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Reducing battery usage in drones

ABSTRACT

Drones have a number of applications and can be very useful in many situations. However, usage of drones is constrained by limited battery capacity. This requires solutions to either increase the battery capacity of drones or reduce battery usage by drones. This disclosure provides strategies to reduce battery usage by drones, enabling drones to fly longer before requiring a recharge. Reduction in battery usage also reduces recharge cycles. Drone flight is optimized by using air draft maps. Further, battery efficient mechanisms are used to implement transfer of drone payloads. These strategies decrease the periods of time when a drone is unavailable.

KEYWORDS

- drone
- air draft
- geocoding
- battery
- payload transfer

BACKGROUND

Drones have limited battery capacity, which constrains their usage. Limitations of battery capacity translate into shorter flying time because more frequent recharging is required. Therefore, to optimize utilization of drones over time, reducing battery usage is an important problem to solve. Alternatives include increasing the battery capacity of drones, which is expensive and may require changes to the hardware specifications of the drones as well.

DESCRIPTION

This disclosure presents strategies to reduce battery usage in drones. The first strategy involves usage of air draft maps to optimize and therefore reduce battery usage. Since most of the drones are expected to travel in urban environments, these drones may encounter air drafts between buildings and objects. Sensors on drones can be used to measure the magnitude and number of air drafts at different locations on drone routes and this data is plotted as air draft maps. These maps help drones find a route with minimal air draft impact on drone efficiency.

Air drafts are typically determined by a combination of weather (i.e., windy, sunny, etc.) and the layout of buildings relative to other nearby buildings. The building layout determines fixed air drafts based on distances between the buildings in the layout. The drones are equipped with sensors to measure air speed and direction and this data is averaged over multiple days. By combining historical air speed data with wind speed expected on a particular day, the predicted magnitude of air draft at locations along potential drone routes is computed and geo-coded.

During the drone's flight, centralized systems use the geo-coded air draft values along with three-dimensional building data to determine routes or paths with the lowest predictable air drafts so that the drone's battery usage is optimized.

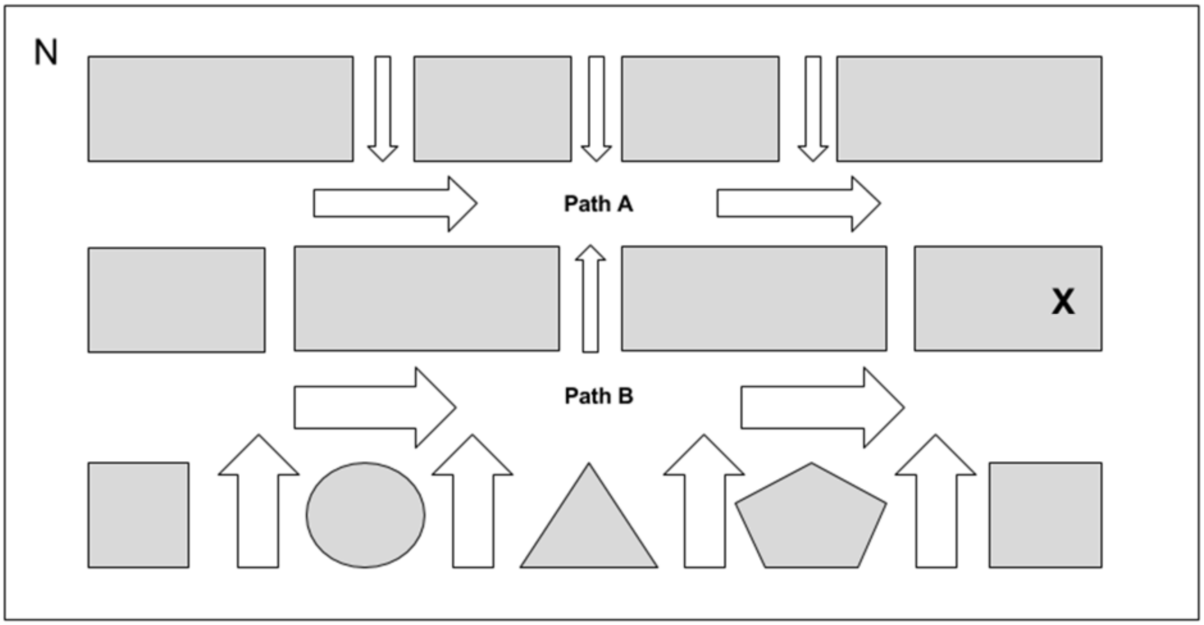

Fig. 1: Sample area with air draft map

Fig. 1 displays the top view of an example area with buildings colored in gray and air drafts denoted by arrows. The thickness of an arrow indicates the corresponding strength of an air draft, e.g., thicker arrows indicate greater magnitude and vice-versa. “X” marks the location where a package is to be delivered by the drone.

As illustrated, two flight paths to reach X are feasible, path A from the north and Path B from the south. Path A is more sheltered due to smaller open spaces between the buildings - therefore the air drafts are smaller. Path B has larger open spaces as well as buildings of different shapes, thus resulting in drafts of greater magnitude. Using this air draft map, the first strategy will choose path A such that the drone experiences smaller air drafts. This can help conserve the drone battery and reduce battery usage.

For various reasons (e.g., limited flight time, size constraints, type of route, delivery location, logistics, etc.), a drone must be able to transfer its payload to another drone if required.

One way to transfer is for a first drone to drop the package at a predetermined location, from which the next drone can pick it up. However, this process uses up significant battery capacity. This disclosure provides battery efficient mechanisms to implement transfer of payloads.

For example, a payload can be transferred between drones during flight by using two bars/rails at the bottom of the payload sending drone to dock with the payload receiving drone. Ideally, to make the transfer, the payload sending drone should be at a higher altitude than the payload receiving drone. The payload sending drone extends the retractable rails and uses docking lasers to guide the rails to dock with the payload receiving drone to make the transfer. Both the payload sending and payload receiving drones include rails.

The connections between the rails and the payload receiving drone can be made more controllable and robust through magnetic ends on the rails and the receiving drone. In case the docking is unsteady, the connection between the receiving and sending drones can be electronically broken. To keep the drones steady and conserve battery usage, the air under the influence of the payload sending and payload receiving drones should not overlap such that air drafts between the drones do not interfere with the receiving drone's propellers. The rails are aligned using magnets and/or laser to ensure that there are continuous rails for transfer of the payload.

Typically, a payload is lowered from the payload sending drone by a few feet to ensure that the air draft between the payload sending and payload receiving drones does not interfere with the transfer. The payload receiving drone has a petal shaped mechanism to hold the payload tight. However, if the size of the payload exceeds a threshold, the payload may interfere with the free area that is required for the receiving drone's propellers to efficiently keep the drone in the air. In such cases, the disclosed reversible propeller capability is employed to flip the receiving drone to capture the payload. The mass during a flip is mass of the drone together with that of the payload. Accurately computing the drone payload mass pre-flight is important part of the calculation. Additionally, the payload weight can increase if there is rain or snow, for example, if the box of the payload absorbs water.

This reverse propeller drone mechanism is typically more useful when the dimensions of the payload are not of standard size. In order to flip successfully, the drone should have the ability to accelerate against gravity with a force greater than (m x g), where m is the mass of the drone and g is the acceleration due to gravity.

The disclosed strategies therefore enable optimal usage of drones due to reduced battery power consumption. Moreover, as these drones fly longer, they spend relatively less time (by proportion) in the recharging mode. Drones with longer flying time can support applications that previously would have required drones with a higher battery capacity. As these higher battery capacity drones are more expensive or require changes to drone hardware, present techniques increase the battery efficiency and reduce the cost of existing drones.

CONCLUSION

This disclosure provides strategies to reduce battery usage in drones so that utilization of drones can be increased. Specifically, reduced battery usage allows drones to fly longer before requiring a recharge. Also, unavailability of drones due to being in recharge mode is less frequent as the drones are in flight mode for a longer period for the same battery capacity. One of the strategies uses air draft maps to route the drones along a path with lower magnitude air drafts to conserve energy and reduce battery usage. Other strategies provide mechanisms to more efficiently transfer payloads between drones in flight mode so that battery usage is reduced.