*Journal of Engineering and Technology*
*The Open University of Sri Lanka (JET-OUSL), Vol. 10, No.2, pp. [63-76], 2022*

# DEVELOPMENT OF AUTOMATED COCONUT SCRAPING MACHINE

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**Abstract** – *Innovation and advancement in technology tends to change the existing products by improved ones. The ultimate objective of this project is to design an automated coconut scraping machine that can perform coconut scraping operations in an easy and safe manner.*

*Coconut is a plant that's very productive. Coconut farming is one of the three main cultivations in Sri Lanka. Coconut has variety of uses and variety of health and nutritional benefits. The uses of coconuts range from cooking, drinking, as a fruit, nutrition to skin health, cancer prevention, beauty products, and as fuel.*

*Currently available coconut scrapers in the market are less safe as it need to hold the coconut near the blade. Further it is time consuming, and laborious. This project aims at evaluating the existing coconut scraper developments has proposed earlier, existing coconut scrapers in the market and proposing a automated design for coconut scrapers in such a way that it is safer and easily operable for common people. The proposed coconut scraping machine is designed in such a way that it is easy, safe and quick to scrape coconuts. The design could help the society in a better way by increasing the safety of people and by reduce the time consumption.*

*This paper describes how an automated coconut scraping machine has been developed to solve the well-known challenges regarding scraping coconuts. The proposed design eliminates virtually all hazards related to the coconut scraping. It is a fully-automated machine that reduces both risk and effort on the part of the operator. The system incorporates a moving blade that allows movement along two axes. The clamping mechanism rotates slowly to scrape coconut accordingly. The mounting of the coconut half shell in the clamp takes less time. Upon mounting, at the push of a start button, the scraping of the coconut is done completely automatically. Details of the design and development of the working model constitute the main contribution of this project.*

***Keywords****: Automated, Coconut scraper, Current sensor, Moving blade, Safe, Two axes*

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## 1 INTRODUCTION

Coconut (Cocos nucifera) belongs to Arecaceae family. Coconuts probably originated somewhere in Indo-Malaya and are one of the most important crops of the tropical countries. A single coconut palm may yield 100 coconuts annually, and each fruit requires nearly a year to fully ripen. Mature coconuts, ovoid or ellipsoid in shape, 300–450 mm (12–18 inches) in length and 150–200 mm (6–8 inches) in diameter. Coconut has variety of uses and variety of health and nutritional benefits. Coconut flesh is high in fat and can be dried or eaten fresh or processed into coconut milk or coconut oil. The liquid of the nut, known as coconut water, is used in beverages. The uses of coconuts range from cooking, drinking, as a fruit, nutrition to skin health, cancer prevention, beauty products, and as fuel.

In Sri Lanka and the southern part of India coconut milk is used from coconut flesh for cooking. When coconut flesh is using for cooking, it is needed to scrape the coconut. Scraping coconut is a time consuming and mostly manual process from early days. This manual process requires an operator to rotate and apply pressure to scrape out the flesh from the coconut. Some coconut scraping machines are introduced to automate this manual process.

The commercially available coconut scraping machines are not fully automated and still involve manual effort. This semi-automated process requires an operator to hold the coconut half-shell against a rotary blade usually powered by an electric motor. The operator holds the coconut half shell and presses the inside of the shell, containing the flesh, against the rotating sharp bit. This process is time consuming and poses some safety hazards as well. Designing a mechanism that can stop the operator during scraping coconuts is therefore necessary.

The commercial coconut scraping machines that are available are not fully automated and still require physical involvement by an operator. In both of these methods, such as manual and semi-automated, the operator is exposed to different risks of injury. In this project I will describe how an automated coconut scraping machine is going to be developed to solve the well-known challenges of scraping coconuts. For the design to be fully automated, it would have to significantly reduce all operator input during operation. Coconuts come in different shapes and sizes. Because of that, the new design needs to accommodate various sizes and shapes of the coconuts (Table 1). The new scraping machine must be design in such a way that it can be self-adjusting, based on the size and shape of the coconut. Today the conventional coconut scrapers in the market, the sharp bit turns at a high revolution rate. This design proposed to eliminate virtually all the hazards related to coconut scraping of both manual and semi-automated processes. Because of that this fully-automated machine is designed to reduce both risk and effort on the operator.

The system incorporates a self-adjusting blade that allows movement along two axes of cylindrical coordinates which uses the current sensor to detect when to scrape and when to stop. On the other hand I have user black/white path detection sensor to detect where to scrape. Used scraping blade is commonly used in the domestic purpose. Scraping process will complete by sector wise. And there is a clamping mechanism that holds and rotates the coconut half shell to scrape. The mounting of the coconut half shell in the clamp takes less time to reduce the total operation time. After mounting of the coconut half shell, the scraping of the coconut is completely automatic and no operator is involved.

**Table 1Various sizes and shapes of the coconuts**

| Particulars | Coconut |
|---|---|
| Shape | Ovoid |
| Length, mm | 210-270 |
| Diameter, mm | 160-206 |
| Weight, kg | 0.62-1.25 |
| Shell Diameter, mm | 80-120 |

## 1.1 Objectives

- Develop user friendly, more efficient and reliable automated system to scraping coconut.
- Minimize the manual works.
- Maximize the time utilization.

- Avoid risks of injury.
- Minimize the wastage.

## 2 METHODOLOGY

The proposed system is designed by adapting and combining the existing technologies which are currently using in the industry. The design consists of four major stages. It was separated in to major four stages for the purpose of designing. Existing concepts of coconut machines have been analysed to identify features that could be incorporated in the proposed model.

### 2.1 Inputs and Outputs of the System

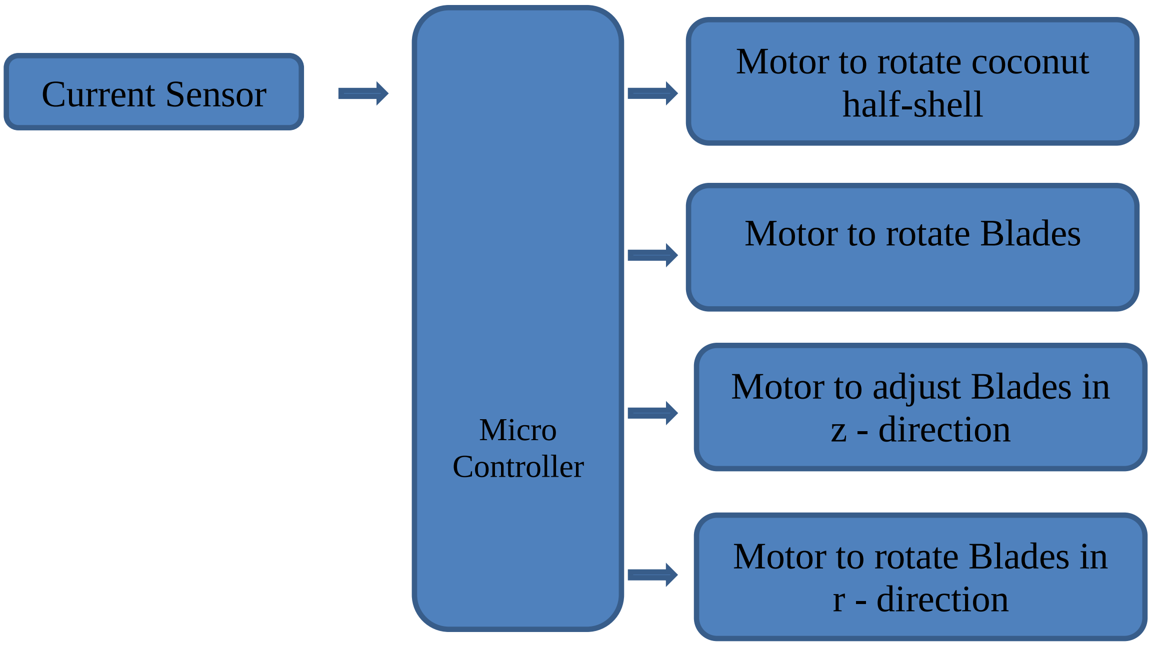


**Fig. 1, Block diagram of the proposed system**

### 2.2 Coconut Scraping Blade Mechanism

Coconut scraping blade mechanism consists of a DC motor to rotate the blade and there is a mechanism to move the scraping blade to "r" and "z" directions.

#### *2.2.1 Coconut Scraping Blade Rotating Mechanism*

The proposed system is used scraping blade which is commonly used in the domestic purpose with an electric motor to rotate.

**Fig. 2. Scraping blade and motor**

#### *2.2.2 Directional Movement of the Scraping Blade*

Two stepper motors are used for more controllable moment of the scraping blade with its motor. One is for z-direction and other one is for r-direction of the cylindrical coordinate system.

**Fig. 3. Top linear sliding rail**

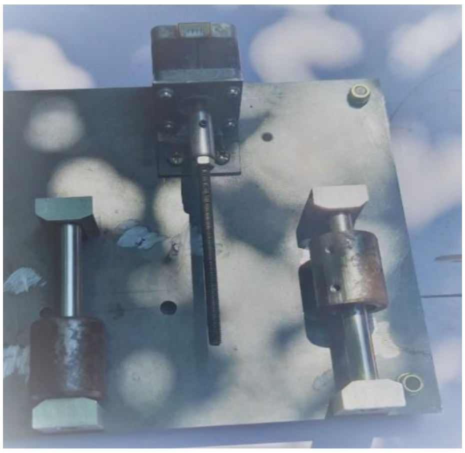

**Fig. 4. Bottom linear sliding rail**

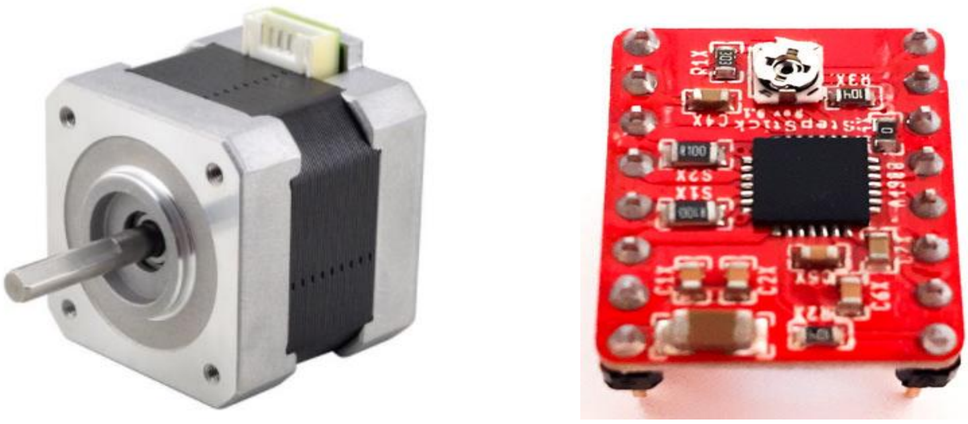

**Fig. 5. NEMA17 Stepper Motor and NEMA17 Stepper Motor Driver (A4988)**

### 2.3 Coconut Clamping Mechanism

The clamp mechanism was developed to hold the coconut half shell firmly in place and ensure that the time taken to mount the coconut is relatively short and specially for avoiding the risks of injury.

**Fig. 6. Tightening screw side and front view**

**Fig. 7. Clamp arm**

**Fig. 8. Clamp arms connecting mechanism**

**2.4 Coconut Half Shell Rotating Mechanism**

I have used DC geared motor for rotating the coconut half shell with the clamping mechanism. DC geared motor is used for steady slow motion of the coconut half shell with the clamping mechanism. Therefore, the scraping blades have enough time to scrape coconut.

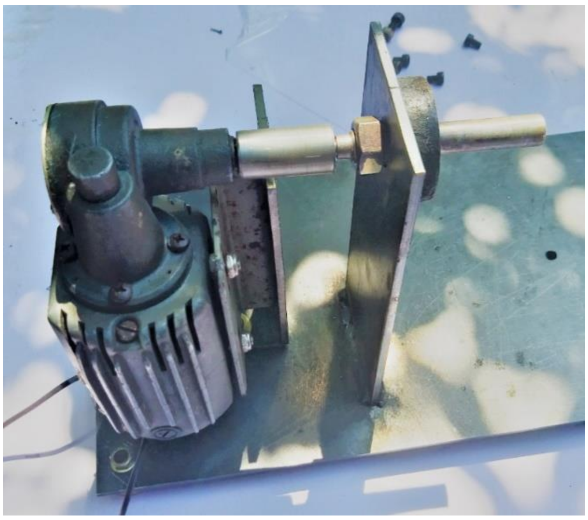

**Fig. 9. DC geared motor used for rotating the coconut**

**2.5 Electrical and Control Systems**

Speed of the scraping blade should be adjustable and there is a control system used for control the moment of the scraping blade mechanism.

Both coconut flesh and coconut shell has different resistance to overcome the scraping action (or rather friction coefficient to overcome the scraping action). The resistance will cause an increase or decrease in torque, which will ultimately cause a change in the current flowing through the DC motor. By knowing the range of resistance caused by the coconut flesh, the blade can be restricted to scrape only the coconut flesh. The control system programmed to assess and detect the differences.

The INA3221 is a three-channel current sensor used to detect the current flowing through the DC motor.

**Fig. 10. INA3221 as Current Sensor**

The INA3221 is a three-channel, high-side current and bus voltage monitor with an I2C- and SMBUS compatible interface. The INA3221 monitors both shunt voltage drops and bus supply voltages, in addition to having programmable conversion times and averaging modes for these signals. The INA3221 offers both critical and warning alerts to detect multiple programmable out-of-range conditions for each channel.

ATmega328 is an Advanced Virtual RISC (AVR) microcontroller. It supports 8-bit data processing. ATmega-328 has 32KB internal flash memory.

ATmega328 has 1KB Electrically Erasable Programmable Read-Only Memory (EEPROM). This property shows if the electric supply supplied to the micro-controller is removed, even then it can store the data and can provide results after providing it with the electric supply. Moreover, ATmega-328 has 2KB Static Random Access Memory (SRAM).

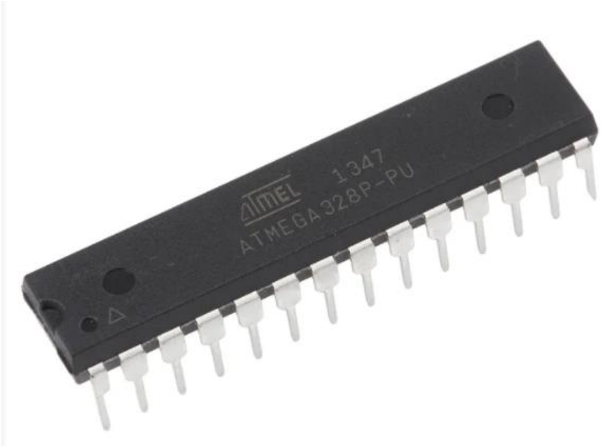


**Fig. 11 – ATmega328 as the microcontroller**

## 2.6 Detailed Design

### *2.6.1 Assembling the Components*

Both the clamp and scraper mechanisms are mounted to a metal bottom base and aligned each other. As seen in Fig. 12, the stepper motors, DC motor and DC geared motor are electrically connected to the control circuit containing the current sensor. Rubber foots were assembled to the metal bottom base, providing friction that eliminates any unwanted movement due to the vibrations of the machine. It acts as a vibration absorber.

The concept developed in this project incorporates a scraping blade mechanism that can be self-adjusting, based on the size and the shape of the coconut while in rotation. The adjusting of the scraping blade mechanism is regulated by two electric stepper motors. A DC motor placed in the linear sliding rail is facilitates the rotation of the scraping blade. The coconut half-shell is then mounted on the coconut clamp. A coconut clamp tightening screw is used to clamp and tighten the coconut shell. The clamp mechanism is fitted to a 12 V, DC geared motor to rotate the clamped coconut. Stepper motors, DC motor and DC motor can be controlled by the control system so that scraping may take place efficiently. By controlling the current flowing through the DC motor (and subsequently the torque), it is possible to maintain a constant torque which is linked to the steps of both stepper motors. This contact torque is the torque required to overcome friction when the blade is in contact with the coconut flesh. An image of the automatic coconut scraping machine is shown in Fig. 13.

Knowing that the coconut flesh has a certain resistance (or rather friction coefficient to overcome the scrape action), the hard shell of the coconut also has a coefficient of friction different from the flesh. The control system programmed to assess and detect the differences. The resistance will cause an increase or decrease in torque, which will ultimately cause a change in the current flowing through the DC motor. By knowing the range of resistance caused by the coconut flesh, the blade can be restricted to scrape only the coconut flesh.

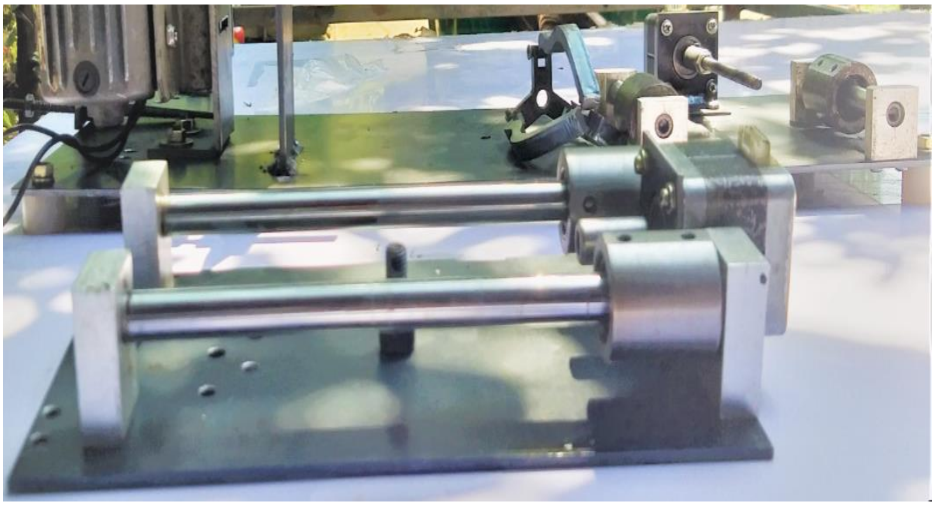

**Fig. 12 – Metal top base (Front) and bottom base (Behind)**

## 2 SYSTEM DESIGN

Hardware design of the system is a combination of several hardware parts. Mainly there are electronic and mechanical parts. Designing a feasible hardware especially for the mechanical design for the proposed system is quite challenging.

### 3.1 Hardware Design

Hardware design of the automated coconut scraping machine is shown in the below figure.

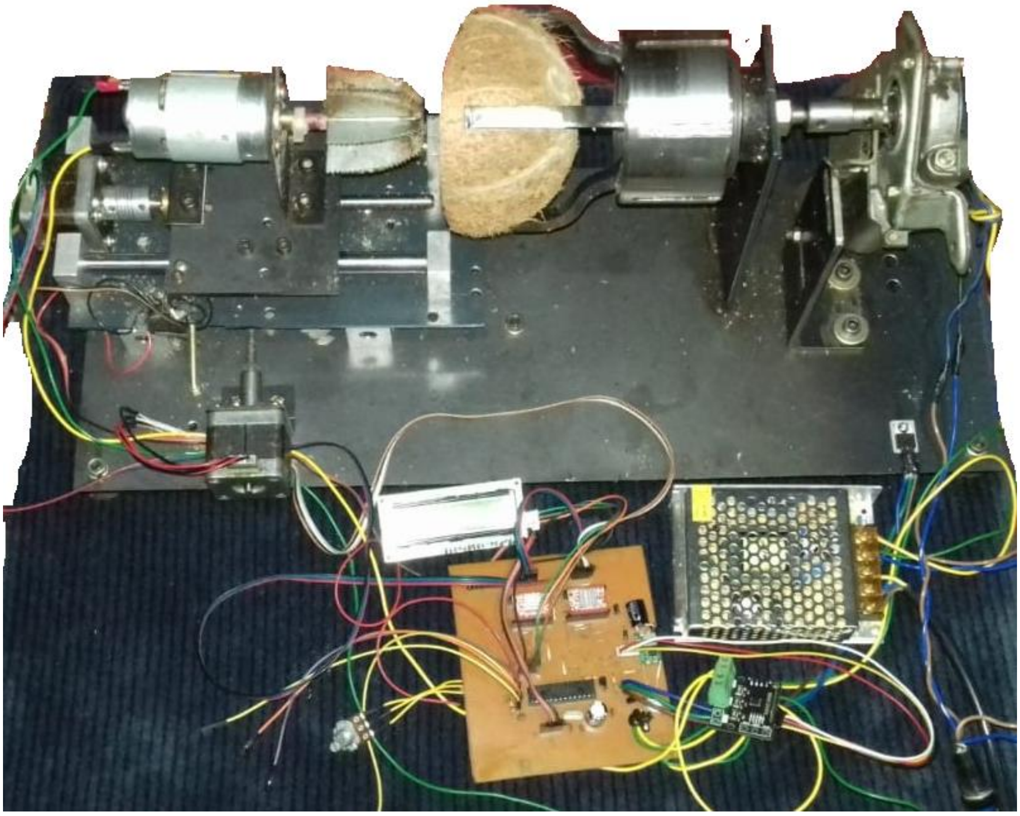

**Fig. 13. Hardware Design**

### 3.2 Software Design

Following codes are written in the microprocessors as follows.

#### *3.2.1 Commands for directional movements*

```
delay(300);
lcd.setCursor(0, 1);
lcd.print("Standby");
sst:

if(digitalRead(3)== HIGH){
  if(digitalRead(4)== HIGH){
  goto eed;
  }
}

if(digitalRead(3)== LOW){    //check Switch 01
  mUPL();   // Stepper motor M1 Right
  stpM1();
 }

if(digitalRead(4)== LOW){     //check Switch 02
  m2RR();    // Stepper motor M2 Right
  stpM2H();
 }

 goto sst;
eed:
delay(300);
Wire.beginTransmission(34);
Wire.write(0b00000000);
Wire.endTransmission();
mUPL();
delay(100);

sttt = 0;
offf = 0;
delay(300);

}
```

#### *3.2.2 Commands for reading current values of current sensor*

```
void loop() {

 section_01:
if(digitalRead(7)== LOW){   // On switch
  lcd.clear();
```

```
  lcd.print("A=");
  lcd.setCursor(0, 1);
  lcd.print("H=");

  delay(200);
  for(int i =0; i<1100 ; i++){
  mUPL(); // Stepper motor M2 Left
  stpM2H();
  }
  delay(200);
  goto section_02;
}
else{
 goto section_01;
}
goto section_01;

section_02:
lcd.setCursor(0, 0);
lcd.print("Running..");
analogWrite(5,150); //PWM out to motor
mula:
float vc1 = analogRead(A0);  // read the input on analog pin 0:
vc1 = map(vc1, 0, 1023, 0, 2500); // convert to 0-2500
vc1 = vc1/100;
 float current[0];
 float voltage[0];

  current[0] = ina3221.getCurrent(INA3221_CH1);
  voltage[0] = ina3221.getVoltage(INA3221_CH1);

  Serial.print("Channel 1: ");
  Serial.print(current[0]);
  Serial.print("A, ");
  Serial.print(voltage[0], PRINT_DEC_POINTS);
  Serial.println("V");
  Serial.println(vc1);

   lcd.setCursor(11, 1);   // I2c LCD Command
   lcd.print(current[0]);
   lcd.setCursor(2, 1);
   lcd.print(vc1);
 mx2:
   if(digitalRead(7)== LOW){
     mUPL(); // Stepper motor M2 Left
     stpM2H();
     delay(1);
     goto mx2;
   }
  if (current[0] > vc1){
   sttt++ ;
   offf++;
   delay(200);
```

```
if (sttt == 4){
 goto meed;
}


  for(int i =0; i<130 ; i++){
  m2RR();    // Stepper motor M2 Right
  stpM2H();
  delay(0);
  }
 }
 meed:
 lcd.setCursor(14, 0);
 lcd.print(sttt);
 Serial.println(sttt);
 Serial.println("offf");
 Serial.println(offf);
```

### *3.2.3 Commands for scraping blade starting and stop*

```
if(digitalRead(3)== HIGH){
  if(digitalRead(4)== HIGH){

  }
  Wire.beginTransmission(34);
Wire.write(0b00000000);
Wire.endTransmission();
goto section_01;
}
delay(200);
  for(int i =0; i<1100 ; i++){
  mUPL(); // Stepper motor M2 Left
  stpM2H();
  }
  delay(200);
  goto section_02;
 }
else{
 goto section_01;
}
section_02:
lcd.setCursor(0, 0);
lcd.print("Running..");
analogWrite(5,150); //PWM out to motor
mula:
float vc1 = analogRead(A0);  // read the input on analog pin 0:
vc1 = map(vc1, 0, 1023, 0, 2500); // convert to 0-2500
vc1 = vc1/100;
 float current[0];
 float voltage[0];

  current[0] = ina3221.getCurrent(INA3221_CH1);
  voltage[0] = ina3221.getVoltage(INA3221_CH1);
```

# 3 TESTING AND IMPLEMENTATION

## 4.1 Calibrating the System with Trial and Error Method

The coconut flesh has a certain resistance (or rather friction coefficient to overcome the scrape action); the hard shell of the coconut also has a coefficient of friction different from that of the flesh.

The current flowing through the DC motor (and subsequently the torque) is a measure of friction when the blade is in contact with the coconut flesh or shell. These ranges of current values are measured and by trial and error method correct ranges are selected for the programming. The control system programmed to assess and detect the current reading differences. By controlling, it is possible to maintain a constant torque which is linked to the steps of both stepper motors.

Sample graph of Current (mA) Vs Time (s) for the three different stages is given below.

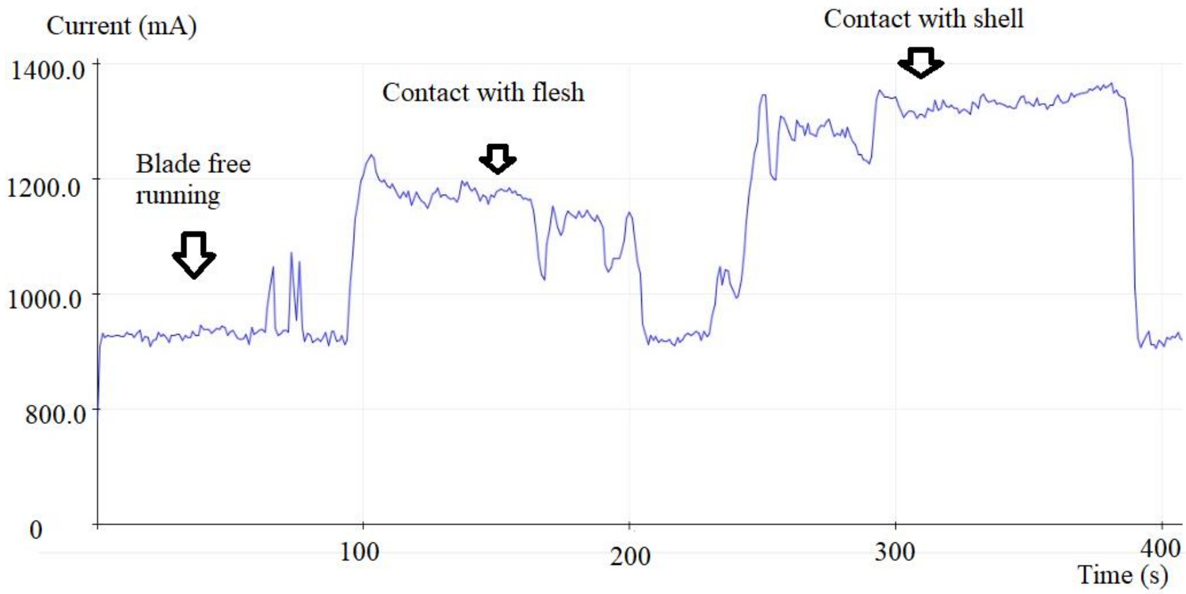


**Fig. 14. Sample graph of Current (mA) Vs Time (s) for the three different stages**

# 4 CONCLUSIONS AND RECOMMENDATIONS

Coconut is a fruit with a variety of uses. The edible fleshy part of the coconut is one of its softest parts, yet it requires considerable effort to remove it from the coconut shell. Several approaches are proposed to remove the flesh of the coconut more safely and easily. The approaches can be classified as manual, semi-automatic and automatic, corresponding respectively to the manual scraper, semi-automatic scraper, and automated scrapers. Objective of this project was to design a fully automated scraper that will reduce time and effort, and be more safe and efficient when compared to the manual and semi-automatic scrapers. The design incorporates two stepper motors, a DC geared motor, a DC motor, a scraping blade mechanism, a clamping mechanism, several sensors, and a microprocessor for control circuit.

A detailed description of the components, the modules, and the mechanism used to develop the automated system is provided. The coconut clamp was designed to grip various sizes and shapes of half-shell de-husked coconuts. The concept developed in this project incorporates a scraping blade mechanism that can be self-adjusting, based on the size of the coconut while in rotation. The adjusting of the scraping blade is regulated by two electric stepper motors. A geared DC motor is connected to a clamping system which is facilitates the rotation of the coconut half shell with the clamped coconut. A coconut clamp tightening screw is used to clamp and tighten the coconut shell. Through the control system, both stepper motors are controlled so that scraping may take place efficiently. Future work will provide clarity about the materials used the size of all components and modules, and the control circuit suitable for this system.

## 5 ACKNOWLEDGMENTS

The author is acknowledged the assistance given by Mr. C.J.S.A.H Perera, senior lecturer of the Department of Electrical and Computer Engineering, Faculty of Engineering Technology, The Open University of Sri Lanka.

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