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Summary

During this week, the Abstract for the paper was revised, and the Introduction for the paper was written by all members.

Furthermore, the audio and image data were collected inside the building as a feasibility test before having an outdoor test. Also, to prepare for the mid-presentation, the first draft of the presentation script and PowerPoint slides were done. Lastly, the data was trained with Deep Learning models to detect drones.

Within the next week, the final draft presentation slides and scripts will be done. Also, the first draft of the Literature Review for the paper will be written.

What K2S3 completed this week:

- Writing the Introduction of this paper
    - Based on the Abstract written last week, the Introduction was written with more specific details. More related news and facts were searched to explain the background of the project.
    - The Introduction written is as follows.

      Unmanned Aerial Vehicles (UAVs) starting with the purpose of the military systems create a new business ecosystem in a commercial way. The demand for UAVs has been increasing as a solution to traffic congestion, prevention of safety in populated areas, and enhancement of the environment compared to cars. The market of industrial UAVs has been accelerated by collaborating with some technologies. One of the technologies is drone delivery service. In recent, the demand for delivery services has increased, and the effective method to deliver payloads has been considered. Delivery service using drones is more eco-friendly, high effectiveness, and economic feasibility.

      Google, Windcopter, Zipline, and Amazon proceed to pilot test, and drone delivery service will be deployed soon. On the negative side, however, problems of drone management such as prevention of collision between two drones are still discussed. Various techniques are needed for the safe management of UAVs, so it is prior to research and develop the technologies related to auto-pilot and

autonomous driving. To manage the safe driving of the drones autonomously, drone collision-related problems have to be solved. Hence, it is crucial to implement some skills such as detecting and tracing the target drone and preventing of target drone not to colliding while two drones are in the air.

Drone detection techniques are still being preceded. However, little is known about detecting a drone collaborating with image and audio features. A combination of two domains would complement their limitations. On the aspect of images, it is hard to distinguish between a drone and a flying object like birds, even objects such as trees or houses could occlude a drone while flying low altitude. As the audio, sounds that are similar to drones such as airplane noise and the actual drone sound are indistinguishable. In the paper [1], the purpose of this paper is real-time detection of the UAV using both visual and audio features with the camera array assisted by multiple microphones, which record videos and sounds in all directions. The researchers used multiple sensors to integrate the information and identified the characteristics of the drones with high efficiency. The result of this paper is shown that the combined features between vision and audio are more accurate to detect a drone.

- Revising the Abstract of this paper
  - As the first draft of the Abstract was not long enough to explain the background of the project, more sentences are added.
  - The Abstract written is as follows.

    Autonomous drones have been studied in a variety of industries in recent years, such as delivery services and disaster protection. Large companies, including Amazon and Google, are currently testing autonomous drones, as the supply of low-cost Unmanned Aerial Vehicles (UAV) has been increasing. Since this situation might occur soon, to manage autonomous drone traffic control, a robust Collision Avoidance System (CAS) is critical. The main challenge is to manage the collision avoidance of drones while several drones are crossing one another at the same altitude. The goal of this paper is to estimate the position of UAVs using vision and acoustic-based features. By flying two drones in the sky at a fixed Euclidean distance, the data is collected using one camera and microphone. Deep learning and (unknown algorithm) methods are applied to investigate the optimal estimation.

- Having a meeting with the Ph.D. Student, Mia
  - Abstract and Introduction: Mia gave feedback about the Abstract and Introduction of the paper. For the Abstract, the result of the paper and the experiment information should be added later. For the Introduction, the purpose of each paragraph and the overall structure should be more organized.
  - Defining terms: As defining specific terms was challenging, Mia suggested terms that are appropriate to use in the paper.

- Collecting the indoor drone data inside and training the data
    - Collecting: Throughout this week, indoor data was collected with two types of drones, SYMA X8SW and SYMA X20P. Also, data with no drone flying was also collected to train a drone detection model. Audio signals and images were extracted from the video file recorded in MacBook Air M1.
    - Training: Audio-based and visual-based deep learning algorithms were used to train the data. MFCC features and CNN algorithm are used to detect the drones.
- Preparing for the mid-presentation
    - Writing the presentation script
        - Three presenters have written the script for the mid-presentation. To fully explain the details of the project, the script was revised several times. Also, other members of the team, including the Purdue student Luke, gave feedback about the context, the content, and grammar.
    - working on the PowerPoint slides
        - The presentation is divided into five different parts, introducing the team and the plan, the introduction, the implementation plan, the methodology of audio and visual-based features, and the future work of the project.
        - For a better understanding, the visualizations for the experiment using icons were made to describe the background of the project and the placement of the equipment and drones.
        - Various tables, graphs, and images were added to describe the process of collecting, applying algorithms, showing results, and explaining the future work.

Things to do by next week

- Finishing the script and PowerPoint slides for the mid-presentation
    - All members of the team will give feedback to the presenters when practicing the presentation in front of the members. It may include nuance, attitude, voice volume and speed, grammar, and the content. Furthermore, the expected questions should also be prepared for the presentation Q&A. Also, the presentation slides should be organized according to the table of contents.
- Revising the Introduction of the paper
    - Based on Mia's feedback, the structure of the Introduction should be organized again. Also, after adding the Introduction into the IEEE format, the length of the Introduction will also be discussed again.
- Writing the Literature review of the paper
    - Based on various related papers that are searched and summarized, the first draft of the Literature review will be written throughout this week.

Problems or challenges:

- Operating the drones for the indoor test

- Although there were various drones for the indoor test, most of the drones were not properly operating. Also, there was a limited number of chargers to charge the batteries of the drones. Therefore, it took time to record enough video data files.

References

[1] N. Jiquan, K. Aditya, K Mingyu, N Juhan, L. Honglak, N. Andrew, “Multimodal Deep Learning”, *ICML 2011*, 2011

[2] H. Liu, Z. Wei, Y. Chen, J. Pan, L. Lin and Y. Ren, "Drone Detection Based on an Audio-Assisted Camera Array" *2017 IEEE Third Int. Conference on Multimedia Big Data (BigMM),* pp. 402-406, 2017