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Smart Oil Palm Multi-purpose Tractor (Prototype)

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Abstract
Advancements in field mechanization for the oil palm industry have improved year by year and urged to the introduction of machines which could be adapted to local usage. A suitable choice of machines is depend on the land size, terrain condition, management practice and economic returns. Recently, mechanization approaches vary from one crop to another crop with the major aim of overcoming labour shortage and to increase the quality of agriculture production. Thus, "Smart Oil Palm Multi-purpose Tractor (SOPMT)" is a multipurpose vehicle designed to perform in all types of terrain, while dutiful of the environment. An articulate 4x4 all-terrain vehicle (prototype) developed with a smart hydraulic system that could work in peat, wet soils and hilly conditions. This tractor offer versatility in performing wide range of tasks which is suitable for harvesting and transporting the fresh fruit bunch (FFB) of oil palm to the implement as well as useful for spraying and applying fertiliser, herbicide, pesticide or insecticide. SOPMT also developed to remove the damaged frond from it trunk and could extremely pull heavy loads. It is also equipped with control chamber that has adjustable sit and digital screen to autonomously control the required tasks. This tractor is of a high standard to solve the harvesting, collection and transportation of FFB. Thus, by using this tractor, it could significantly enhance the quality of labour works as well as the quality of oil palm production.

Keywords: oil palm, fresh fruit bunch (FFB), multi-purpose tractor, SOPMT, terrain vehicle (prototype)

Introduction

The production of our primary commodity crop and industry; oil plam is very labour intensive. The industry requires many labours for its operations, ranging from the planting to processing. Labour problem is highlighted to be one of the main factor for the higher production cost. Foreign labours are usually employed in Malaysian palm oil plantations. Faizah (2010) had figured out that there are four main tasks in the oil palm plantation which are totally dependent of foreign workers who are employed as harvester, fresh fruit bunch (FFB) collector, loose fruit collector and field worker for general maintenance works. Currently, the problem of labour shortage is very critical (Azman 2012). Thus, to overcome this issue, the industry has to focus on the adoption of mechanization at oil palm plantation. Mechanization could increse the labour productivity and at the same time decrease the dependency on human resources. Numerous advance machines have been introduced into the oil palm industry in the last 30 years such as motorized cutter, mechanical harvester, mechanical grabber, compact transporter and many more (Abd Halim et al. 1988; Ahmad et al. 2008; Guturu et al. 2015).

The application of mechanization in oil palm industry is increasingly being used. There are a lot of research for oil palm harvesting, evacuation, loose fruit collection and the application of fertilizer and pesticide have been conducted to enhance the production of FFB and to speed up the field work. Thus, the "Smart Oil Palm Multi-purpose Tractor (SOPMT)" is a prototype of multipurpose vehicle that has been designed to fulfil those objective by designing its hydraulic robotic arm. This arm can automatically perform the harvesting of FFB and the design of crane grapple could bring the harvested FFB into a trailer which requires less workers as compared by using chisel or motorized cutter. In addition, this SOPMT not just limited for harvesting purposes but also useful for spreading the fertilizer as well as pesticide or herbicide on its own. Thus, it was named as "Smart Oil Palm Multi-Purpose Tractor (SOPMT)" since it can do multi-purpose works.

Materials and methods

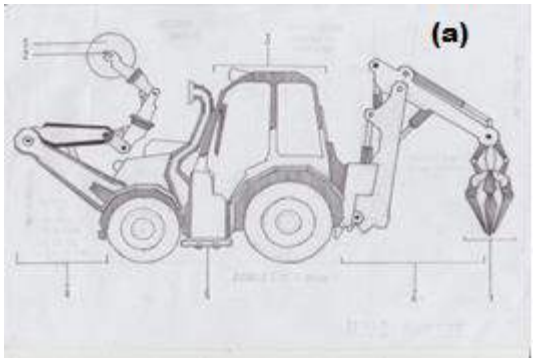
The design of the prototype's body is based on the structure of '*construction'* tractor type which is an articulated dual wheel four wheels drive. Firstly, the sketch of the tractor body was developed into three stages which are the front, side and top views. Secondly, an accurate measurement of length on a recycle paper box for each part was measured and cut accordingly. Geometry method was used in order to confirm the accurate measurement and produced the symmetry shape for each component. Thirdly, those cut components were attached together using glue or glue gun as per sketch. Fourthly, the wheel part also was established according to the desired size which is the front wheel is relatively small as compared to the back wheel. This is due to the stability purposes especially when the tractor will be attached with the hydraulic components. Fifth, hydraulic components

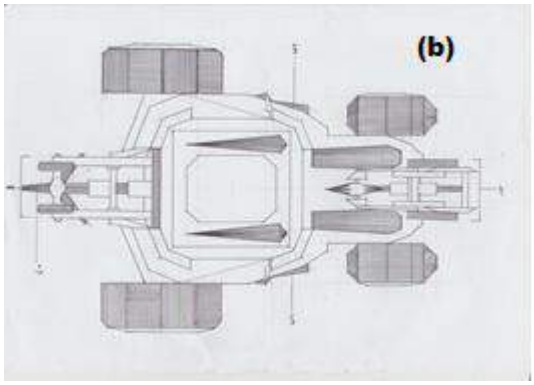
at the front and back sides of the tractor were attached to the tractor body which applied a simple hydraulic concept such as using syringe and silicone tube together. The design of those hydraulic components were as same as to those attached to the real tractor in order to maintain the real concept of hydraulic. Sixth, fluid that has high viscosity like cooking oil was used as a medium for hydraulic system for efficiency of prototype's movement.

Results and discussion

Design Consideration

SOPMT was designed to be able to perform several specific functions, i.e. a) ability to harvest FFB automatically by hydraulic robotic arm's component; b) ability to scan and determine the ripe or unripe fruit and determine the precise position to cut the ripe fruit by using a scanner and camera located at both side of an adjustable chainsaw; c) able to hold and bring the harvested fruit into the trailer by using crane grapple; d) ability to depositing fertilizer and pesticide on both sides of SOPMT automatically by using an automatic spreader located under SOPMT's body; e) easy to operate; f) good manoeuvrability on uneven surface; g) durability insulator material protect the control chamber from an unexpected electric shock event. The schematic views of SOPMT is presented in Figure 1 while Figure 2 shows the prototype view of SOMPT.





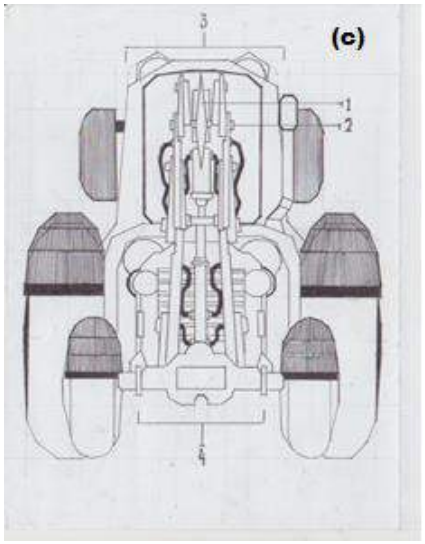


Figure 1. Schematic of (a) side, (b) top, and (c) top views of SOMPT (Prototype).

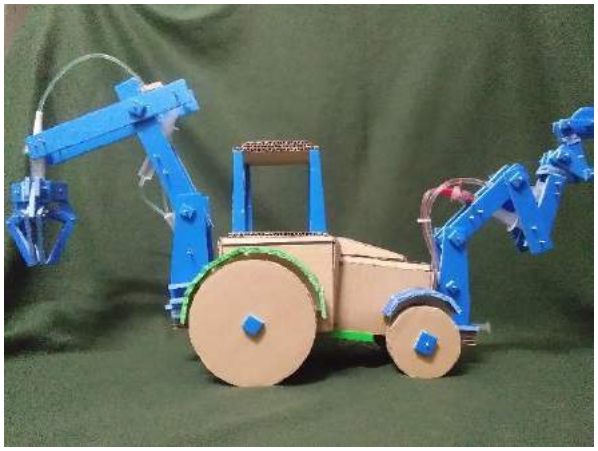
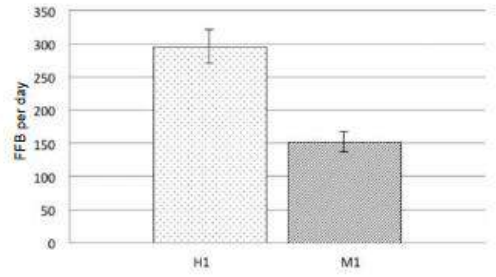


Figure 2. Prototype view of SOMPT.

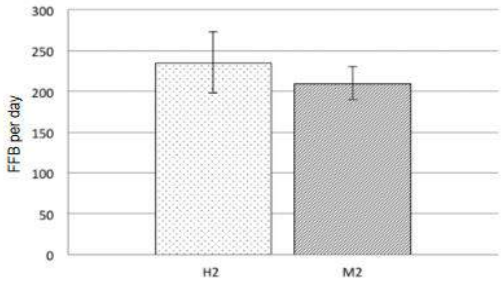
Advantages of SOMPT

The design and functions of SOMPT will speed up the harvesting activity and reduce the time for evacuating the FFB to the factory within or less than 24 hours which could maintain the quality of the FFB. According to Khalid and Shuib (2014), statistic has shown the comparison of detached fruits between the mechanical and manual harvesting methods which can be used to show the benefit of the application of mechanization in this industry. This have been reflected in Figures 3 and 4.



Note: FFB – fresh fruit bunch.

Figure 3. Average productivity per day for a complete harvesting machine with bucket (H1) and manual harvesting with a transportation-buffalo cart (M1).



Note: FFB – fresh fruit bunch.

Figure 4. Average productivity per day for the cutting only harvesting machine without a bucket (H2) and manual harvesting without transportation (M2).

Many of the oil palm farmers and labours neglect to follow the safety rules such as wear the safety helmet, safety boot and glove during harvesting activity with an excuse that all those things will affect work's concentration. Considering that, SOMPT also has been design to prevent injured when unexpected event happen and provide more safety and comfortable work environment to the workers.

Disadvantages of SOMPT

SOMPT has disadvantages too. Firstly, SOMPT can be very expensive to purchase by the small oil palm companies and farmers. To solve this problem, the government or related authorities should help with approving the loan or help them to make an investment. Secondly, it can be very dangerous if operated by unskilled operators. Therefore, the companies have to make sure that operators are well trained and hold the certification to operate the SOMPT.

Conclusions

The oil palm's researcher and authorities need to help and assure that the palm oil industries could sustain, go further and could bring maximum profits to the country. One of practical measured could be taken is through the improvement of efficiency at the field work, productivity and management system involving such as by enhancing the mechanization in fertilizing, weeding and replanting. SOMPT provide great potential to replace the conventional harvesting techniques that have a lot of flows and loose. Operational competency and management costs are factors that need to emphasize and not just depend on the market price to maximize profits in the production of FFB. The important role of hydraulic robotic arm's component that located at the front of SOMPT is suitable to harvest FFB automatically without using of human workload which will minimize the time required in harvesting FFB and improve processing of FBB less than 24 hours which also will enhance producing of oil extraction rate. Furthermore, it also could reduce the cost of hiring extra labours.

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