**Compare Delivery Drones Based on Obstacle Detection, Collision Avoidance and GPS Technologies**

* **Project Outline**

Paired with self-driving grocery delivery vehicles, a delivery drone is an autonomous vehicle used to transport packages, food or other goods [1], and it is possible that human delivery is necessary only when deliveries are too challenging for a sidewalk bot or a drone to navigate. The development of drone logistics is the trend of automation, with high efficiency, low cost and great economic value and marketspace.

Drones with obstacle detection and collision avoidance sensor are becoming more prevalent. The project reviews and compares these sensors being used, including information on software programming which include mathematical modelling, algorithms, machine learning and SLAM technology, which is used to interpret the images being scanned by the sensors [4]. The algorithms are evaluated because if the software and algorithm is not written well, the data from the sensor will not be interpreted, then incorrectly leading to flight errors and the drone crashing. Besides, technologies from aerodynamics of the drone, materials in the manufacture to the circuit boards, chipset and software should be evaluated in the project.

* **Objectives of the Project (Vision)**

The main goals of the project are:

With real systems in place, it is possible to mainly compare the efficiency of:

* the obstacle detection and collision avoidance technology system of drones.
* compare the GPS and autopilot flight system of drones.
* various algorithms.
* **Project Needs**

The project uses a crane to lift the drones off the ground and then quickly lower it to test whether they can effectively avoid obstacles and land safely within the predetermined range. The project may use six-rotor, large eight-rotor, and fixed-wing drones, they could be on autopilot mode, and fly a programmed route. Below, drones contain from 1 to 6 directions of obstacle avoidance technology, the project will compare to see which has the best obstacle detection and avoidance system, as well as GPS autopilot system.

*DJI Mavic Air*

1. It has front, below and backward dual vision sensors. It also has a downward infrared sensing system. Both Vision and IR work together.
2. The DJI Mavic Air uses both GPS and GLONASS which means the quadcopter will pick up maximum satellite connectivity, up to 20 satellites.

*DJI Mavic Pro*

1. dual satellite system is used
2. both Mavic Pro and Mavic 2 Zoom have autonomous Intelligent Flight Modes.

*DJI Mavic 2 Pro & Zoom*

1. faster, quieter and can fly further
2. Obstacle sensing is on all 6 sides with front and back collision avoidance technology, allowing the Mavic 2 to fly around obstacles.

*DJI Phantom 4 Pro*

1. can create 3D maps of land mass or buildings
2. dual satellite system

DJI Assistant 2 Mavic software contains the below components:

* Firmware Update
* Data Upload
* Black Box
* Calibration
* Simulator

There is not just one type of obstacle detection sensors being used, manufacturers are fusing various sensors together to create the obstacle detection and collision avoidance systems. These various sensors feed the data back to the flight controller which is running obstacle detection software and algorithms. The following sensors are used:

* Stereo Vision
* Ultrasonic (Sonar)
* Time-of-Flight
* Lidar
* Infrared
* Monocular Vision

Along with GPS autopilot system, the following technologies are needed:

* Active Track (Profile, Spotlight, Circle)
* Draw Waypoints
* TapFly
* Terrain Follow Mode
* Tripod Mode
* Gesture Mode
* S-Mode (Sport)
* P-Mode (Position)
* A-Mode (Attitude)
* Beginner Mode
* Course Lock
* Home Lock
* Obstacle Avoidance
* **Project Benefits**
* drones with better obstacle detection system are safer, furthermore, drones with obstacle avoidance system crashes less
* safe autonomous drones can deliver groceries to customers’ door
* evaluations of existing technologies and algorithms would help with calibration, software set, manufacturing, etc.
* **Project Payoffs**
* The most obvious payoff is customer convenience
* Less waiting time for delivery when ordering groceries from the Internet
* Drone-based delivery could reduce greenhouse gas emission and energy use
* Save fast shipping cost
* **Major Risks**
  1. In the real world there might be designated routes that drones must follow, then that's going to make the paths long and more drones are needed to go farther, then there would be more storage warehouses to service the same area [3], and the cost increase accordingly.
  2. In the U.S., regulators are trying to address how to create a low-level air-traffic system to ensure drones don’t hit each other or traditional aircraft. Other problems include a standard for communicating with the craft, safety and privacy concerns [2]. The US Department of Transportation and its affiliated FAA rules for small unmanned aircraft, that allows drones to operate at low altitudes (generally defined as 200 feet below AGL and below 400 feet in individual locations) with weight less than 55 pounds [5].
  3. Drones can’t fly long enough to get packages to everyone due to battery life limitations.
  4. Drones are targets for thieves.
* **Future**

The idea is to build a network that includes not only small drones for final delivery, but a whole system [2] including large autonomous fixed-wing planes that take off from small airports or landing strips to ferry bulk shipments between warehouses.

**References**

1. Wikipedia, <https://en.wikipedia.org/wiki/Delivery_drone>
2. Bloomberg News, July 3, 2018, *China Is on the Fast Track to Drone Deliveries*, <https://www.bloomberg.com/news/features/2018-07-03/china-s-on-the-fast-track-to-making-uav-drone-deliveries>
3. Matt Simon, Science, February 13, 2018, *Would Delivery Drones Be All That Efficient? Depends Where You Live*, <https://www.wired.com/story/would-delivery-drones-be-all-that-efficient/>
4. Fintan Corrigan, December 28, 2018, *12 Top Collision Avoidance Drones And Obstacle Detection Explained*, https://www.dronezon.com/learn-about-drones-quadcopters/top-drones-with-obstacle-detection-collision-avoidance-sensors-explained/
5. Fact Sheet – Small Unmanned Aircraft Regulations, July 23, 2018, <https://www.faa.gov/news/fact_sheets/news_story.cfm?newsId=22615>