VOL. 11, NO. 14, JULY 2016 ISSN 1819-6608
ARPN Journal of Engineering and Applied Sciences

www.arpnjournals.com

ROLLER PICKER ROBOT (ROPICOT 1.0) FOR LOOSE FRUIT COLLECTION SYSTEM

Muhammad Muzakkir Mohd Nadzri[1] and Afandi Ahmad[1,2,3]
[1]Bioelectronics and Instrumentation Research Laboratory MiNT-SRC, Universiti Tun Hussein Onn Malaysia
[2]VLSI Architecture and Systems Design Research Laboratory MiNT-SRC, Universiti Tun Hussein Onn Malaysia
[3]Embedded Computing Systems, Research Cluster, Department of Computer Engineering, Malaysia
Faculty of Electrical and Electronic Engineering, Universiti Tun Hussein Onn Malaysia
E-Mail: muzakkir.nadzri.psac1415@gmail.com

ABSTRACT

Generally, loose fruit has been neglected and many of the fruit was left to rot due to the conventional collection system that can cause back pain to workers and very time consuming process. This project is about rapid prototyping of loose fruit collection system including its robotic mechanism as well as roller picker for the collection part. Wireless controller is used to move the robot towards the loose fruit and the rolling tool with minimum pressure are rolled on the land. Arduino Mega 2560 that capable to process and execute commands that have been programmed being used as the hardware platform, whilst the Arduino software was used to develop the system architecture. Evaluation on the proposed system in terms of its movement, quantity and quality of the collections as well as stability shows that the prototype is capable to collect scattered loose fruit with average of 0.5kg/min on various ground and 0% trash and injury.

Keywords: loose fruit, robotic, embedded.

INTRODUCTION

The oil palm tree (Elaeis guineensis jacq.) originates from West Africa where it grows in the wild and later was developed into an agricultural crop. It was introduced to Malaya, by the British in early 1870's as an ornamental plant. In 1917, the first commercial planting took place in Tennamaran Estate in Selangor, laying the foundations for the vast oil palm plantations and the palm oil industry in Malaysia (Palm Oil Facts and Figures, 2013).

Today, 4.49 million hectares of land in Malaysia is under oil palm cultivation; producing 17.73 million tonnes of palm oil and 2.13 tonnes of palm kernel oil. Malaysia is one the largest producers and exporters of palm oil in the world, accounting for 11% of the world's oil fats production and 27% of export trade of oils fats (Economic Transformation Program, 2013). The industry provides employment to more than half a million people and livelihood to an estimated one million people.

Loose fruit, its collection and non-collection, has always been one of the hottest topics in the daily operation of the upstream plantation (Palm Oil Facts and Figures, 2013). Loose fruit is the ripest in the bunch and drop naturally to the ground. In estates, the visual indication that a bunch is ready for harvesting is when there are five (5) loose fruit on the ground.

Loose fruits were deemed insignificant compared to the fresh fruit bunch (FFB) which is larger in size. Hence the collection of loose fruit was never taken seriously and one of the conventional collection system are using hand as shown in Figure-1.

Figure-1. Manual loose fruit collection using hand.

With manual loose fruit collection, it consumes more time and yet resulting back pain among workers. To solve this problem, loose fruit collection system with less dependent on human with better efficiency is required. Hence, roller picker robot (ROPICOT 1.0) which is a combination between rolling element with its robotic mechanism is proposed.

RELATED WORKS

Yusof (1995) develops a machine that capable to collect with an average of 1.0 to 1.2 kg/min with less than 10% debris. Fruit were not damaged during the operation. On the average this machine is capable of collecting 300 to 400 kg of clean loose fruit in a day. The use of this machine are effective in cases where the fruits are scattered.

Yusof (1999) expands the previous idea and modification were made to the main frame of machine so that it is suitable to attach to the collector and this can be divided into two (2) parts; suction and machine movement parts.

Roller loose fruit picker or in short roller picker (RP) has been proposed by Deraman (2009). It collects loose oil palm fruits by picking and retaining the loose fruits in a case without tedious and laborious efforts. The invention is an oval-shaped case made of a plurality of wires or rods. RP is rolled with a little pressure against the ground causing the wires or rods of the case to split open and to trap the loose fruit inside.

Shuib (2012) suggests a new idea with constant suction power as the main advantage of the cyclonic vacuum, using the vacuum concept. The cylindrical shape creates a cyclone atmosphere once the fruits are sucked, with minimal bruising to the fruits.

As the fruits circulate within the barrel/chamber, the heavier fruits fall to the bottom of the barrel/chamber while the lighter materials such as dried leaves will be sucked out of the system. To summarise the discussion, spectrum of issues are shown in Figure-2 and Table-1.

METHODOLOGY

To execute this project, three (3) main parts have been identified; input, processing unit and output. Wireless controller is used as an equipment to give an input data for the system and the controller will provide input to the Arduino Mega to perform the operation. Input signal is delivered when the button is pressed by the user.

Arduino Mega is used as an analog to digital signal converter (ADC) device to give translate analog to digital signal in the prototype. It is also noted that it also works to control the process executed in the systems.

The prototype will collect scattered oil palm loose fruit on the various ground condition with expected trash content less than 10%. The prototype will also targeted to move forward, backward, left and right according to the instruction from the microcontroller.

The prototype will use roller picker to collect the loose fruit and it also available with four (4) tyres that able to work on various ground condition. An overview of this proposed solution is depicted in Figure-3.

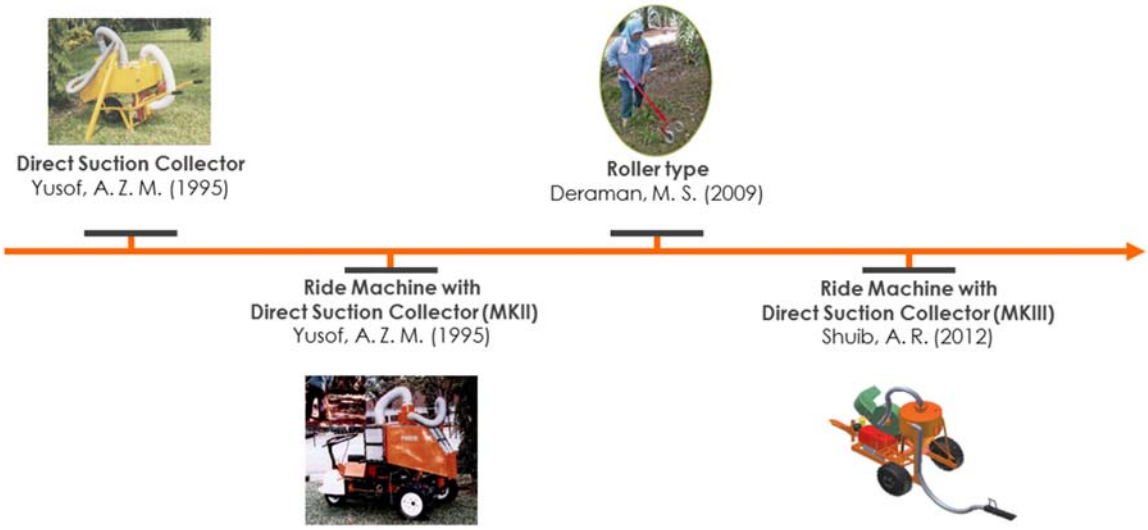

Figure-2. The development of the loose fruit collection technologies.

Table-1. Spectrum of issues in loose fruit collection system

Ref.	Technique	Power, kW	Collection Capability, kg/min	Trash, %	Injury, %
Yusof, A. Z. M. (1995)	Direct Suction Collector	4.5	1.0 – 1.2	<10	0
Yusof, A. Z. M. (1999)	Ride Machine with Direct Suction Collector (MKII)	4.5	1.0 – 1.2	< 10	0
Deraman, M. S. (2009)	Roller type	Rolling	0.5 -1.0	0	0
Shuib, A. R. (2012)	Ride Machine with Direct Suction Collector (MKIII)	6.7	4.2 – 5.1	<15	0

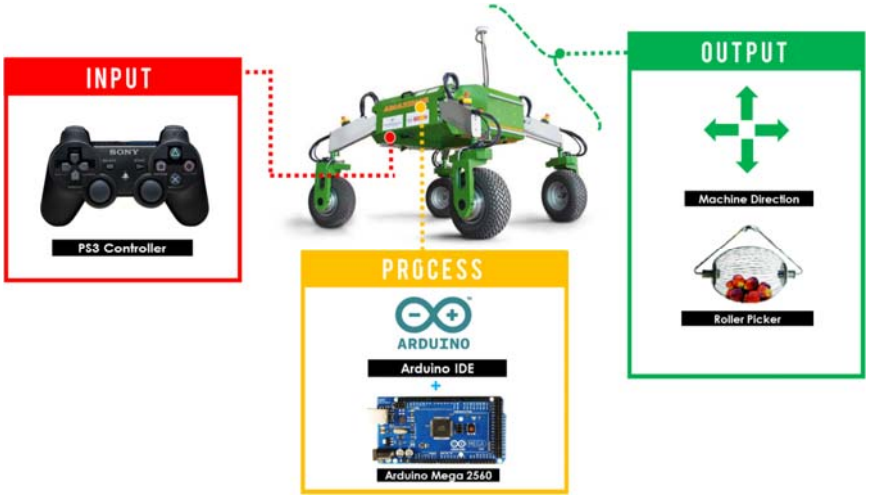

Figure-3. Overall structure of the prototype.

RESULTS AND DISCUSSIONS

To test the proposed systems functionality, four (4) studies have been executed as follows:

a) movement of the systems;
b) quantity of the collections;
c) quality of the collections; and
d) its stability.

Movement of the systems

The prototype's movement were tested by controlling all four (4) motors attached in the prototype with requirements given in Table-2, including move forward, backward, right and left direction. In addition, Figure-4 and Figure-5 show the real prototype and its motor position.

Figure-4. Real prototype.

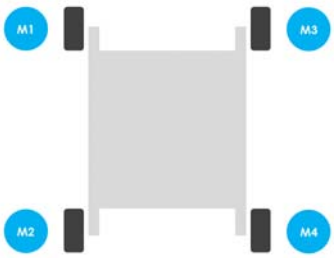

Figure-5. Position of motors.

Table-2. Motor movement.

Prototype Movement	Motor1	Motor2	Motor3	Motor4
Forward	Forward	Forward	Forward	Forward
Reverse	Reverse	Reverse	Reverse	Reverse
Right	Forward	Forward	Reverse	Reverse
Left	Reverse	Reverse	Forward	Forward

Quantity of the collections

In terms of quantity of the collections, the proposed prototype has been examined to collect loose fruit (in kg) in every 30 second. Results obtained are tabulated in Table-3.

Table-3. Weight of loose fruit collected in every 30 seconds

Time(s)	Weight (Kg)
00 – 30	0.45
30 – 60	1.1
60 – 90	1.5
90 – 120	2.0

Quality of the collections

On top of the quantity, quality aspect is also important. The proposed prototype with roller collection method resulting 0% trash and injury as shown in Figure-6.

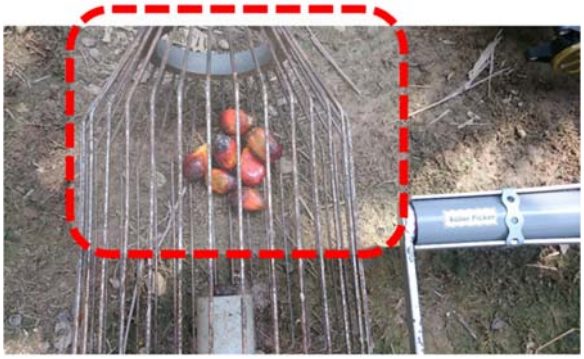

Figure-6. Loose fruit collected in good condition.

Stability

Due to the various surface conditions available in the area of oil palm plantations, stability test has been executed at different angle of surface as illustrated in Figure-7. Results as tabulated in Table-4 indicate that the proposed systems was in good condition and no slip backward until it is tested on 45 degree angle. On the other hand, full examination of the prototype has been also executed as shown in Figure-8.

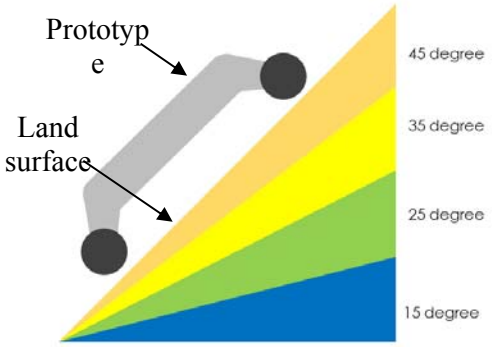

Figure-7. Loose fruit collected in good condition.

Table-4. Prototype angle test.

Surface Degree	Slip backward	Stability
15	No	Stable
25	No	Stable
35	No	Stable
45	3cm	Stable

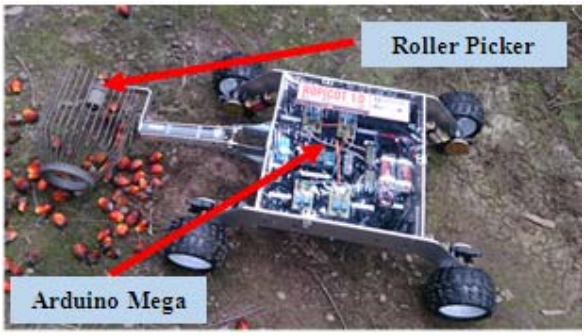

Figure-8. Real surface condition on oil palm plantation.

CONCLUSIONS

Due to the highest oil to weight ratio of loose fruit, an efficient loose fruit collection system is vital. An implementation of loose fruit collection system with combination of embedded platform (Arduino Mega) with robotic mechanism reveals convincing results, in terms of its movement, quantity and the quality of the collections as well as stability.

To further explore this work, another version of ROPICOT will be carried out, including with storage and availability of the roller to move vertically, utilising renewable energy for power supply and finally another version with fully automated and camera as a detector.

REFERENCES

Deraman, M. S. 2009. Roller-Type Oil Palm Loose Fruit Picker. MPOB Information Series, MPOB TT NO. 419.

Economic Transformation Program. 2013. In Palm Oil and Rubber. Retrived January 18, 2015, from http://etp.pemandu.gov.my/annualreport2014/

Ja'afar, M. S. (n.d). Teknik Pemungutan Buah Kelapa Sawit Terlerai: Cabaran dan Pendekatan Baru. Jabatan Kejuruteraan Biologi dan Pertanian, Fakulti Kejuruteraan Universiti Putra Malaysia.

Palm Oil Facts and Figures. 2013. In Sime Darby Plantation. Retrived August 8, 2014, from http://www.simedarbyplantation.com/upload/Palm-Oil-Facts-and-Figures.pdf

Shuib, A. R. 2012. "Oil Palm Loose Fruit Collector (MKIII)". MPOB Information Series, MPOB TT NO. 505.

Yusof, A. Z. M. 1995. "Loose Fruit Collector". PORIM Information Series, PORIM TT NO. 19.

Yusof, A. Z. M. 1999. "Mechanical Loose Fruit Collector (MKII)". PORIM Information Series, PORIM TT NO. 57.