Intelligent Unmanned Aerial Vehicle for Agriculture and Agroindustry

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Abstract. Unmanned Aerial Vehicle has been adopted in various different areas starting from hobby photography to professional measurement techniques. This paper focuses on the potential of using UAV for agriculture and agroindustry to improve the overall productivity and reducing the overall product cost. It provides brief overview of available UAV systems on the market including their sensors and capabilities. More important is the software part and required algorithms for controlling the AUV in such way that it becomes intelligent. The more advanced the software the more intelligent is the AUV. Some of available algorithms and applications for this purpose are discussed in this paper.

Keywords: intelligent, Unmanned Aerial Vehicle, agroindustry, algorithms.

1. Introduction
Globalization on the food markets stimulates the international competition in the agriculture. In order to survive on the market production costs must be reduced and resources have to be utilized optimally. The UN/DESA published the growth prediction of the world population in [1] where the global population will increase from 6.5 billion to 8.9 billion in year 2030. On the other hand, the total arable land will only increase marginally [2], which means that the arable land per capita will shrink by a quarter. Therefore, the agriculture is required to utilize the limited resources better amongst others approaches. This can be achieved by precision farming which performs tasks more intelligently and efficiently.

In industrial nations, agriculture has completely changed within three generations. In the twentieth century was the era of mechanization of the agriculture sectors. Farmers are no longer tether little oxen or goats to their ploughs but using heavy machinery instead. Today, many industries have applied the fourth industrial revolution which known also as “Industry 4.0” on their daily business. This revolution is not only affecting the manufacturing industry but also agriculture and agroindustry. Information technology and data driven processes have changed the processes in the plantation and cattle industry. Machines are no longer stand-alone, they are connected to the cloud and other machines and equipped with special sensors to perform precision farming [3, 4].

In past decades, many agricultural machine industries improved the productivity by increasing the size of the machine and adding more power to the machines. However, this approach reached its limit where the size of the machine cannot be increased anymore due to the traffic limitation where nowadays those machines reached the maximum allowed size to operate on the road. Additionally, increasing the size of the machines will have negative impact of the soil, where the heavier the machine the more
damage occurs to the soil compaction. Large and heavy machines can only be operated on the large flat fields but not for small fields and mountain side crops. Knowledge about the environment, soil, and crops health can help farmers react accordingly in certain situations, for example using adequate fertilizer for certain part of the soils depending on the soil data [5]. In order to receive this knowledge, measurements using special sensors have to be conducted or using telemetry information from the satellite imagery.

Recent development in unmanned aerial vehicles (UAVs) or also knowns as drones has become an interesting game changing in the agriculture and agroindustry. The UAVs cost only a fraction of large or heavy agricultural machine and can be equipped with special sensors to perform some measurements on the field gaining additional or specific information from the crops. Therefore, the UAV is one of the many different approaches in today’s farming techniques known also as smart farming. This paper focuses on the UAV technologies and their application supporting agriculture and agroindustry [6]. Two applications of using UAVs for supporting activities in agriculture and agroindustry are briefly discussed in this paper.

The following section will discuss smart farming and digital agriculture to see how far the technology and digitalization have been used in the agriculture and agroindustry. Next, the fundamental information about unmanned aerial vehicles from the classification to the autonomy is then presented. Two application of using UAVs in agriculture and agroindustry is presented in the following section. Challenges and further development are discussed in section 5. Finally, section 6 concludes the paper.

2. Smart Farming and Digital Agriculture

Smart Farming and digital agriculture are the two new trends in the agriculture technologies which change the way how farmers manage or operate their business. Information technology and digitalisation are not only change in the industrial sector but also influencing the agriculture and agroindustry. Applications of these technologies range from data management, precision farming, robotics as well as farm management to agro-engineering including sensors network in agriculture.

Experts in Germany reported that the pace of digitalization in agriculture and agroindustry is higher than in the factories. In term of involved human workers on the field, 60 years ago a farm of 100 hectares employ 25 people but today three people can do the same work on the same field size. In term of throughput, what harvested on the same area increased from 300 to 900 tonnes. Therefore, it is not surprising when the result of a poll conducted by the German Farmers Association (DBV) reported that 53% of agricultural business use already digital solution, e.g. cow milking robots, drones mapping fields and sensors measure the required nutrient of plants. 28% of agricultural companies are currently investing specifically in education and training on digital agriculture based on survey on 850 farm managers. The last AgriTechnica exhibition fair in Hanover, one whole hall was dedicated only to the digital agriculture [7].

Modern agriculture not only producing livestock and crops but also energy. Smart energy is the terminology used for this purpose where modern farms produce electricity, heat, and even hydrogen energy. Those energy are produced from solar and geothermal as well as biomasses, which are side products of the farms. A modern barn resembles an industrial production facility where instead of pitchfork machines and robots are used. Livestock 4.0 is the terminology for this kind of barn which includes automatic feed dispensing, networked cattle, smart milking robots, animals’ fitness trackers, video surveillance system and automated cleaning system being used in the barn. In order to deal with limited agricultural space in the future, a new approach of farming has been introduced where the crops are vertically planted. This technique is known as vertical farming that uses high-tech production of plant and animal products in multi-story buildings which are also known as farm-scrapers.

In digital agriculture, the farmers are required to use information technology infrastructure and have necessary knowledge about it. They have to control and monitor their daily activities on the farm using
this technology. These are mostly done by the precision farming machines where heavy machines not only simple machines by an intelligent one. Most of the modern machines have been equipped with autonomous driving capability, where the farmers just sit on the control cockpit and over-watch the overall process. Some machines still require the drivers to drive the machine to move from one lane to another. Such machines which able to perform tasks autonomously are also known as agricultural robotics. Moreover, in some cases multiple agricultural robots are working together in swarm with a common goal. These are necessary to further optimize the infield transport logistic chain by minimizing the process time of the machines [8]. Applications of agricultural robots vary from sowing, fertilizing, and harvesting fields.

Further optimization in the agriculture can be achieved using smart fertilizing which reduces the cost as well as environmentally friendly. For this approach, it requires special sensors that can measure the soil quality and the amount required fertilizer by the plants, even more in certain situation individual need of a particular plant. The required fertilizer will be dosed exactly and given to the plants or individual plant. Injecting individual fertilizer can be done with the support of agricultural robots. Moreover, support from the air can also found in the modern agriculture, where agricultural drones or UAVs are used to support farming processes. The UAVs deliver not only aerial imagery but equipped with special sensors they can also detect further data such as humus composition, soil moist, or nitrogen level. Some UAVs can even fertilize or sow the field from the air. The rest of the paper is dedicated for the UAV technology including sensors and algorithms for data processing and analyzing.

3. Intelligent Unmanned Aerial Vehicle

Unmanned aerial vehicle (UAV) can also be seen as mobile robot which can move freely in three-dimensional space. It has one more degree of freedom in comparison with mobile robot which move on land, but it introduces additional challenges namely the energy required to maintain certain position on the air. A mobile robot can stop in a fixed position without drawing any energy from its battery and performing other tasks such as analyzing image or detecting object. However, a UAV will continuously draw energy from its battery to maintain its position as well draw additional energy to perform other tasks. Further challenge is on the control dynamic of a UAV which is higher than one in a mobile robot. Due to the gravitational force applied on the UAV and disturbances from wind, the UAV must be able to adjust its control command to avoid any collision. Researches and developments on the UAV technology have develop UAVs that can deal with those challenges and still have reasonable flying time to perform further tasks. Today, such UAVs are available on the market as freely owned product in affordable prices. As a result, many private persons acquiring UAVs for various purposes, e.g. hobby photography. Applications on the agriculture and agroindustry have also been coming as well with various different kind of researches and commercial application in this area. What are the requirements needed in order to make such UAV not just a flying drone but an intelligent tool for agricultural purposes?

The classification of UAVs is done based on different criteria such as the operation mode, the flying range, climb rate mass, and endurance or duration of flight. There is no one standard on the UAVs classification. Looking from the size factor, the UAVs can be classified into very small UAVs (micro or nano UAVs), small UAVs (mini UAVs), medium UAVs, and large UAVs. According to US Department of Defense, classification of UAVs based on their travel range and their endurance resulting in very low-cost close-range UAVs, close-range UAVs, short-range UAVs, mid-range UAVs, and endurance UAVs. US DoD classified the UAVs into five categories as shown in the Table 1. [9]

The tactic group of a non-profit organization ITHACA, Information Technology for Assistance, Cooperation and Action, classified the UAVs in three categories with respect to their possible usage. Each type is subdivided into subcategories based on their features and performance, travel range, maximum climb rate, endurance and weight. Table 2 shows this classification [10].
Table 1. UAVs classification according to the US Department of Defense [9].

| Category | Size         | Maximum Gross Takeoff Weight (kg) | Normal Operating Altitude (m) AGL | Airspeed (km/h) |
|----------|--------------|-----------------------------------|-----------------------------------|-----------------|
| Group 1  | Small        | < 9                               | < 366 above ground level (AGL)   | < 185           |
| Group 2  | Medium       | 9.5 - 25                          | < 1067 AGL                       | < 463           |
| Group 3  | Large        | < 600                             | < 5486 mean sea level (MSL)      | < 463           |
| Group 4  | Larger       | > 600                             | < 5486 MSL                       | any airspeed    |
| Group 5  | Largest      | > 600                             | > 5486 MSL                       | any airspeed    |

Table 2. ITHACA’s UAVs classification [10].

| UAV Categories | Acronym | Range (km) | Climb rate (m) | Endurance (hours) | Mass (kg) |
|----------------|---------|------------|----------------|-------------------|-----------|
| Micro          | Micro   | < 10       | 250            | 1                 | < 5       |
| Mini           | Mini    | < 10       | 150 to 300     | < 2               | 150       |
| Close Range    | CR      | 10 - 30    | 3000           | 2 to 4            | 150       |
| Short Range    | SR      | 30 - 70    | 3000           | 3 to 6            | 200       |
| Medium Range   | MR      | 70 - 200   | 5000           | 6 to 10           | 1250      |
| Medium Range   | MRE     | > 500      | 8000           | 10 to 18          | 1250      |
| Low Altitude   | LADP    | > 250      | 50 - 9000      | 0.5 to 1          | 350       |
| Deep Penetration | LALE | > 500    | 3000           | > 24              | < 30      |
| Low Altitude   | MALE    | > 500      | 14000          | 24 to 48          | 1500      |
| Long Endurance | MALE    | > 500      | 14000          | 24 to 48          | 1500      |

Available UAVs on the market are typically group 1 according to U.S. DoD classification or micro to mini categories according to ITHACA. These kinds of UAVs are designed to carry small payload, which are typically camera system. More professional drones will go toward group 2 and can carry heavier payload, such as fertilizer or herbicide. The higher the group the more restriction will apply to the UAVs, because such drones are able to fly in relatively high altitude and thus must follow the airline traffic regulation or civil aviation department of the corresponding country. These regulations vary from one country to another. Therefore, one must read and follow the valid regulation before operate any UAVs for agricultural or agrobusiness purposes.

3.1. UAV Locomotion
The locomotion of UAVs depends on the underlying flying principles. [11] classified UAVs based on their flying principles. Figure 1 shows this categorization, where first classified by their weight in comparison with air and followed by wing-based or rotor-based locomotion. The lighter-than-air UAVs rely on buoyancy force such as helium gas or heat air to fly. The heavier-than-air UAVs depend on aerodynamic and propulsive thrust to fly. Wing-based UAVs use their wings to generate aerodynamic lift. The fixed-wing UAVs using the same principles like aero planes. Rotor-based UAVs rely on the rotors and propellers pointing upwards to generate propulsive thrust. Wing-based UAVs have longer range and fly faster than rotor-based ones. Therefore, in agriculture application wing-based UAVs can be used for fast sweeping an area to gather some aerial imagery or throwing fertilizer or herbicide over certain area. The rotor-based fly slower than wing-based but can be controlled easily to move in 3D space in 6 degree-of-freedom (DoF).
Figure 1. Type of UAVs based on locomotion based on [11].

Figure 2 shows the graph of endurance or flight time versus weight or mass. As shown in the graph, fixed-wing is heavy but still has longer flight time in comparison with rotor-based UAVs. Flapping-wing and lighter-than-air types, such as blimp or balloon have typically smaller mass. Blimp and balloon can fly longer than flapping-wing one. This is due to the required flapping action to produce enough thrust to fly but the weight must remain small. As a result, the flapping actions consume energy but the drone itself cannot carry large battery. The graph shows that the rotor-based UAVs are heavy and have less endurance than fixed-wing, but still these types are quite popular due to the ability of hovering on a certain position, which allows this kind of UAVs to perform additional tasks in addition to take aerial imagery, such as object manipulation, taking image with different time exposures, on-system object detection, etc. This capability offers various potential applications in the agriculture or agrobusiness domain. Therefore, the remaining sections focus on this type of UAVs.

3.2. Flight Control System
UAVs are equipped with various sensors and actuators to perform the given tasks. Some of the sensors and actuators are belong to the flight control system, which is responsible for controlling the UAV, and some are used for the telemetry system. Typical sensors for the flight control system are inertial measurement unit (IMU) to estimate the position and orientation of the UAV, global positioning system
(GPS), barometer to estimate the altitude or sometimes sensors for measuring distance to ground, e.g., laser or ultrasound. The system itself must be able to measure the speed of the UAVs’ motors or wind speed and direction.

Figure 3 shows an overall guidance, navigation, and control structure implemented in flight control system. The blue boxes are the proprioceptive sensors used for navigating the UAV. The orange boxes show the automatic flight control system. The control signal to the actuators can be override by the ground station. Depending on the operation mode, the UAV can be directly remote controlled from the ground station or a set of waypoints can be sent to the UAV for an automatic flight control following the waypoints.

![Diagram of navigation, guidance and control loop in UAV based on [12]](image)

An automatic flight control does not make the UAV intelligent. Table 3 shows classification of the autonomy levels of UAVs system [13]. As shown in the table, UAVs with automatic flight control can only be categorized into level 2. There are still features and capabilities required by the UAV in order to make it into full autonomous system. Achieving level 10 will enable the UAV to cooperate with other UAVs and perform a collaborative mission.

![Table 3. List of autonomy levels [13].](image)

| Autonomy Level | Description                           |
|----------------|---------------------------------------|
| 1              | Remote Control                        |
| 2              | Automatic Flight Control              |
| 3              | System Fault Adaptive                 |
| 4              | GPS Assisted Navigation               |
| 5              | Path Planning & Execution             |
| 6              | Real Time Path Planning               |
| 7              | Dynamic Mission Planning              |
| 8              | Real Time Collaborative Mission Planning|
| 9              | Swarm Group Decision Making           |
| 10             | Full Autonomous                       |

3.3. Telemetry Sensors

In addition to the proprioceptive sensors for the flight control, telemetry sensors are mounted on the UAVs as payloads. There are various different kind of sensors for different purposes. The most typical sensor is camera with different lenses and resolutions. Depending on the flying height of the UAV the
area covered by one single snapshot can vary. The higher the drone flies the larger the coverage area for one single shot and the smaller the object appear on the image. Therefore, the flying height of the drone must be adapted to the purpose of the measurement.

Special camera such as infrared camera, multi-spectral camera, and hyper-spectral camera can be used to extract more information from the imagery. Hyper-spectral camera works on wider electromagnetic spectrum. Therefore, the image taken from the hyper-spectral camera provides more information which can help finding certain objects by identifying specific material on those objects. Infrared camera works on the small band of the spectrum namely the infrared spectrum. This camera can be used to detect living animal on the field to help field harvesting process by detecting wild animal on the field. Multi- and hyper-spectral cameras can give much more information than normal or infrared camera but the post-processing algorithms on the imagery taken from those cameras are much more complex than the one from infrared camera.

Small light detection and ranging or LiDAR can be mounted on the UAV for telemetry purpose as well. LiDAR usually uses for reconstruction of 3D imaging from either multiple 2-dimensional or 3-dimensional scan of an area. The 3D imaging provides the structure of the area, such as the height of the plants and their forms. A combination of LiDAR with camera or hyper-spectral camera can provide rich information of the scanned area for various kind of purposes. One major challenge is when the overall weight of all telemetry sensors carried by the drone. Each additional payload which a drone still can carry will reduce the flight time or the endurance.

3.4. Data Processing Algorithms

A large area is typically assembled from a number of images captured from overlapping snapshots of the sensors. Those snapshots are then combined using image stitching algorithms to create one single image forming a larger area. Before combining those images, the scaling factor resulting from snapshot from different height must be first corrected. The corrected images are known as orthophoto, orthophotograph or orthoimage. The final image is known as orthomosaic which comprises from individual orthoimages.

Further algorithms are required to process the orthomosaic image to extract various different features from it. There are numerous different image processing algorithms starting from simple color segmentation to trained deep learning algorithm for detecting specific species of plant on the image. These algorithms require typically CPU or GPU to process a large area to produce meaningful result. Once the results are generated, it can be combined with other data such as satellite imagery in order to deduce further knowledge upon the area.

Due to these two steps before one can get results from the image taken from an UAV, a real-time or online data processing is difficult to achieve using small or mini UAVs. Equipped with GPU accelerated processor on the UAV might enable the system to perform onboard orthomosaic while flying but further extraction of the image will still be challenging and might consume adequate energy which reduces the endurance of the UAVs. This is also the reason why specific purpose UAV uses specialized sensors instead of rich feature ones which can deliver the target object immediately from the sensor without or with less post processing, e.g. infrared camera for detecting wild animal.

4. Example Applications

In this section, two applications using UAVs in agriculture and agroindustry are presented. The first application is for counting the number of trees in a plantation from the aerial imagery. The second one is toward the agroindustry by evaluating the development process of a village, which can be used for further decision making and optimizing the agroindustry business.
4.1. Automated Tree Counting in Palm Plantations

The number of trees in a plantation correlated directly with the expected outcome of the final product. Having the number of trees, one can predict the outcome by averaging the number of fruits could be produced from each tree. This information can be retrieved from the previous harvesting data or rule of thumb from the expert person. Typically, this can be done quite easily while planting the trees the farmers can count the number of trees being planted. However, the interesting task is to determine how many of these trees are survive and finally grown up. Some of the trees might be damage due to various different factors. Therefore, the farmers must regularly maintain their data by counting the number of trees in their plantation. This is one activity which can be fully supported by using UAVs technology to automatically extracting this number from the aerial imagery [14-16].

Figure 4. shows the result of applying the automated tree counting algorithm on aerial imagery of a palm plantation. On the left image, it shows the colour separated image using green channel to focus on the leaves of the trees and removing any background information from the image [17]. The next step is to segment the individual palm trees. This can be done quite straight forward because the palm plantation has good structure which allow clear separation between trees. The right image shows the original image overlaid with the counted trees. From the image, it can be seen that the algorithm work quite well on the palm plantation for counting the number of palm trees.

![Automated palm-tree counting from the aerial imagery (source: PSP3-IPB).](image)

In some cases, the fruit can be distinguished quite easily form the tree because they have special form or colour that can be separated from the leaves. In this case, an automated process can be developed further in order to count the number of fruits on a tree. Of course, for this purpose the image has to be taken from shorter distance than the one for counting the number of trees. The drone has to be able to fly into the object of interest on the certain distance and take some image from that position. This action must not be done to every single tree but it should be enough using adequate statistical approach for sampling a certain area on the plantation. One major benefit of having this approach is that more precise approximation can be done directly from the observed plantation instead from previous year data or expert knowledge.

Moreover, not only the number of trees on the plantation is interesting for agriculture or agroindustry, there are various different parameters or indices which could be extracted from the aerial imagery. One of the aspects which also part of the research project is to determine the sustainability index of such plantation form those images. This of course presents further challenges as one of the goals is to determine the number of different species living on a palm plantation. For this purpose, the drone must fly underneath the palm canopy to take images below it. Furthermore, an human expert is needed in the
beginning of the process to analyze the image and create a ground truth data from those images. This data will be used later to measure how good the algorithm can determine the sustainability index of the plantation.

4.2. Village Drone Project

In 2017, Bogor Agricultural University (IPB) team was able to extract data which can be used to manage village data more accurately by using UAV within the village drone project, or so-called “drone desa”. Drones were used to capture aerial imagery of a village which will be used later for calculating village data. The research activities have produced aerial photography, village orthophoto maps, village thematic maps, and other spatial information, such as: population, education and settlement. The spatial information of the village is used for building an artificial intelligence system to support the preparation of the Village Medium Term Development Plan (MTDP), or so-called “Rencana Pembangunan Jangka Menengah (RPJM) Desa”, and the Village Development Activity Plan (DAP), or so-called “Rencana Kegiatan Pembangunan (RKP) Desa”. This system was needed because the past decisions to form Village RPJM or Village RKP which led to village development programs and activities did not correspond with the actual conditions and needs of the village. Therefore, one of the objectives of this research project is to collect and to update the outdated village data with the UAV to create a spatial information of the village. Furthermore, variables required to create accurate Village RPJM and Village RKP will be further investigated and developed. The main objective of this research is to develop an intelligent software framework to generate required information which is used in the preparation of the Village RPJM and the Village RKP. The framework shall use the spatial data generated from the aerial imagery captured from the drones. The resulting Village RPJM and Village RKP will then be used by the local government together with the village community as based for their decision making to improve the living quality of the community.

In order to achieve these objectives, the research study is supported by quantitative and qualitative methods. The quantitative method is done based on the questionnaire and surveys. The qualitative methods approach is performed using participatory data mining, discussions, group discussions focused on social media groups in the targeted locations. These are supported by proper dissemination of intelligence system platforms for the preparation of the Village RPJM and Village RKP to the village local community.

Qualitative and quantitative data is not enough to create an optimal result for the Village RPJM and Village RKP. Further information containing deepen knowledge of the population is required, for example people’s welfare, production factors, educational level, or market demands. This information is crucial for producing more accurate data for both Village RPJM and Village RKP. Moreover, the developed system is supported by expert’s decision making in the field by providing sensitive variables and strategic information used for preparing both documents.

The spatial data of the village, i.e., village area, land use, population, education, and settlement, obtained from the previous year's research study will be compared with the recent year data. This information is required in order to justify how good is the development in various different area in the previous years. The results are then fed into the developed system to predict the potential of the village. Figure 5 shows an example of fuzzy rule set designed for the Village RPJM and the Village RKP.

5. Challenges and Further Development

Although several applications using UAVs for the agriculture and agroindustry have been slowly being deployed on the market, many recent developments are still available on the research and development only. There are still many open issues which have to be further investigated in order to achieve a fully autonomous system which can collaborate with other UAVs performing a common mission. This level needs not only hardware development but software as well.
In the aerospace system, NASA has introduced the readiness level, so called technology readiness level (TRL). This terminology has been adopted by many disciplines to define how mature the technology is. Table 4 shows the list of technology readiness levels for UAVs [13]. As one can see from the list, as long the system only passes laboratory test, it reached only level 5. A prototype system that runs on real mission can be found by a number of applications. These are the positive signs toward a fully operational system on the market.

Table 4. List of technology readiness levels (TRL) [13].

| Level | Description                                           |
|-------|-------------------------------------------------------|
| 1     | Basic Principles                                      |
| 2     | Application Formation                                 |
| 3     | Technology Concepts and Research                       |
| 4     | Technology Development and Proof of Concept            |
| 5     | Low Fidelity Component Testing (Labs)                  |
| 6     | System Integration and Flight Tests                    |
| 7     | Prototype Demonstration and Operation                  |
| 8     | Prototype Operation in Realistic Mission Scenario      |
| 9     | UAV Mission Deployment                                |
| 10    | Fully Operational Status                               |

Technology readiness level is only one aspect of the hardware and software system. There are still many challenges which still have to be discussed or investigated further. One important aspect which challenging is the data ownership. As one might know that the UAVs are gathering aerial telemetry information, which can be used further to improve or make profit on a certain the industry. Who owns the information? Do the farmers have to pay for that information? How to protect the information from the third party who might create negative impact to the industry?

6. Conclusion
This paper has shown a brief review of the unmanned aerial vehicles for the agriculture and agroindustry. Together with other technological approaches such as smart farming, UAVs bring additional benefit.
which can complement those systems. UAVs can gather necessary data which is really crucial for the agriculture to further increase the productivity. It can help farmers predict the outcome of a certain field by gathering aerial imagery from a plantation. Having certain algorithms which can count the number of the tree on the plantation will give great benefit to the farmers. Moreover, depending on the extractable features the algorithms might also tell how many fruits can be expected from those trees.

Other example shows that UAVs can help the politician to make a wise decision. In the village drone project, the system is able to extract important information like infrastructure, number of houses, roads, etc. Further information such as educational level or ages of the population can be combined with data from the UAVs to create overview of the village. This information will then tell how or what could improve the village, which infrastructure has to be built in the next period. Do the roads good enough to transporting all goods from the sources to the silos?

The drones are still need to be further developed in order to achieve the full autonomy level and reach the highest technological readiness level. Researches and application of UAVs technology in the agricultural or agroindustry will help further development on the drones toward this goal. The drones technology is one important technological among others to improve the overall throughput in the agroindustry.

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