Project Title: UAV Visual Perception for Safe Landing (UAV-VPSL)

Host Laboratory: *Laboratoire d'Informatique Gaspard-Monge (LIGM)*

International Host Laboratory: Melbourne Centre for Data Science, The University of Melbourne, Australia

Principal Supervisors:

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Specialties: *Informatique*; *Data Science*; *Intelligence Artificielle*

Subject:

- **Research Background & Motivation:**

One of the core tasks of the takeaway business is to deliver goods to customers in a timely and non-destructive manner. However, with the continuous increase in the number of takeaway orders, traffic congestion, and shortage of delivery personnel in big cities have become increasingly prominent. It has become a big challenge to deliver goods to customers in a timely manner.

In order to solve the above problems, the demand for drone delivery has emerged. Unmanned Aerial Vehicles (UAV) delivery has the characteristics of zero congestion, zero contact, and short paths. With appropriate infrastructure, it can even complete tasks such as delivery to communities and direct delivery to households. As early as 2013, Amazon founder Bezos predicted that drone delivery will become the mainstream of business in the future, while Uber and United Parcel Service (UPS), and FedEx have been rapidly advancing drone commercial delivery projects.

Currently, the delivery of drones has not reached the expected development speed. The reasons include the lack of clarity in the scene, the inability to reliably guarantee the safety performance, and the excessive weight of accessories. In particular, the safe flight of drones cannot be successful without the help of sensors. Among the sensors, vision sensors provide the most abundant information. According to research, 90% of the information received by humans comes from vision. Thus, it is imperative to develop fast and accurate visual analysis algorithms that could guide the flight of UAVs.

There are many machine vision algorithms directly related to UAVs [1,2]. However, the performance is not good enough for real applications. Hence, we propose to study one important visual perception problem[1] (e.g., depth estimation [3,4], occlusion boundary estimation [5], etc.) in the context of UAV safe landing so as to advance the state of the art. Below is one concrete project on depth estimation in UAVs.

- **Depth Estimation in UAVs**:

Depth estimation is the basis for the vision system to understand the three-dimensional world and is widely used in scene analysis tasks based on computer vision technology, such as three-dimensional object detection, three-dimensional reconstruction of objects and scenes, positioning and path planning. This technology can give depth information to each pixel in the image

[1] The concrete subject to study can be discussed, depending on the student's interests & background.

(the vertical distance from the three-dimensional point corresponding to the pixel to the center of the camera where the image was taken) to achieve the purpose of understanding the three-dimensional world from the two-dimensional image. The combination of depth estimation and camera motion estimation can provide advanced perception information for tasks such as subsequent path planning, obstacle avoidance, and safe and precise landing.

While there has been extensive research on depth estimation in self-driving cars, depth estimation in UAVs has its own challenges. For example, the three-dimensional motion of drones is more flexible and complex than unmanned vehicles, and the estimation of depth and camera motion is more uncertain. In addition, due to the uneven height of the buildings on the ground, it is easy for the drone to encounter occlusions when shooting, and the noise caused will greatly reduce the performance of the algorithm. Finally, due to size limitations, the computing power of UAVs is far less than that of unmanned vehicles, and the real-time requirements of the algorithm are very high.

This project aims to develop a state-of-the-art method for estimating the depth information from the video taken by the drone. In particular, we will search for novel efficient depth estimation methods that combine the particularity of UAV shooting videos, by modeling various challenging factors in practice, such as occlusion, moving objects, distribution changes, etc..

- For more details, please send emails to: chaohui.wang@univ-eiffel.fr

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[5] Wang, Chaohui, Huan Fu, Dacheng Tao, and Michael Black. "Occlusion Boundary: A Formal Definition & Its Detection via Deep Exploration of Context." IEEE Transactions on Pattern Analysis and Machine Intelligence (2020).