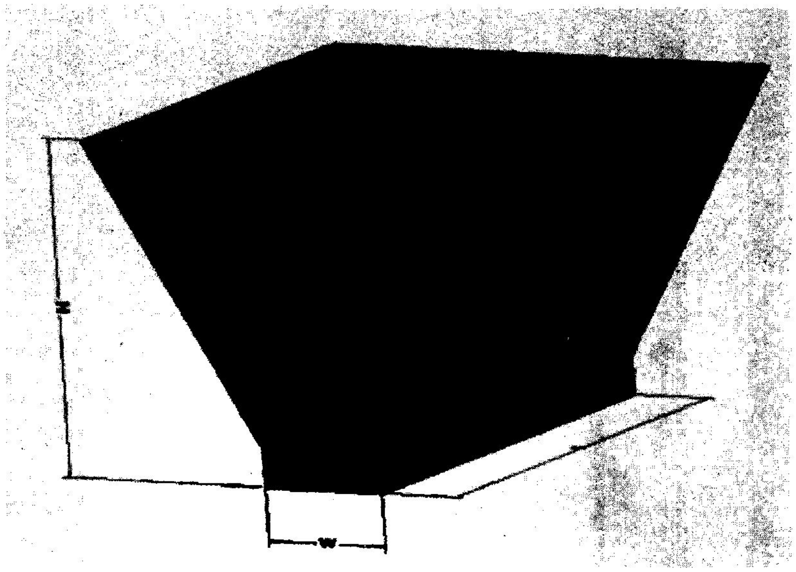


Figure 3.2: Wedge type Hopper

H = height of Hopper

W = width of hopper

Ø = Angle of Pour

L = Length of hopper, ($L > 3W$)

The angle of pour can be determined from the coefficient of friction (μ) between rice and the material of the hopper galvanized steel, this give the minimum angle at which the rice will flow through the hopper outlet, the friction coefficient is 0.4061.

W = 30 mm

L = 230 mm

Angle of pour (Ø) • $\tan^{-1} \mu$ ……….. Equation (1)

$\mu = 0.4061$

$Ø = 25^0$

Using Johanson's Equation (About us: Chegg Study, 2007) to determine the mass flow (m) through the hopper outlet,

$$m = A\sqrt{\frac{5g}{2(1+n)\tan \emptyset}}$$ ……….. Equation 2

Where g = acceleration due to gravity = 9.81 m/s^2

B = w = for a symmetric slot hopper and n = 0

ρ = bulk density of rice = 541 kg/m^3

A = outlet cross sectional area = w x L = 30 x 230 = 6900 mm^3

The mass flow rate (m) is 2.1 kg/s which is equivalent to 7.5 t/hr.

The velocity (v) of discharging through the hopper outlet can be determined from the equation:

$$m = Av$$ ………Equation 3

Carleton (George, 2002) proposed an expression for predicting the velocity of the solids as

$$\frac{4V^2 sin\emptyset}{5} + 15\frac{\emptyset^2 \times 3\mu^2 \times 3V^{\frac{4}{3}}}{\emptyset_p d_p^{\frac{5}{4}}}$$ …………Equation 4

The velocity of (v) of discharge = 2000m/s

The capacity of the machine is 7.5tonnes per hour

3.3.1 Height of Hopper

The height of the hopper can be determined using the equation below

Density of rice = Mass / Volume

Volume = (w H + H2tan Ø) L ……………Equation 5

Designing a hopper that can hold a mass of 5 kg

The Height (H) = 250 mm

3.3.2. Design of Sieve A (Rice Size)

Taking into consideration the physical properties of rice grain in order to design the sieve at the first stage of the separation, figure 3 shows the dimension of the average rice grain and Figure 4 is the arrangement of the holes that make up the sieve with the dimension. The dimension of the sieve can be determined by using the table below, considering the maximum length and width of rice grain, the following parameters can be determined.

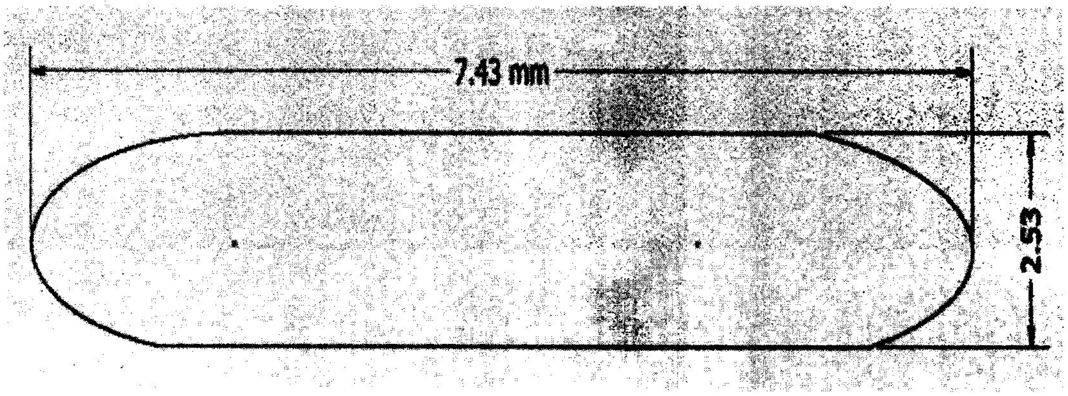
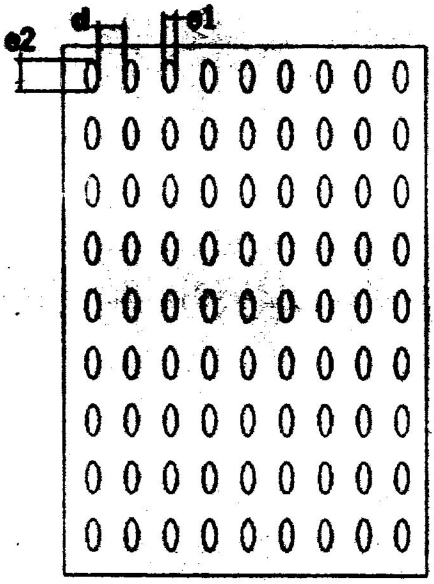


Figure 3.3: Rice Dimension (Average Size)

Source: (Oluwarotimi, et al., 2013)



e1 = 2.8 mm; e2 = 8.4 mm

Figure 3.4: Dimension of sieve A (rice size)

Source : (Oluwarotimi, et al, 2013)

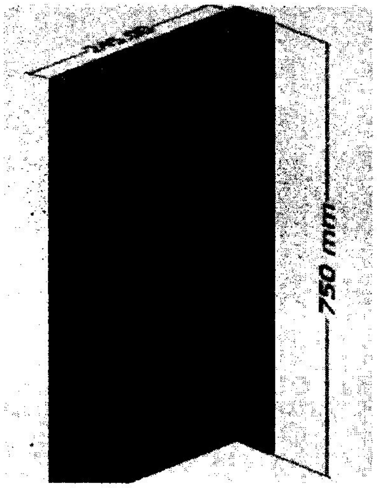


Figure 3.5: Isometric view of Sieve A (Rice Size) with dimension

Source: (Oluwarotimi, et al, 2013)

The distance which is between the openings can be determined from equation [14]

$$d = \sqrt{\frac{\emptyset^2}{C_p(3\pi - 2C_p)}} \quad \text{........Equation 6}$$

D = Maximum diameter of required grain size = 8.31mm

C_0 = Coefficient of opening = 0.4

D = 5mm

Area of sieve = $L_s \times B_s$. The area of the sieve is 183750mm^2

PROPERTY	MEAN	MAX	MIN	CV (%)
Length (mm)	7.43	8.31	7.26	1.02
Width (mm)	2.53	2.62	2.11	0.33
Thickness (mm)	2.75	2.97	1.88	0.68
Equivalent diameter (mm)	3.48	3.87	3.21	0.42
Sphericity (%)	4.352	4.631	4.107	0.31
Thousand weight of grains	28	31	23	3.41
Porosity (%)	46	49	41	1.08
Bulk Density (Kg/m^3)	541	589	520	3.02
True Density (kg/m^3)	1108.98	1218.06	1048.47	35.70
Angle of repose (deg)	34	36	31	0.28

Table 3.1: Some Physical properties of Sandri Society

Source : (Oluwarotimi, et al, 2013)

SURFACE	NO OF OBSERVATION	MEAN	MAX	MIN	SD
Plywood	40	0.4835	0.5021	0.4330	0.4420
Glass	40	0.3670	0.3984	0.3176	0.3244
Galvanized Iron Sheet	40	0.4061	0.4248	0.3752	0.3781

Table 3.2: Static Coefficient of friction of sadri variety against different surface

Source: (Oluwarotimi, et al, 2013)

3.3.3 Design of Sieve B (Sand)

Sieve B is designed such that the openings are smaller than the size of the minimum width of rice which is 2.11 mm from the table above. So the opening was given a dimension of 2.0 mm and the distance between openings is 3 mm.

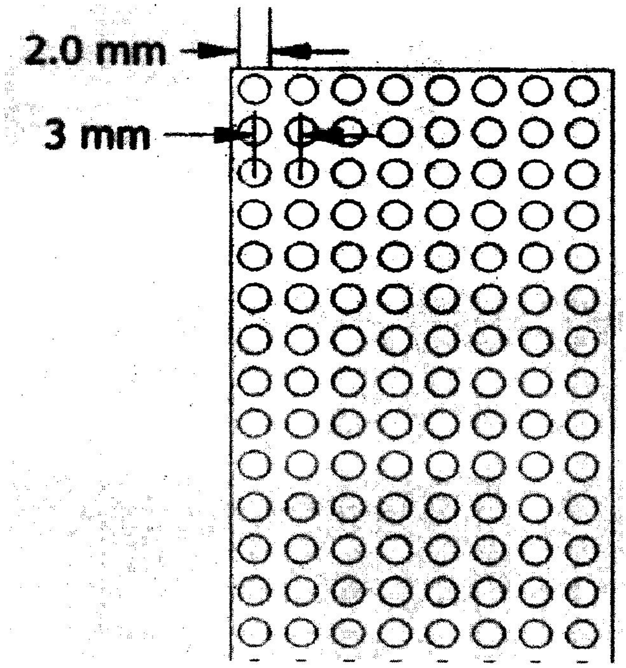


Figure 3.6: Sieve B (sand) Opening Dimension

Source: (Oluwarotimi, et al, 2013)

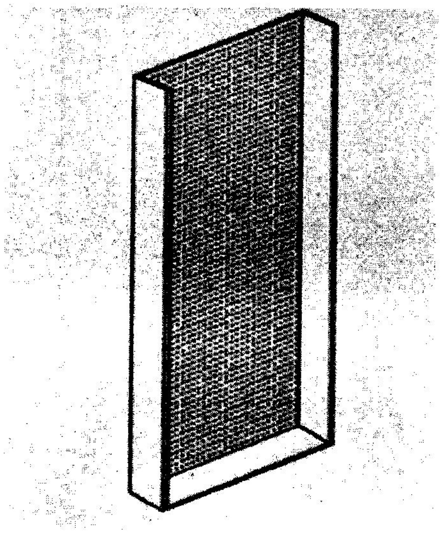
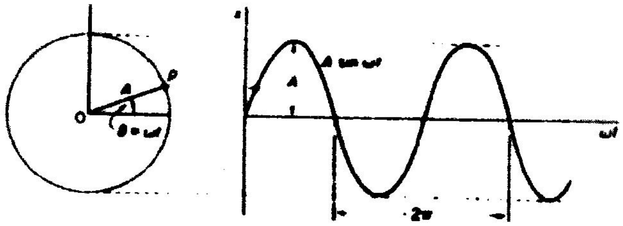


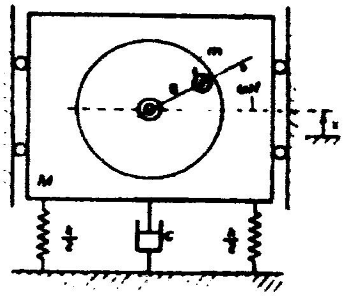
Figure 3.7: Isometric View of Sieve B (sand size)

Source: (Oluwarotimi, et al, 2013)

3.3.4 Design of Vibration Motor



ERM Rotation Position as a Sin Wave



ERM Model with One Degree of Freedom

Figure 3.8: Diagram of a Rotating Mass Supported by a spring

Source: (Oluwarotimi, et al, 2013)

Where M = total Mass of the body (excluding eccentric body)

m = mass of eccentric body

ω = angular velocity of eccentric body

k = stiffness of spring or spring constant

e = eccentricity of the body (distance from the motor shaft to the eccentric mass)

F_o = Centripetal force of the eccentric mass

Using the following equation for a loaded spring with forced vibration we have:

For spring with stiffness k from Hooke's law (Khurmi, et al, 2005):

F = k x ....Equation 7

For viscous damping from the velocity

$$F = C\frac{dy}{dx}$$ ....Equation 8

For mass of a body (excluding the eccentric mass) follows Newton's second law of motion;

$$F = (M - m)\frac{d^2x}{dt^2}$$ ....Equation 9

The total force is the sum of all the forces;

$F_o = \sin(\omega t)$ ....Equation 10

Therefore the equation of motion for the system is (Khurmi, et al, 2005)

$$(M - m)\frac{d^2x}{dt^2} + C\frac{dy}{dx} + kx$$

$= F_o \sin(\omega t)$ .... Equation 11

The response of the system at any given amplitude is given as

$X = X_o \sin(\ t)$ .... Equation 12

$$x_0 = \frac{mr^2\theta/m}{(1-r^2)^2+(2\zeta\, r)^2} \quad \text{..................Equation 13}$$

$$= \sqrt{\frac{k}{m}} \quad \text{..................... Equation 14}$$

Where r = $\frac{\Omega}{m}$ ....Equation 15

$$F = m\boldsymbol{\Omega}^2 \boldsymbol{e}\sqrt{[\frac{1+(2\zeta r)^2}{(1-r^2)^2+(2\zeta r)^2}} \quad \text{.................................. Equation 16}$$

Designing for vibration with the following data below:

X_0 = 5 mm

r = 100mm

m = 5 kg

ω = 0.15

Sieves are made of steel with density = **8000 kg/m^3**

Volume of sieve = 0.004165 m^3

Mass of sieves = 3.332 kg

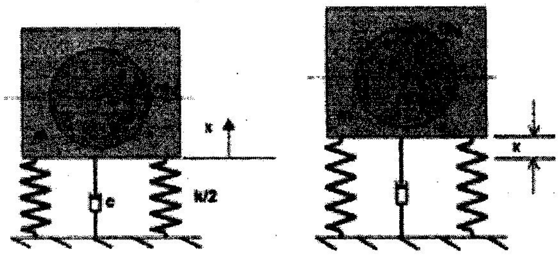
Mass of rice on **both sieves is taken as 5kg since mass flow rate** is 2.1 kg/s

Assuming **a Mass of electric motor = 40 kg**

Total mass **M = 48.332 kg**

F = M x g = **force on spring**

F = 474.14 N



(a) At time t = 0, in equilibrium

(b) After time t

Figure 3.9: Model of an unbalanced rotating machine

Source: (Oluwarotimi, et al, 2013)

From equation (15), r = 1.732

From equation (16), $\omega = 41.625$ rad/s

The angular velocity of the motor required to vibrate the system to that specified data as above.

Using equation (11), $\omega = 72.094$

The rotational speed of the motor is given as

$N = 60 \times \omega/2\pi$ ....Equation(17)

= 688.44rpm

Rotational speed of the motor is 700rpm.

Power of the motor need is 359.55 watts.

Electric Motor specification for the vibrator, assuming efficiency of 80%, power rating of the electric motor is 500watts

3.3.5 Design for the Remote Control

The following components are used for the remote control

- Encoder
- Decoder
- RF transmitter and RF receiver 433MHz
- Push buttons
- IC socket
- Resistor (51 kilo-ohms and 1Mega ohms)

3.3.5.1 Circuit Diagram for the Remote Control

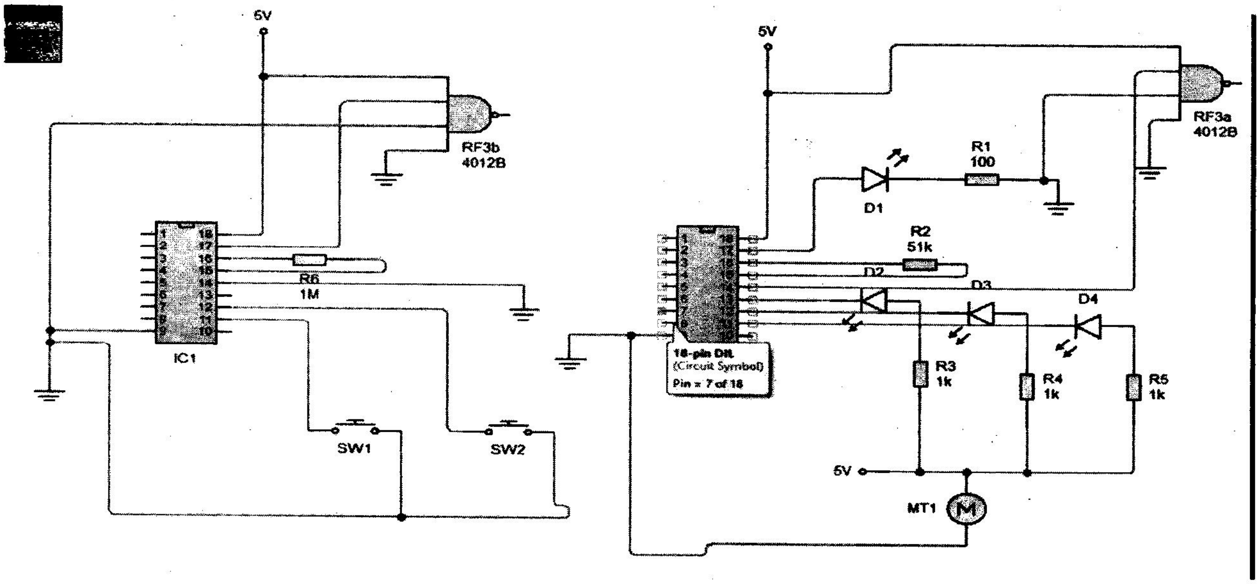


Figure 3.10: Circuit diagram for the remote control

Source:

3.3.7 Design of Spring

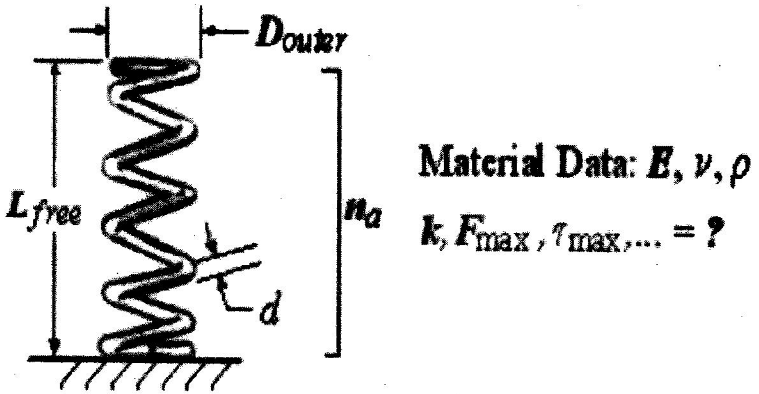


Figure 3.11: Labeled Spring Wire

Source: (About Us: An engineering Fundamental, 1999)

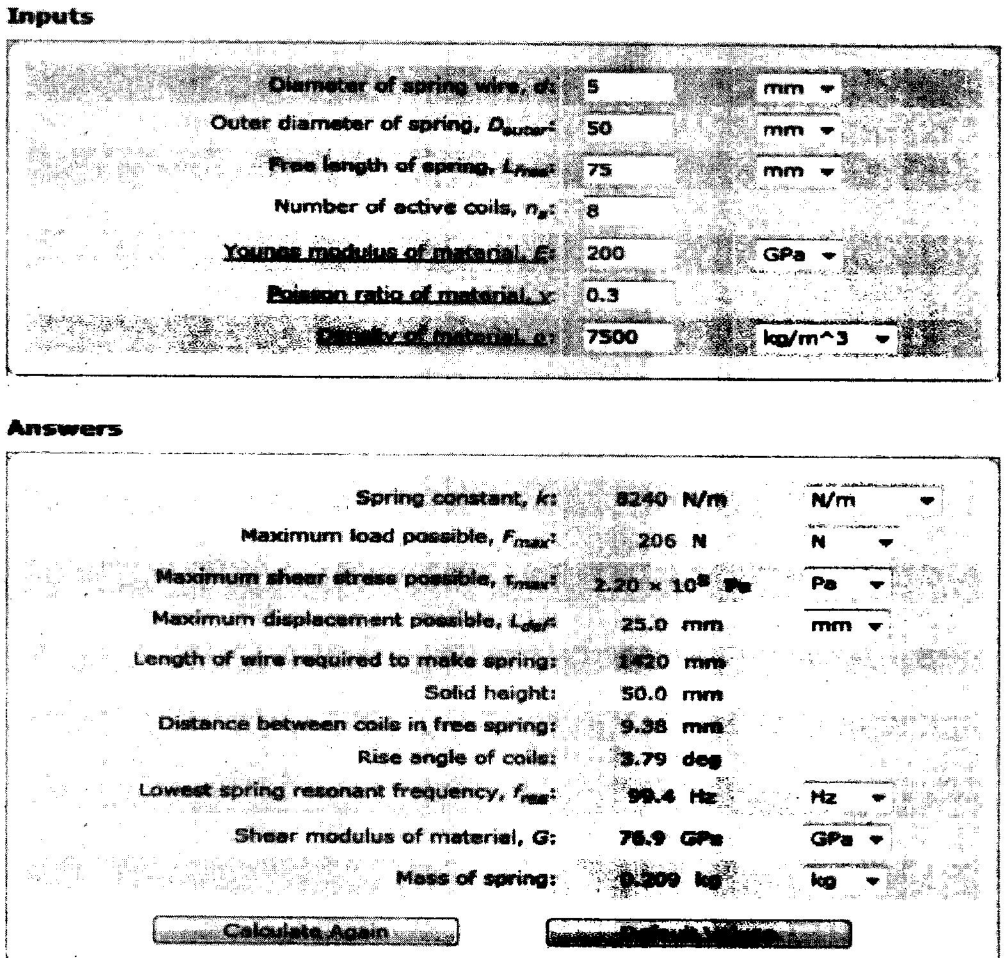
D = Diameter of spring wire

D_{outer} = Outer diameter of spring

L_{free} = Free length of spring

n_a = Number of active coils

For the computation of the parameters needed for the spring design, online spring calculator software (efunda compression spring designer) was used with the data as shown in Figure 3.9. Using steel as the material for the spring design, material data for steel was used for the computation.



Inputs

Diameter of spring wire, d: 5 mm

Outer diameter of spring, D_{outer}: 50 mm

Free length of spring, L_{free}: 75 mm

Number of active coils, n_a: 8

Youngs modulus of material, E: 200 GPa

Poisson ratio of material, ν: 0.3

Density of material, ρ: 7500 kg/m^3

Answers

Spring constant, k:	8240 N/m	N/m
Maximum load possible, F_{max}:	206 N	N
Maximum shear stress possible, τ_{max}:	2.20×10^8 Pa	Pa
Maximum displacement possible, L_{def}:	25.0 mm	mm
Length of wire required to make spring:	1420 mm	
Solid height:	50.0 mm	
Distance between coils in free spring:	9.38 mm	
Rise angle of coils:	3.79 deg	
Lowest spring resonant frequency, f_{res}:	99.4 Hz	Hz
Shear modulus of material, G:	76.9 GPa	GPa
Mass of spring:	0.209 kg	kg

Figure 3.12: Spring Calculator of Efunda Compression Spring Designer

Source: (About Us: An engineering Fundamental, 1999)

From the design data gotten for the spring (Figure 10), for one spring, k = 8240 N/m

Number of springs required: From equation 19, K = 94827.38

For parallel connected springs with the same spring constant k,

$$K = n\,k \qquad \text{.....................Equation 18}$$

Where; n = number of springs

Substituting into equation (12) n is equal to 11.508.

Total number of springs required is 12.

3.4 Using Analytical Calculations

The spring constant k is the function of the spring geometry and the spring material's shear modulus G,given in the equation below (Khurmi, et al, 2005),

$$k = \frac{Gd^4}{8D^3 n_a} \qquad \text{................................ Equation 19}$$

Where;

D = mean diameter of the spring (measure from the center of the wire cross sections).

n_a = number of active coil

The shear modulus or modulus of rigidity G can be found from the relationship below, using steel as the material for the spring [14],

$$G = \frac{E}{2(1+V)} \qquad \text{............Equation 20}$$

Where E = 200 GPa

v = 0.3

G = 7500 kg/m^3

D = 5 mm

D = D_{outer} – d = c x d =45mm

c = 9 (for Optimum Value)

From equation (18) using 12 springs, the spring constant for one spring is 7902.28 N/m.

Using equation (20), G = 76.92GPa

Therefore n_a(number of coil) = 8.3542 which is approximately 8 active coils.

The distance between adjacent coils (coil pitch):

$$Coil_{pitch} = \frac{L_{free}}{n_a}$$ .... Equation 21

The angle between the coil and the base of the spring from

$$\theta = tan\frac{Coil\ pitch}{\pi D} = 3.794^0$$ ....Equation 22

Solid height of the spring H_{solid}

H_{solid} = n x d = 10 x 5mm = 50mm

The Wahl correction factor which account for shear stress resulting from spring curvature W (R.S & J.K, 2005)

$$W = \frac{4C-1}{4c-4} + \frac{0.615}{C}$$ ....Equation 23

W = 1.162 but c = D/d = 9

However, maximum shear stress, τ max

$$\tau_{max} = \frac{8FDW}{\pi d^3}$$ ....Equation 24

= 219.4MPa

3.5 Material Selection

MACHINE PARTS	DESIGN DATA	MOST SUITABLE MATERIAL	REASON
Main Frame	1" Angle Iron Mild Steel	Galvanized Steel	• Suitable • Readily Available • Cheap
Hopper	30 X 230 mm	Galvanized Steel	• Suitable • Readily Available • Cheap
Bearing		Steel	• Most Suitable
Sieve	245 X 700mm	Galvanized Steel	• Suitable • Durable • Resistance to corrosion

Bolts and Fasteners		Steel	• Suitable • Durable
Electric Motor	700rpm 0.5KW		• Suitable based on design calculations

Table 3.3: Material Selection

Source: (Oluwarotimi, et al, 2013)

CHAPTER 4

4.0 RESULTS AND DISCUSSION

The physical realization of the project is very vital. After carrying out all the paper design and analysis, this project was implemented and tested to ensure its working ability, and was finally constructed to meet desired specifications.

4.1 IMPLEMENTATION

The implementation of this project was done on the breadboard. The power supply was first derived from a bench power supply to confirm the workability of the circuits before the power supply circuit was soldered. Circuit by circuit testing was done according to the block representation on the breadboard, before soldering of circuit commenced on Vero board. The various circuits were soldered in tandem to meet the desired workability of this project.

4.1.2 CONSTRUCTION

The construction of the project was done in two different circuits; the transmitter circuit and the receiver circuit which are pictured below

Fig 4.1: The transmitter circuit

In the transmitter circuit, we have the RF transmitter, a junction box, an encoder, IC socket, the resistor and a switch. This is where the signal is being transmitted with the aid of the RF transmitter.

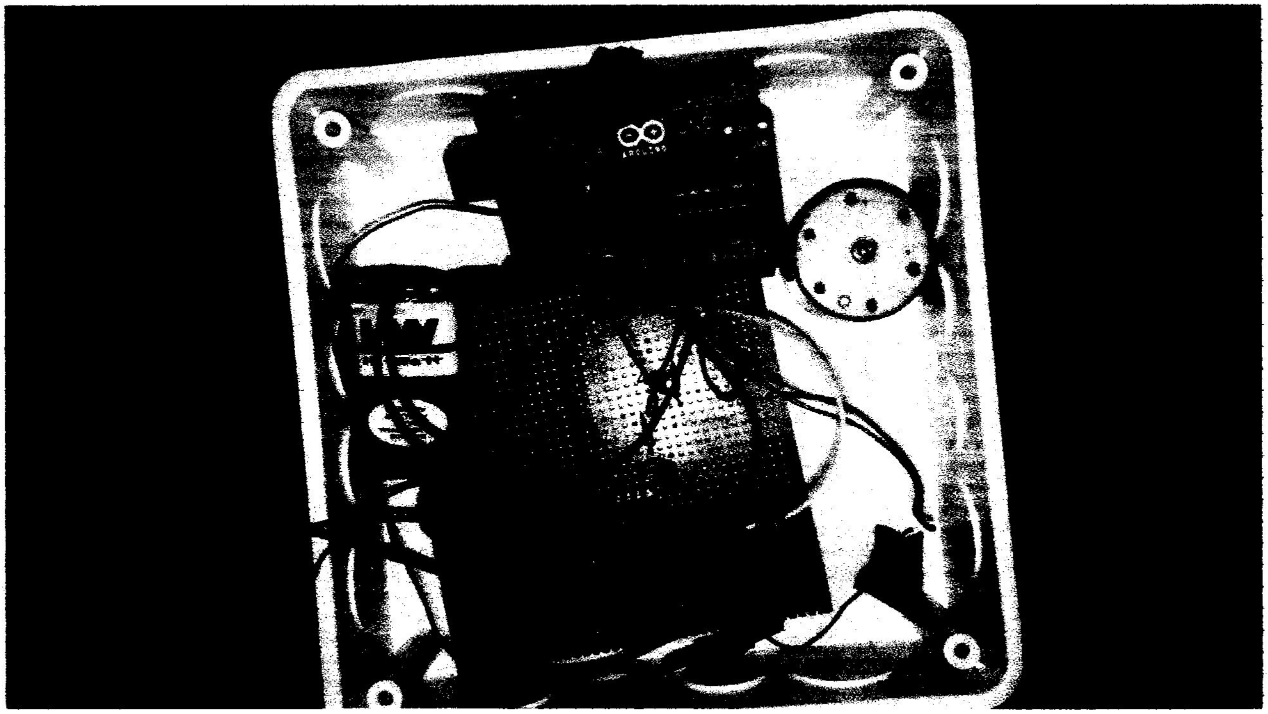


Fig 4.2: The receiver circuit

In the receiver circuit, there is an arduino powered by the battery and powering the whole receiver circuit, the DC motor is also in the receiver circuit board, there are three LEDs in this which indicates when the signal has been received, the RF receiver is also in the board and it receives the signal, there is a decoder in the circuit that decodes the signals that has been sent by the encoder in the transmitter circuit.

Fig 4.3 The receiver circuit and the transmitter circuit.

CHAPTER FIVE

5.1 SUMMARY AND CONCLUSION

5.1.1 SUMMARY

This project reveals design and implementation of a remote controlled rice de-stoner for separating stones from rice based on their different properties. It has a sieve with opening based on the size of rice grain to separate the rice from the stones larger than it and also a second sieve which allows sands and stones smaller than the rice only. Both sieves are vibrated, powered by a 0.50kW DC and rotational speed of 700rpm electric motor which is the main thing controlled by the remote control . The de-stoner has the efficiency of 80% and mass flow rate of 2.10 kg/s (kilogram/seconds) which is equivalent or equal to 7.50t/hr (tonnes/hour) capacity. The design of the de-stoner was carried out economically. A machine of this nature can be manufactured for small entrepreneurs and rural level applications in the developing countries, due to its low cost of and easy production and maintenance, where rice is locally produced for better quality and quantity.

5.1.2 CONCLUSION

The design of a remote control for the rice destoner machine was successfully carried out. The machine can effectively separate rice from stones based on their physical properties which are basically on the size differences with the aid of a remote control. The remote control is designed with an encoder, decoder, RF transmitter and Receiver, Push Buttons, IC sockets, Resistors of 51kilo-ohm and 1Mega-Ohms. The machine is designed with two sieves of different meshes and vibration is powered by a 0.50 kW and rotational speed of 700 rpm DC electric motor. The de-stoner has the efficiency of 80% and mass flow rate of 2.10 kg/s which is equivalent to 7.50 t/hr capacity.

5.2 RECOMMENDATIONS

For future research and developments, the following are recommended

- Keypads can be used on the rice destoner to control the speed, putting on or putting off

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