

Auto Guided Oil Palm Planter by using multi-GNSS

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Abstract. Planting is one of the most important operations in plantation because it could affect the total area of productivity since it is the starting point in cultivation. In oil palm plantation, lining and spacing of oil palm shall be laid out and coincided with the topographic area and a system of drains. Conventionally, planting of oil palm will require the polarization process in order to prevent and overcome the lack of influence of the sun rise and get a regular crop row. Polarization is done after the completion of the opening area by using the spike wood with 1 m length painted at the top and 100 m length of wire. This process will generally require at least five persons at a time to pull the wire and carry the spikes while the other two persons will act as observer and spikes craftsmen respectively with the ability of the team is 3ha/day. Therefore, the aim of this project is to develop the oil palm planting technique by using multi-GNSS (Global Navigation Satellite System). Generally, this project will involve five main steps mainly; design of planting pattern by using SOLIDWORKS software, determine the boundary coordinate of planting area, georeference process with ArcGIS, stakeout process with Tracy software and finally marking up the location with the wooden spikes. The results proved that the multi- GNSS is capable to provide the high accuracy with less than 1 m in precise positioning system without augmentation data. With the ability of one person, time taken to complete 70 m x 50 m planting area is 290 min, which is 25 min faster than using GPS (Global Positioning System) only.

1. Introduction

Oil palm cultivation in Malaysia began in 1917 and accelerated during the last 50 years through large-scale investments to become one of the approved crops for diversifying the country's agricultural development. As reported by MPOB [1], Malaysia has become one of the largest producers and exporters of oil palm in the world with the total of 4.69 million ha oil palm planted area in 2009. Due to this high demand and preference of oil palm, new technology should be implemented to facilitate the planting activities within a huge area of plantation.

Turner and Gillbanks [2] mentioned that there are several operational activities that involve in oil palm transplanting which are preparations of planting holes, placement of seedling in the prepared hole, covering the seedling in prepared hole and compaction of the soil around the planted seedling. Prior to the planting operation, planting points need to be identified and marked precisely in the plantation field before preparing the planting hole by using a hoe or mechanized drill. Darius et al. [3] stated that these present practices are very laborious and impose extensive stress to the field workers



and thus become an unattractive job for others to pursuit. According to Basiron [4], almost all field operations in the plantation could be mechanized with the exception to the cutting operation of fresh fruit bunches. Hence, efforts to promote mechanization have to be made in order to combat the problem of labor shortages in plantation and also to maintain production.

1.1. Oil palm planting pattern

Desa et al. [5] suggested that planting pattern must make optimum use of space per hectare and at the same time be of optimal economic density which would minimize the competition between palms for nutrients to ensure high productivity. Generally, oil palm is planted in triangular system at spacing of 9 x 9 x 9 m accommodating 143 plants per ha. Hartley [6] proposed a palm spacing of 7.5 to 10 m in a triangular arrangement to give total number of 115 and 205 palms per ha.

The planting rows run north to south and the palm in one row will not be opposite the palm in adjacent row. The line from each palm to the nearest palm in the adjacent row will make an angle of 60° with the row and the distance between rows will be less than planting distance. According to Siamak [7], this triangular orientation and planting arrangement ensures maximum sunlight falls on the individual palms.

1.2. Conventional method in planting the oil palm

Contemporary techniques and technologies employed by the plantation industries in the planting and replanting of oil palm seedlings are very laborious and time consuming. Referring to Basiron [8], oil palm planting is preceded by preparation of the land, which may be previously logged-over areas alienated for agricultural use, old oil palms stands or areas once planted with rubber or cocoa. The places to plant the oil palm seedlings need to be pegged out carefully in order to provide an evenly spaced of oil palms and to achieve the optimum stand per ha for systematic irrigation and further harvesting.

Presently, the pegging out process is usually commenced soon after the completion of land preparation or one to two months prior to seedlings being planted in the plantation area by using wooden spike with 1 m length painted at the top and 100 m length of wire. This process will generally require at least five persons at a time to pull the wire and carry the spikes while the other two persons will act as observers with the ability of the team is 3 ha/day. For a huge plantation area, the theodolite is used to determine the angle, horizontal distance and to fix the planting points. This method has created a lot of problems at which it will consume a lot of time and also the high cost is required for the labour wages, equipment and overall activity.

Therefore, the purpose of the present study was to develop a standardised procedure of planting the oil palm by reducing the time for planning, lining, alignment and labour workforce. Field testing has been carried out to evaluate the accuracy, availability and also the reliability of multi-GNSS which comprise of GPS (Global Positioning System) from United States and GLONASS (Global Navigation Satellite System) from Russia.

2. Materials and method

2.1. Equipment

The study area was conducted at Plot Industrial Crops Plot, Universiti Putra Malaysia at latitude 2°59'N and longitude of 101°43'E which covers an area of about 70 m x 50 m. The main equipment that was used throughout this research study was JAVAD GrAnt Antenna, JAVAD Sigma Receiver and also JAVAD Victor with Tracy software installed.

JAVAD GrAnt antenna is a versatile high performance antenna that has the capability to track not only GPS but also GLONASS, Galileo, Compass, WAAS (Wide Area Augmentation System), EGNOS (European Geostationary Navigation Overlay Service), MSAS (Multi-Functional Satellite Augmentation System) and also QZSS (Quasi-Zenith Satellite System) signals. JAVAD Victor on the

other hand is a handheld controller that is equipped with Tracy software, comprehensive field software to control the receiver, automate GNSS post processing surveying task, performing RTK (Real-Time Kinematic) survey and to perform the stakeout tasks. For this study this controller was used locate the oil palm planting point precisely. So far, only two satellites systems are available in this Tracy software which is GPS L1 + L2 and also GLONASS L1 + L2.

2.2. Procedure

To start the experiment, the oil palm planting pattern was sketched predominantly by using SOLIDWORKS software. For this case, triangular planting pattern was chosen as it can provide the most optimum density per hectare with the distance between each oil palm was 9 m. The boundary coordinates of the planting area were then determined by using JAVAD Victor for further georeferencing and rectifying process in ArcGIS software. Georeferencing process will enable us to obtain the coordinates of each planting points by only adding the boundary point coordinates of the planting area.

After each coordinates of the planting point was identified in ArcGIS software, it was then exported to JAVAD Victor for navigating to a certain planting point. Once the target point has been determined, the survey process was carried out to specify the coordinates of the new point and the wooden spikes were staked out onto the ground to mark out the surveyed point. The distance difference between the surveyed points and designed points were then computed by using CoGo tab (Direct Transverse) in Tracy software that gave the readings of horizontal, vertical and also the slant distance between both coordinates.



Figure 1. Survey process to the target planting point by using JAVAD Victor.



Figure 2. Wooden spikes that were staked out onto the ground to mark the surveyed points.

3. Results and discussion

Table 1 below shows the summarize result for the availability, accuracy and time taken during the field test. The results showed that the number of satellite available during the field test for GPS only was about 5-6 SVs while, multi-GNSS obtained about 13-14 SVs, which is more than double. The standard deviation of the point by using GPS was about 1.013 m and 0.715 m when using multi-GNSS. This really proved that multi-GNSS is capable enough to provide more satellite availability compared to GPS only. For this study, the accuracy of the satellite system is determined by the average offline distance deviated from the designed points. Without any correction, the average offline distance for GPS was 0.9952 m while, multi-GNSS was 0.5375 m. This shows that multi-GNSS will provide higher accuracy than GPS. Time to complete the navigation process was 5 hrs 15 min when

using GPS and 4hrs 50 min when using multi-GNSS. The longer time taken might be due to the low availability of GPS to acquire satellite signals.

Table 1. Summarize results of the accuracy, availability and time taken for Multi-GNSS and GPS.

	Multi-GNSS	GPS
Number of satellite	13-14	5-6
Standard deviation (m)	0.715	1.103
Average offline distance (m)	0.995	0.538
Time taken (minutes)	290	315

Figure 3 below on the other hand shows the oil palm planting pattern designed with SOLIDWORKS software and the target points navigated with Multi-GNSS and GPS. The pattern produced shows that the navigation with multi-GNSS could still produce the planting point in straight line even though the average offline distance was still high (0.538 m). Compared to GPS, the planting points are scattered within the planting area due to the loss of continuity. This is because most of the time GPS simply stops working and cannot broadcast the signals to compute the planting position and hence, will lead to longer time taken to complete all 40 surveyed points.

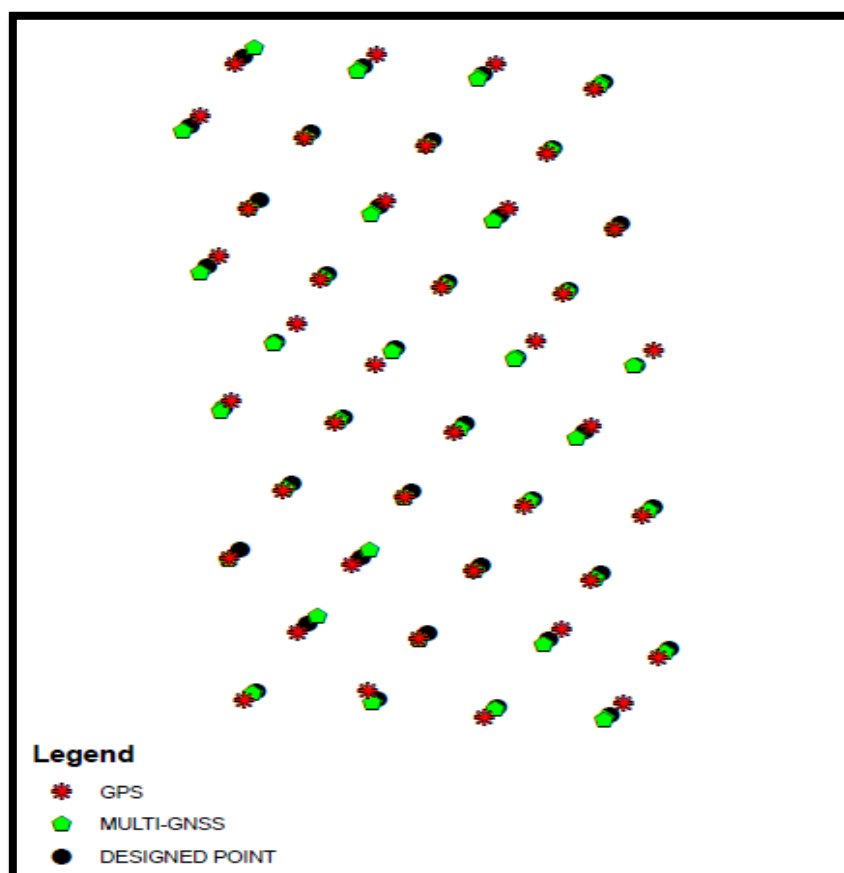


Figure 3. Comparison of designed and target planting point navigated by using GPS and multi-GNSS.

4. Conclusion

Overall, it can be concluded that Multi-GNSS could be adapted as a new technology in planting the oil palm without the requirement for planning, lining and alignment activities. It can also be proven that the multi-GNSS is capable to provide a high accuracy with less than 1 m in precise positioning system without any augmentation data with the minimum labour workforce. This result could be improved further if more satellites systems are available in Tracy software and configuration to JAVAD Victor is made to obtain the correction from the base station. However, at the huge plantation area, adapting this standard procedure would promise a great achievement in time management, proceeding benefit and as well as the efficiency of agricultural activities. Using multi-GNSS positioning is very current and will continue to grow in intensity as it will become a crucial element in increasing profit of agriculture field.

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