# Model of Autonomous Unmanned On-Road and Aerial Vehicle

*by* Ali Khumaidi

---

**PAPER · OPEN ACCESS**

# Model of Autonomous Unmanned On-Road and Aerial Vehicle Carriers For Precision Agricultural Transport 4.0 : A Literature Review

To cite this article: I Afrianto *et al* 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **879** 012019

View the article online for updates and enhancements.

# Model of Autonomous Unmanned On-Road and Aerial Vehicle Carriers For Precision Agricultural Transport 4.0 : A Literature Review

**I Afrianto[1*], A Khumaidi [2], Adriyendi[3]**
[1] Program Studi Teknik Informatika, Universitas Komputer Indonesia, Indonesia
[2] Program Studi Teknik Informatika , Universitas Krisnadwipayana, Indonesia
[3] Program Studi Manajemen Informatika, IAIN Batusangkar, Indonesia


Email: *irawan.afrianto@email.unikom.ac.id

**Abstact.** The purpose of this study is to build a model of conveyance using unmanned land vehicles and unmanned aerial vehicles as transport vehicles on oil palm plantations. The method used in this study is a literature review on studies relating to unmanned vehicles, their potential and role in the future. One of the things that can be utilized from unmanned vehicles is the automation process of transporting goods from one place to another. In this study, unmanned vehicles are used to transport oil palm from plantations and bring it to the palm processing plant. The results of this study is a model that illustrates the use of unmanned vehicles for the automation of transporting oil palm on plantations. By utilizing this unmanned vehicle, it is hoped that the process of palm oil products will be faster, more accurate and precise in the process of transporting it from the plantation to the processing plant.

## 1. Introduction

Indonesia is the biggest producer of palm oil in the world. Most people would already know that palm oil is the main raw material for cooking oil. Even though palm oil is not only processed into cooking oil, it can also be processed into other products, one of which is soap. No wonder that most people are indirectly dependent on palm oil. This also makes palm oil the most important commodity in Indonesia. At present, there have been many oil palm cultivation in several places in Indonesia. The concept of oil palm cultivation is mainly in the form of vast plantations. Even some oil palm plantations in Indonesia are managed by private parties and community plantations, but not a few of them come from the government with details of community plantations around 6.77 million hectares, private plantations 8.56 million hectares, and state or government ownership reaches 1,05 million hectares [1] . Demand from processed palm oil has increased every year, and this also has an impact on expanding the area of oil palm plantations. As of October 2019, the total land area for oil palm in Indonesia is around 16.38 million hectares. Even so, not all of Indonesia's land area is suitable for oil palm plantations. The islands of Sumatra and Kalimantan are good places to do palm oil processing [2].

The Industrial Revolution 4.0 has raised the role of technology in accelerating, facilitating, and making work operations more precise. The role of mobile technology, wireless technology, as well as the internet for storing and processing large data can help agriculture improve quality and operations [3]. The role of unmanned vehicles both on land and in the air is one of the future solutions in an industry. This is because of the efficiency that can be obtained by operating these unmanned vehicles [4] [5]. Broader network technology has also led to wireless network technologies such as Long Range (LoRa) technology. LoRa is proposed because it has the right characteristics for developing an IoT-based

system. LoRa is a wireless communication system for the Internet of Things, offering long distance communication (> 15 km in remote areas) and low power (5-10 years) [6], but it also has limited data transmission with a relatively small size of 0.3 - 50 kbps and data size of 10-20 bytes [7]. Drones have the potential to be integrated with the environment and human life, modes of transportation and social systems [8]. Utilization of unmanned vehicles such as drones is a potential that is possible in the agricultural industry, especially in remote sensing activities such as land mapping [9, 10]. The use of drones in oil palm plantations is used as a tool to calculate and identify oil palm plants [11,12]. Drones as a conveyance make it possible to carry various kinds of commodities for various purposes, such as for transporting air quality samples [13] and blood products [14]. In addition, the use of robots and land transport vehicles is a solution that can be used as part of digital agriculture and plantations to increase the effectiveness of work in the plantation environment [15, 16]. This needs to be supported by data communication that is able to transmit data over great distances, bearing in mind that vast plantations require technology such as LoRa to result in the integration of data communication between entities across a wide area of land [17,18].

The purpose of this study is to create a model of conveyance using unmanned and aerial vehicles and utilize LoRa technology as a data communication medium, in order to produce an overview of technology that can be applied to the production activities of oil palm plantations so as to produce a precision system in the future.

## 2. Method

This study uses the literature review method to see the potential of alternative technologies that can be used in an oil palm plantation environment. The next stage is to analyze the potential of the technology which will be developed into a model that is proposed as an alternative solution in the oil palm plantation environment. The research flow is shown in Figure 1.
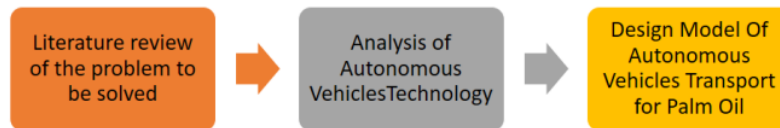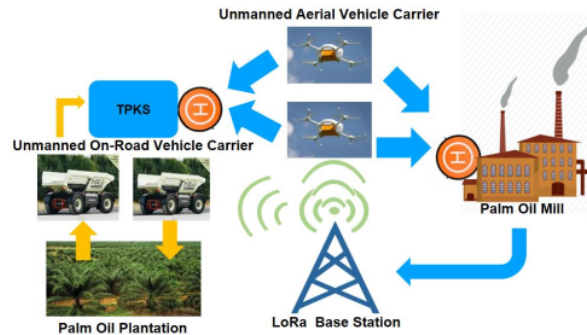


**Figure 1.** Research method
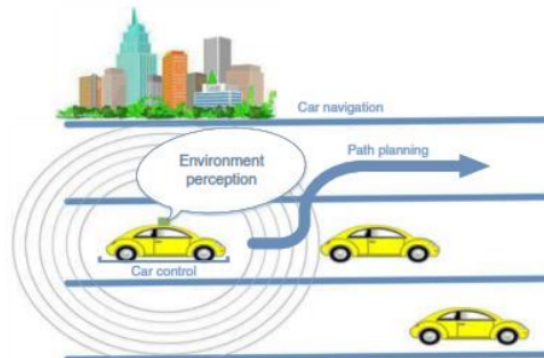
## 3. Results and Discussion

Unmanned transport vehicles are haulers that are controlled or implanted with artificial intelligence to be able to recognize and understand their environmental situations [19]. This transport vehicle can be used as transportation for palm oil from the plantation to the mill. The solution offered is a model that integrates land transport (for gardening to TPKS), and air transport (drones) to transport palm from TPKS to processing plants. Long distance and centralized control require a reliable remote connection network. LoRa was chosen because it has the ability to transmit long distances, control capabilities on the conveyance and fast data transmission into the system. Model of unmanned ground and air transport vehicles is shown in Figure 2.

**Figure 2.** Autonomous Vehicle Architectural Model for Palm Oil Processing

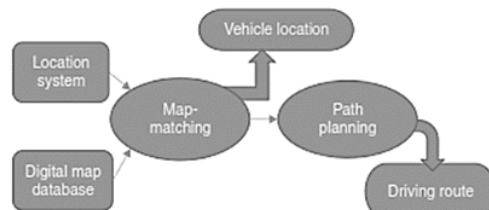### 3.1 Vehicle Movement Mechanism

An autonomous vehicle or self-driving vehicle is a form of vehicle that includes automatic control, artificial intelligence, image processing, pattern recognition and intelligent automatic control [20]. The vehicle movement mechanism can be seen in Figure 3.



**Figure 3.** Classification of unmanned vehicles

The important things in controlling unmanned vehicles are as follows (Figure 4):

1.  Navigation system: the problems brought are the vehicle's initial position and the objectives to be achieved. The use of GPS that has a position (longitude and latitude) can be a solution for this vehicle's mitigation system. As well as the existence of lane search algorithms such as Djikstra can be used to direct vehicles from origin to destination.
2.  Location system: the location system is used to determine the location of the vehicle where this location can be relative, fixed and hybrid location.
3.  Electronic Maps: used to store additional information such as geographical information, traffic information, buildings, traffic signs, road facilities, and so on.
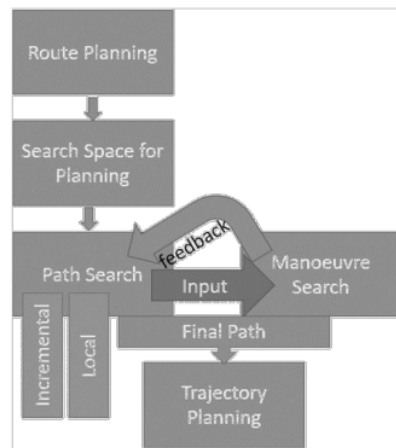


**Figure 4.** Unmanned Vehicle Location Systems

Software is the main driving factor underlying autonomy in which the planning algorithm responsible for important decision making holds an important position. While transporting passengers or goods from a certain origin to a particular destination, the motion planning method combines the search for the road to be followed, avoiding obstacles and producing the best path that guarantees safety, comfort, and efficiency [21].

*3.2 Lane Search for Unmanned Vehicles*
The movement of an unmanned vehicle starts from the planning of the vehicle's movement, methods that can be used for movement planning include route planning, path planning, maneuver planning, and trajectory planning [21]. The vehicle movement planning mechanism can be seen in Figure 5.



**Figure 5.** The Unmanned Vehicle Motion Planning Model

*3.3 Autonomous Vehicles Model of Oil Palm*
The unmanned vehicle model used as a solution to the problem in oil palm plantations consists of 2 parts, namely the transport vehicle from the plantation to the TPKS and from the TPKS to the palm oil processing factory. The first sub-system is the Palm oil transport vehicle from the plantation to the TPKS. The number of transport vehicles is more than 1 with a uniform pattern, lane, and a predetermined schedule for each vehicle that is centrally controlled from the palm oil mill through the LoRa network. The Model of Unmanned Land Transport Vehicle can be seen in Figure 6.
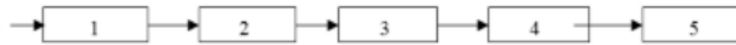


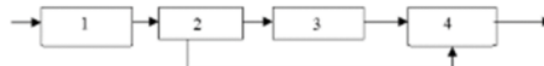**Figure 6.** Model of Unmanned Land Transport Vehicle

For scheduling transport vehicles using the flow shop method. Flow Shop is the process of determining the order of work that has the same or nearly the same product path. Basically there are several types of flow shop patterns, including: (a) Pure Flow Shop (See Figure 7), Flow shop that has

the same production line for all tasks. The machine is arranged according to the existing process flow where a job is required to undergo one process for each condition. (b) General Flow Shop (See Figure 8) has a different flow pattern, where the General Flow Shop flow pattern has the characteristics: Process flow always shows the direction to the right, the sequence of operations may not be sequential, no reverse flow is allowed [22].
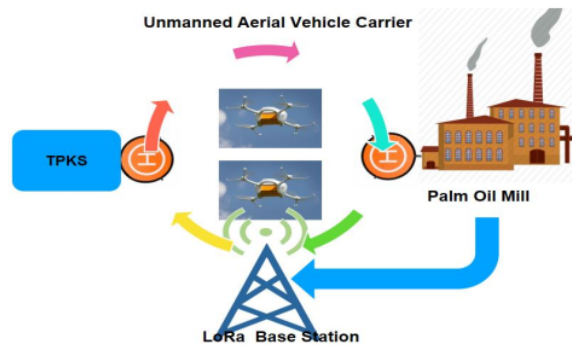


**Figure 7.** Pure Flow Shop Work Flow



**Figure 8.** General Flow Shop Work Flow

The second sub-system is the palm oil transport vehicle from the TPKS to the palm oil mill. The number of transport vehicles (drones) used is more than 1 with a uniform pattern, lane and schedule that has been determined on each vehicle that is centrally controlled from the palm oil mill through the LoRa network. The Unmanned Aerial Vehicle Transport Model can be seen in Figure 9.



**Figure 9.** The Unmanned Aerial Vehicle Transport Model

The use of drones to transport oil to palm mills is an alternative solution to reduce congestion, reduce labor and speed of delivery [23]. The scheduling process certainly requires a new model in controlling drone movements. Setting the shortest distance and the trajectory of the movement using the method of traveling saleman problem (TSP). Where by applying the TSP on the drone, the path taken from the place of origin (palm oil mill) to return to the palm oil mill is the optimal path. The scheduling of the drones is made by taking into account the flow shop work flow, while the need to handle the long flying capability, battery charging and the transporting power of the drone [24] to carry the palm. Development towards big data systems and plantation data mining is necessary [25] while the development of management systems can be realized in the form of information systems based on web technology and mobile applications [26, 27] and based on augmented reality visualization [28].

## 4. Conclusion
The proposed model is an alternative model for the transportation of oil palm commodities from the plantation to the palm oil processing factory. The proposed model uses 2 types of unmanned conveyance vehicles on land and in the air. Proper scheduling is needed to schedule these transport vehicles to work optimally. Methods such as flow shop and TSP can be used to handle vehicle scheduling problems,

while problems related to battery charging, natural conditions need to be added as advanced parameters to optimize the operation of the conveyance.

**References**

[1] Palm Oil Production by Country in 1000 MT - Country Rankings. 2019. [Online]. Available: https://www.indexmundi.com/agriculture/?commodity=palm-oil.

[2] Lestari, I. Inilah 7 Daerah Penghasil Kelapa Sawit Terbesar Di Indonesia. IlmuGeografi.com. 2019 [Online]. Available: https://ilmugeografi.com/ilmu-sosial/daerah-penghasil-kelapa-sawit-terbesar-di-indonesia.

[3] Abdullah, I., Dahlan, A. and Rahman, A., 2015. The transformation of an agriculture to an industrial-based economy through crowd sourcing in Malaysia. *International Journal of Computer Science and Information Technology Research*, **3**(1), pp.34-41.

[4] Sanders, A.W., 2017. Drone swarms. US Army School for Advanced Military Studies Fort Leavenworth United States.

[5] Habibie, N., Nugraha, A.M., Anshori, A.Z., Ma'sum, M.A. and Jatmiko, W., 2017. Fruit mapping mobile robot on simulated agricultural area in Gazebo simulator using simultaneous localization and mapping (SLAM). *In 2017 International Symposium on Micro-NanoMechatronics and Human Science (MHS)* (pp. 1-7). IEEE.

[6] Augustin, A., Yi, J., Clausen, T. and Townsley, W. 2016. A study of LoRa: Long range & low power networks for the internet of things. *Sensors*, **16**(9), p.1466.

[7] Sinha, R.S., Wei, Y. and Hwang, S.H., 2017. A survey on LPWA technology: LoRa and NB-IoT. *Ict Express, 3(1)*, pp.14-21.

[8] Applin, S.A., 2016. Deliveries by Drone: Obstacles and Sociability. In *the Future of Drone Use* (pp. 71-91). TMC Asser Press, The Hague.

[9] Rokhmana, C.A., 2015. The potential of UAV-based remote sensing for supporting precision agriculture in Indonesia. *Procedia Environmental Sciences*, **24**, pp.245-253.

[10] Lu, B. and He, Y., 2017. Species classification using Unmanned Aerial Vehicle (UAV)-acquired high spatial resolution imagery in a heterogeneous grassland. *ISPRS Journal of Photogrammetry and Remote Sensing*, **128**, pp.73-85.

[11] Aliero, M.M., Mukhtar, N.R.B. and Al-Doksi, J., 2014. The Usefulness of Unmanned Airborne Vehicle (UAV) Imagery for Automated Palm Oil Tree Counting. In *Journal of Forestry. Researchjournali* (1)-1.

[12] Wang, Y., Zhu, X. and Wu, B., 2019. Automatic detection of individual oil palm trees from UAV images using HOG features and an SVM classifier. *International Journal of Remote Sensing*, **40**(19), pp.7356-7370.

[13] Ruiz-Jimenez, J., Zanca, N., Lan, H., Jussila, M., Hartonen, K. and Riekkola, M.L., 2019. Aerial drone as a carrier for miniaturized air sampling systems. *Journal of Chromatography A*, **1597**, pp.202-208.

[14] Amukele, T., Ness, P.M., Tobian, A.A., Boyd, J. and Street, J., 2017. Drone transportation of blood products. *Transfusion*, **57**(3), pp.582-588.

[15] Shamshiri, R.R., Weltzien, C., Hameed, I.A., J Yule, I., E Grift, T., Balasundram, S.K., Pitonakova, L., Ahmad, D. and Chowdhary, G., 2018. Research and development in agricultural robotics: A perspective of digital farming. *Int J Agric & Biol Eng*, **11**(4), pp.1-14.

[16] Juman, M.A., Wong, Y.W., Rajkumar, R.K. and H'ng, C.Y., 2017. An integrated path planning system for a robot designed for oil palm plantations. In *TENCON 2017-2017 IEEE Region 10 Conference* (pp. 1048-1053). IEEE.

[17] Tapashetti, S. and Shobha, K.R., 2018. Precision Agriculture using LoRa. *Int. J. Sci. Eng. Res*, **9**(5).

[18] Adiono, T., Dawani, F., Rifai, A., Fuada, S. and Purwanda, I.G., 2018, October. Functionality test of communication systems based on Lora technology in oil palm plantations area. In *2018 International Conference on ICT for Rural Development (IC-ICTRuDev)* (pp. 18-22). IEEE.

[19] Badue, C., Guidolini, R., Carneiro, R.V., Azevedo, P., Cardoso, V.B., Forechi, A., Jesus, L.F.R., Berriel, R.F., Paixão, T.M., Mutz, F. and Oliveira-Santos, T. 2019. Self-driving cars: A survey. arXiv preprint arXiv:1901.04407.

[20] Zhao, J., Liang, B. and Chen, Q. 2018. The key technology toward the self-driving car. *International Journal of Intelligent Unmanned Systems*, **6**(1), pp.2-20.

[21] Katrakazas, C., Quddus, M., Chen, W.H. and Deka, L. 2015. Real-time motion planning methods for autonomous on-road driving: State-of-the-art and future research directions. *Transportation Research Part C: Emerging Technologies*, **60**, pp.416-442.

[22] Sonata, F., 2015. Sistem Penjadwalan Mesin Produksi Menggunakan Algoritma Johnson dan Campbell. *Jurnal Buana Informatika*, **6**(3).pp. 172-182.

[23] Agatz, N., Bouman, P. and Schmidt, M. 2018. Optimization approaches for the traveling salesman problem with drone. *Transportation Science*, **52**(4), pp.965-981.

[24] Hong, I., Kuby, M. and Murray, A.T. 2018. A range-restricted recharging station coverage model for drone delivery service planning. *Transportation Research Part C: Emerging Technologies*, **90**, pp.198-212.

[25] Pratama, Y.R., Atin, S. and Afrianto, I. 2019. Predicting Student Interests Against Laptop Specifications Through Application of Data Mining Using C4. 5 Algorithms. In *IOP Conference Series: Materials Science and Engineering* **662**(2)p. 022129. IOP Publishing.

[26] Heryandi, A. and Afrianto, I. 2019. Online Diploma Supplement Information System Modelling for Indonesian Higher Education Institution. In *IOP Conference Series: Materials Science and Engineering* **662**(2), p. 02209. IOP Publishing.

[27] Afrianto, I. and Guntara, R.G. 2019. Implementation of User Centered Design Method in Designing Android-based Journal Reminder Application. In *IOP Conference Series: Materials Science and Engineering* **662**(2), p. 022029. IOP Publishing.

[28] Afrianto, I., Faris, A.F. and Atin, S. 2019. Hijaiyah Letter Interactive Learning for Mild Mental Retardation Children using Gillingham Method and Augmented Reality. *technology*, **10**(6).

# Model of Autonomous Unmanned On-Road and Aerial Vehicle

# Model of Autonomous Unmanned On-Road

*by* sky high

**PAPER · OPEN ACCESS**

# Model of Autonomous Unmanned On-Road and Aerial Vehicle Carriers For Precision Agricultural Transport 4.0 : A Literature Review

View the article online for updates and enhancements.

# Model of Autonomous Unmanned On-Road and Aerial Vehicle Carriers For Precision Agricultural Transport 4.0 : A Literature Review

I Afrianto[1], A Khumaidi [2], Adriyendi[3]

[1] Program Studi Teknik Informatika, Universitas Komputer Indonesia, Indonesia
[2] Program Studi Teknik Informatika , Universitas Krisnadwipayana, Indonesia
[3] Program Studi Manajemen Informatika, IAIN Batusangkar, Indonesia

Email: *irawan.afrianto@email.unikom.ac.id

**Abstact.** The purpose of this study is to build a model of conveyance using unmanned land vehicles and unmanned aerial vehicles as transport vehicles on oil palm plantations. The method used in this study is a literature review on studies relating to unmanned vehicles, their potential and role in the future. One of the things that can be utilized from unmanned vehicles is the automation process of transporting goods from one place to another. In this study, unmanned vehicles are used to transport oil palm from plantations and bring it to the palm processing plant. The results of this study is a model that illustrates the use of unmanned vehicles for the automation of transporting oil palm on plantations. By utilizing this unmanned vehicle, it is hoped that the process of palm oil products will be faster, more accurate and precise in the process of transporting it from the plantation to the processing plant.

## 1. Introduction

Indonesia is the biggest producer of palm oil in the world. Most people would already know that palm oil is the main raw material for cooking oil. Even though palm oil is not only processed into cooking oil, it can also be processed into other products, one of which is soap. No wonder that most people are indirectly dependent on palm oil. This also makes palm oil the most important commodity in Indonesia. At present, there have been many oil palm cultivation in several places in Indonesia. The concept of oil palm cultivation is mainly in the form of vast plantations. Even some oil palm plantations in Indonesia are managed by private parties and community plantations, but not a few of them come from the government with details of community plantations around 6.77 million hectares, private plantations 8.56 million hectares, and state or government ownership reaches 1,05 million hectares [1] . Demand from processed palm oil has increased every year, and this also has an impact on expanding the area of oil palm plantations. As of October 2019, the total land area for oil palm in Indonesia is around 16.38 million hectares. Even so, not all of Indonesia's land area is suitable for oil palm plantations. The islands of Sumatra and Kalimantan are good places to do palm oil processing [2].

The Industrial Revolution 4.0 has raised the role of technology in accelerating, facilitating, and making work operations more precise. The role of mobile technology, wireless technology, as well as the internet for storing and processing large data can help agriculture improve quality and operations [3]. The role of unmanned vehicles both on land and in the air is one of the future solutions in an industry. This is because of the efficiency that can be obtained by operating these unmanned vehicles [4] [5]. Broader network technology has also led to wireless network technologies such as Long Range (LoRa) technology. LoRa is proposed because it has the right characteristics for developing an IoT-based

system. LoRa is a wireless communication system for the Internet of Things, offering long distance communication (> 15 km in remote areas) and low power (5-10 years) [6], but it also has limited data transmission with a relatively small size of 0.3 - 50 kbps and data size of 10-20 bytes [7]. Drones have the potential to be integrated with the environment and human life, modes of transportation and social systems [8]. Utilization of unmanned vehicles such as drones is a potential that is possible in the agricultural industry, especially in remote sensing activities such as land mapping [9, 10]. The use of drones in oil palm plantations is used as a tool to calculate and identify oil palm plants [11,12]. Drones as a conveyance make it possible to carry various kinds of commodities for various purposes, such as for transporting air quality samples [13] and blood products [14]. In addition, the use of robots and land transport vehicles is a solution that can be used as part of digital agriculture and plantations to increase the effectiveness of work in the plantation environment [15, 16]. This needs to be supported by data communication that is able to transmit data over great distances, bearing in mind that vast plantations require technology such as LoRa to result in the integration of data communication between entities across a wide area of land [17,18].

The purpose of this study is to create a model of conveyance using unmanned and aerial vehicles and utilize LoRa technology as a data communication medium, in order to produce an overview of technology that can be applied to the production activities of oil palm plantations so as to produce a precision system in the future.

## 2. Method

This study uses the literature review method to see the potential of alternative technologies that can be used in an oil palm plantation environment. The next stage is to analyze the potential of the technology which will be developed into a model that is proposed as an alternative solution in the oil palm plantation environment. The research flow is shown in Figure 1.
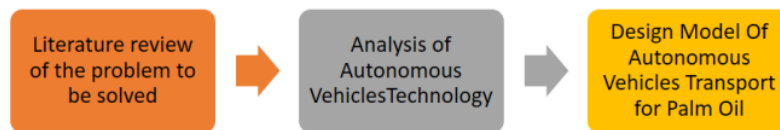


**Figure 1.** Research method

## 3. Results and Discussion

Unmanned transport vehicles are haulers that are controlled or implanted with artificial intelligence to be able to recognize and understand their environmental situations [19]. This transport vehicle can be used as transportation for palm oil from the plantation to the mill. The solution offered is a model that integrates land transport (for gardening to TPKS), and air transport (drones) to transport palm from TPKS to processing plants. Long distance and centralized control require a reliable remote connection network. LoRa was chosen because it has the ability to transmit long distances, control capabilities on the conveyance and fast data transmission into the system. Model of unmanned ground and air transport vehicles is shown in Figure 2.
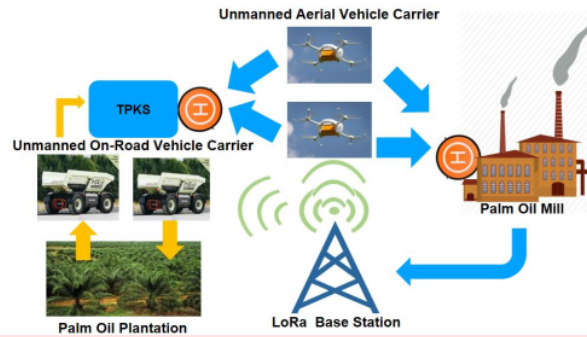
**Figure 2.** Autonomous Vehicle Architectural Model for Palm Oil Processing

*3.1 Vehicle Movement Mechanism*

An autonomous vehicle or self-driving vehicle is a form of vehicle that includes automatic control, artificial intelligence, image processing, pattern recognition and intelligent automatic control [20]. The vehicle movement mechanism can be seen in Figure 3.
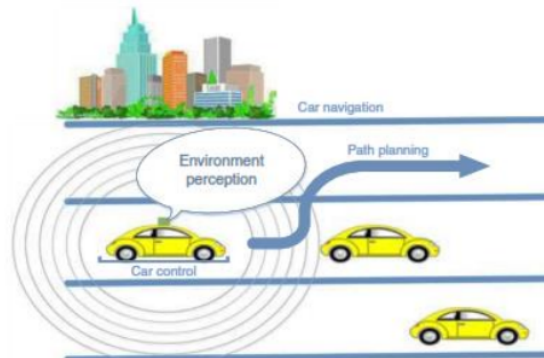


**Figure 3.** Classification of unmanned vehicles

The important things in controlling unmanned vehicles are as follows (Figure 4):

1. Navigation system: the problems brought are the vehicle's initial position and the objectives to be achieved. The use of GPS that has a position (longitude and latitude) can be a solution for this vehicle's mitigation system. As well as the existence of lane search algorithms such as Djikstra can be used to direct vehicles from origin to destination.
2. Location system: the location system is used to determine the location of the vehicle where this location can be relative, fixed and hybrid location.
3. Electronic Maps: used to store additional information such as geographical information, traffic information, buildings, traffic signs, road facilities, and so on.
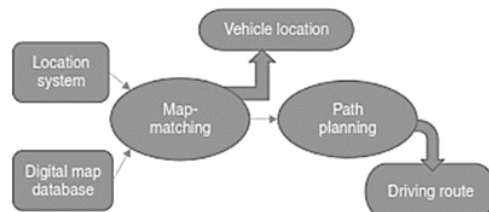


**Figure 4.** Unmanned Vehicle Location Systems

Software is the main driving factor underlying autonomy in which the planning algorithm responsible for important decision making holds an important position. While transporting passengers or goods from a certain origin to a particular destination, the motion planning method combines the search for the road to be followed, avoiding obstacles and producing the best path that guarantees safety, comfort, and efficiency [21].

### 3.2 Lane Search for Unmanned Vehicles

The movement of an unmanned vehicle starts from the planning of the vehicle's movement, methods that can be used for movement planning include route planning, path planning, maneuver planning, and trajectory planning [21]. The vehicle movement planning mechanism can be seen in Figure 5.
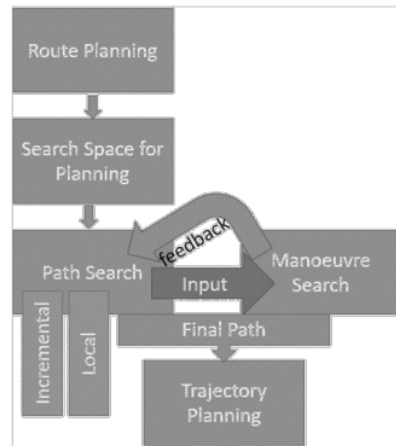


**Figure 5.** The Unmanned Vehicle Motion Planning Model

### 3.3 Autonomous Vehicles Model of Oil Palm

The unmanned vehicle model used as a solution to the problem in oil palm plantations consists of 2 parts, namely the transport vehicle from the plantation to the TPKS and from the TPKS to the palm oil processing factory. The first sub-system is the Palm oil transport vehicle from the plantation to the TPKS. The number of transport vehicles is more than 1 with a uniform pattern, lane, and a predetermined schedule for each vehicle that is centrally controlled from the palm oil mill through the LoRa network. The Model of Unmanned Land Transport Vehicle can be seen in Figure 6.



**Figure 6.** Model of Unmanned Land Transport Vehicle

For scheduling transport vehicles using the flow shop method. Flow Shop is the process of determining the order of work that has the same or nearly the same product path. Basically there are several types of flow shop patterns, including: (a) Pure Flow Shop (See Figure 7), Flow shop that has

the same production line for all tasks. The machine is arranged according to the existing process flow where a job is required to undergo one process for each condition. (b) General Flow Shop (See Figure 8) has a different flow pattern, where the General Flow Shop flow pattern has the characteristics: Process flow always shows the direction to the right, the sequence of operations may not be sequential, no reverse flow is allowed [22].

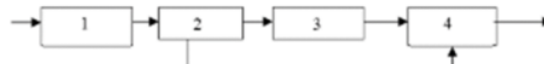**Figure 7.** Pure Flow Shop Work Flow

**Figure 8.** General Flow Shop Work Flow

The second sub-system is the palm oil transport vehicle from the TPKS to the palm oil mill. The number of transport vehicles (drones) used is more than 1 with a uniform pattern, lane and schedule that has been determined on each vehicle that is centrally controlled from the palm oil mill through the LoRa network. The Unmanned Aerial Vehicle Transport Model can be seen in Figure 9.
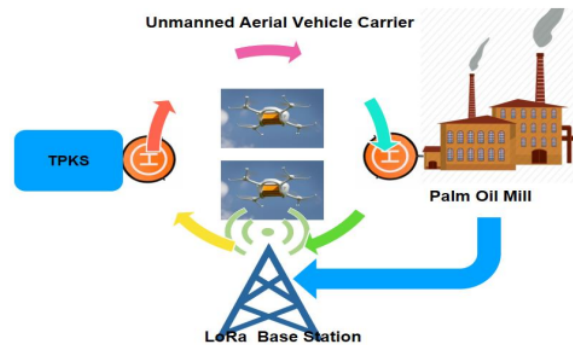
**Figure 9.** The Unmanned Aerial Vehicle Transport Model

The use of drones to transport oil to palm mills is an alternative solution to reduce congestion, reduce labor and speed of delivery [23]. The scheduling process certainly requires a new model in controlling drone movements. Setting the shortest distance and the trajectory of the movement using the method of traveling saleman problem (TSP). Where by applying the TSP on the drone, the path taken from the place of origin (palm oil mill) to return to the palm oil mill is the optimal path. The scheduling of the drones is made by taking into account the flow shop work flow, while the need to handle the long flying capability, battery charging and the transporting power of the drone [24] to carry the palm. Development towards big data systems and plantation data mining is necessary [25] while the development of management systems can be realized in the form of information systems based on web technology and mobile applications [26, 27] and based on augmented reality visualization [28].

## 4. Conclusion

The proposed model is an alternative model for the transportation of oil palm commodities from the plantation to the palm oil processing factory. The proposed model uses 2 types of unmanned conveyance vehicles on land and in the air. Proper scheduling is needed to schedule these transport vehicles to work optimally. Methods such as flow shop and TSP can be used to handle vehicle scheduling problems,

while problems related to battery charging, natural conditions need to be added as advanced parameters to optimize the operation of the conveyance.

## References

[1] Palm Oil Production by Country in 1000 MT - Country Rankings. 2019. [Online]. Available: https://www.indexmundi.com/agriculture/?commodity=palm-oil.

[2] Lestari, I. Inilah 7 Daerah Penghasil Kelapa Sawit Terbesar Di Indonesia. IlmuGeografi.com. 2019 [Online]. Available: https://ilmugeografi.com/ilmu-sosial/daerah-penghasil-kelapa-sawit-terbesar-di-indonesia.

[3] Abdullah, I., Dahlan, A. and Rahman, A., 2015. The transformation of an agriculture to an industrial-based economy through crowd sourcing in Malaysia. *International Journal of Computer Science and Information Technology Research*, **3**(1), pp.34-41.

[4] Sanders, A.W., 2017. Drone swarms. US Army School for Advanced Military Studies Fort Leavenworth United States.

[5] Habibie, N., Nugraha, A.M., Anshori, A.Z., Ma'sum, M.A. and Jatmiko, W., 2017. Fruit mapping mobile robot on simulated agricultural area in Gazebo simulator using simultaneous localization and mapping (SLAM). *In 2017 International Symposium on Micro-NanoMechatronics and Human Science (MHS)* (pp. 1-7). IEEE.

[6] Augustin, A., Yi, J., Clausen, T. and Townsley, W. 2016. A study of LoRa: Long range & low power networks for the internet of things. *Sensors*, **16**(9), p.1466.

[7] Sinha, R.S., Wei, Y. and Hwang, S.H., 2017. A survey on LPWA technology: LoRa and NB-IoT. *Ict Express, 3(1)*, pp.14-21.

[8] Applin, S.A., 2016. Deliveries by Drone: Obstacles and Sociability. In *the Future of Drone Use* (pp. 71-91). TMC Asser Press, The Hague.

[9] Rokhmana, C.A., 2015. The potential of UAV-based remote sensing for supporting precision agriculture in Indonesia. *Procedia Environmental Sciences*, **24**, pp.245-253.

[10] Lu, B. and He, Y., 2017. Species classification using Unmanned Aerial Vehicle (UAV)-acquired high spatial resolution imagery in a heterogeneous grassland. *ISPRS Journal of Photogrammetry and Remote Sensing*, **128**, pp.73-85.

[11] Aliero, M.M., Mukhtar, N.R.B. and Al-Doksi, J., 2014. The Usefulness of Unmanned Airborne Vehicle (UAV) Imagery for Automated Palm Oil Tree Counting. In *Journal of Forestry. Researchjournali* (1)-1.

[12] Wang, Y., Zhu, X. and Wu, B., 2019. Automatic detection of individual oil palm trees from UAV images using HOG features and an SVM classifier. *International Journal of Remote Sensing*, **40**(19), pp.7356-7370.

[13] Ruiz-Jimenez, J., Zanca, N., Lan, H., Jussila, M., Hartonen, K. and Riekkola, M.L., 2019. Aerial drone as a carrier for miniaturized air sampling systems. *Journal of Chromatography A*, **1597**, pp.202-208.

[14] Amukele, T., Ness, P.M., Tobian, A.A., Boyd, J. and Street, J., 2017. Drone transportation of blood products. *Transfusion*, **57**(3), pp.582-588.

[15] Shamshiri, R.R., Weltzien, C., Hameed, I.A., J Yule, I., E Grift, T., Balasundram, S.K., Pitonakova, L., Ahmad, D. and Chowdhary, G., 2018. Research and development in agricultural robotics: A perspective of digital farming. *Int J Agric & Biol Eng*, **11**(4), pp.1-14.

[16] Juman, M.A., Wong, Y.W., Rajkumar, R.K. and H'ng, C.Y., 2017. An integrated path planning system for a robot designed for oil palm plantations. In *TENCON 2017-2017 IEEE Region 10 Conference* (pp. 1048-1053). IEEE.

[17] Tapashetti, S. and Shobha, K.R., 2018. Precision Agriculture using LoRa. *Int. J. Sci. Eng. Res*, **9**(5).

[18] Adiono, T., Dawani, F., Rifai, A., Fuada, S. and Purwanda, I.G., 2018, October. Functionality test of communication systems based on Lora technology in oil palm plantations area. In *2018 International Conference on ICT for Rural Development (IC-ICTRuDev)* (pp. 18-22). IEEE.

[19] Badue, C., Guidolini, R., Carneiro, R.V., Azevedo, P., Cardoso, V.B., Forechi, A., Jesus, L.F.R., Berriel, R.F., Paixão, T.M., Mutz, F. and Oliveira-Santos, T. 2019. Self-driving cars: A survey. arXiv preprint arXiv:1901.04407.

[20] Zhao, J., Liang, B. and Chen, Q. 2018. The key technology toward the self-driving car. *International Journal of Intelligent Unmanned Systems*, **6**(1), pp.2-20.

[21] Katrakazas, C., Quddus, M., Chen, W.H. and Deka, L. 2015. Real-time motion planning methods for autonomous on-road driving: State-of-the-art and future research directions. *Transportation Research Part C: Emerging Technologies*, **60**, pp.416-442.

[22] Sonata, F., 2015. Sistem Penjadwalan Mesin Produksi Menggunakan Algoritma Johnson dan Campbell. *Jurnal Buana Informatika*, **6**(3).pp. 172-182.

[23] Agatz, N., Bouman, P. and Schmidt, M. 2018. Optimization approaches for the traveling salesman problem with drone. *Transportation Science*, **52**(4), pp.965-981.

[24] Hong, I., Kuby, M. and Murray, A.T. 2018. A range-restricted recharging station coverage model for drone delivery service planning. *Transportation Research Part C: Emerging Technologies*, **90**, pp.198-212.

[25] Pratama, Y.R., Atin, S. and Afrianto, I. 2019. Predicting Student Interests Against Laptop Specifications Through Application of Data Mining Using C4. 5 Algorithms. In *IOP Conference Series: Materials Science and Engineering* **662**(2)p. 022129. IOP Publishing.

[26] Heryandi, A. and Afrianto, I. 2019. Online Diploma Supplement Information System Modelling for Indonesian Higher Education Institution. In *IOP Conference Series: Materials Science and Engineering* **662**(2), p. 02209. IOP Publishing.

[27] Afrianto, I. and Guntara, R.G. 2019. Implementation of User Centered Design Method in Designing Android-based Journal Reminder Application. In *IOP Conference Series: Materials Science and Engineering* **662**(2), p. 022029. IOP Publishing.

[28] Afrianto, I., Faris, A.F. and Atin, S. 2019. Hijaiyah Letter Interactive Learning for Mild Mental Retardation Children using Gillingham Method and Augmented Reality. *technology*, **10**(6).

# Model of Autonomous Unmanned On-Road

**1** I Afrianto, A Khumaidi, Adriyendi. "Model of Autonomous Unmanned On-Road and Aerial Vehicle Carriers For Precision Agricultural Transport 4.0 : A Literature Review", IOP Conference Series: Materials Science and Engineering, 2020
Publication

**80**%

**2** Submitted to University of North Texas
Student Paper

**6**%

**3** Xiaofeng Han, Xuejia Qi, Jincheng Zhang, Songlin Yang, Shuling Chen. "The Analysis Method of Performance Comprehensive Performance Optimization Design for Multi-body Unmanned Boat", Journal of Physics: Conference Series, 2022
Publication

**2**%

**4** Yulin Liu, Jian Zhou, Lin Wang, Yu Wang, Yong Yin, Zhongjun Ding. "Radio Frequency Identification target location based on the Unmanned Aerial Vehicle", Journal of Physics: Conference Series, 2022
Publication

**1**%

# Model of Autonomous Unmanned On-Road

**Article Error** You may need to use an article before this word.

**Article Error** You may need to use an article before this word.

**Proofread** This part of the sentence contains an error or misspelling that makes your meaning unclear.

**S/V** This subject and verb may not agree. Proofread the sentence to make sure the subject agrees with the verb.

**Wrong Article** You may have used the wrong article or pronoun. Proofread the sentence to make sure that the article or pronoun agrees with the word it describes.

**Missing ","** Review the rules for using punctuation marks.

**P/V** You have used the passive voice in this sentence. You may want to revise it using the active voice.

**Prep.** You may be using the wrong preposition.

**Sp.** This word is misspelled. Use a dictionary or spellchecker when you proofread your work.

**Article Error** You may need to remove this article.

**Article Error** You may need to use an article before this word.

**Sp.** This word is misspelled. Use a dictionary or spellchecker when you proofread your work.

**Article Error** You may need to use an article before this word. Consider using the article **the**.

**Article Error** You may need to use an article before this word.

**Sp.** This word is misspelled. Use a dictionary or spellchecker when you proofread your work.

**Article Error** You may need to use an article before this word. Consider using the article **the**.

**S/V** This subject and verb may not agree. Proofread the sentence to make sure the subject agrees with the verb.

**Prep.** You may be using the wrong preposition.

**Article Error** You may need to use an article before this word.

**Article Error** You may need to use an article before this word.

**Article Error** You may need to use an article before this word. Consider using the article **a**.

**Article Error** You may need to use an article before this word. Consider using the article **the**.

**Article Error** You may need to use an article before this word. Consider using the article **the**.

**Missing ","** Review the rules for using punctuation marks.

**Missing ","** Review the rules for using punctuation marks.

**Prep.** You may be using the wrong preposition.

**Article Error** You may need to use an article before this word. Consider using the article **the**.

**Article Error** You may need to remove this article.

**Missing ","** Review the rules for using punctuation marks.

**Missing ","** Review the rules for using punctuation marks.

**Sp.** This word is misspelled. Use a dictionary or spellchecker when you proofread your work.

**Article Error** You may need to use an article before this word.

**P/V** You have used the passive voice in this sentence. You may want to revise it using the active voice.

**Prep.** You may be using the wrong preposition.

---

**Article Error** You may need to use an article before this word. Consider using the article **the**.

---