



SOC Final Project Group 3: Drone-Aided Police Control System

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Outline

- **Introduction**
- **System Architecture**
- **Specification and Technology Analysis**
 - Drone system
 - Camera - Electronic Image Stabilization (EIS)
 - AI algorithm
 - Edge server
- **Industrial Analysis**
 - Porter's 5 force analysis
 - S.W.O.T analysis
- **Conclusion**
- **Task Partition**
- **References**



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Introduction

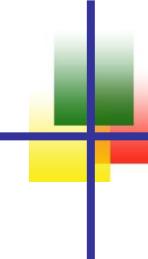
- We propose a drone-aided police control system, which assist the police for real-time surveillance on big events
- Target market
 - Police, event host, telecom operator (CHT, FET, TWM)
- Application scenarios
 - Concert, new year eve's party, baseball game
 - Traffic jam during commute time



Motivation

- Itaewon crowd crush (梨泰院)
 - It's difficult for the police to rescue since the space is full people
- To prevent the tragedy happens again
 - We aim to propose a framework provide a better efficiency to evacuate crowd

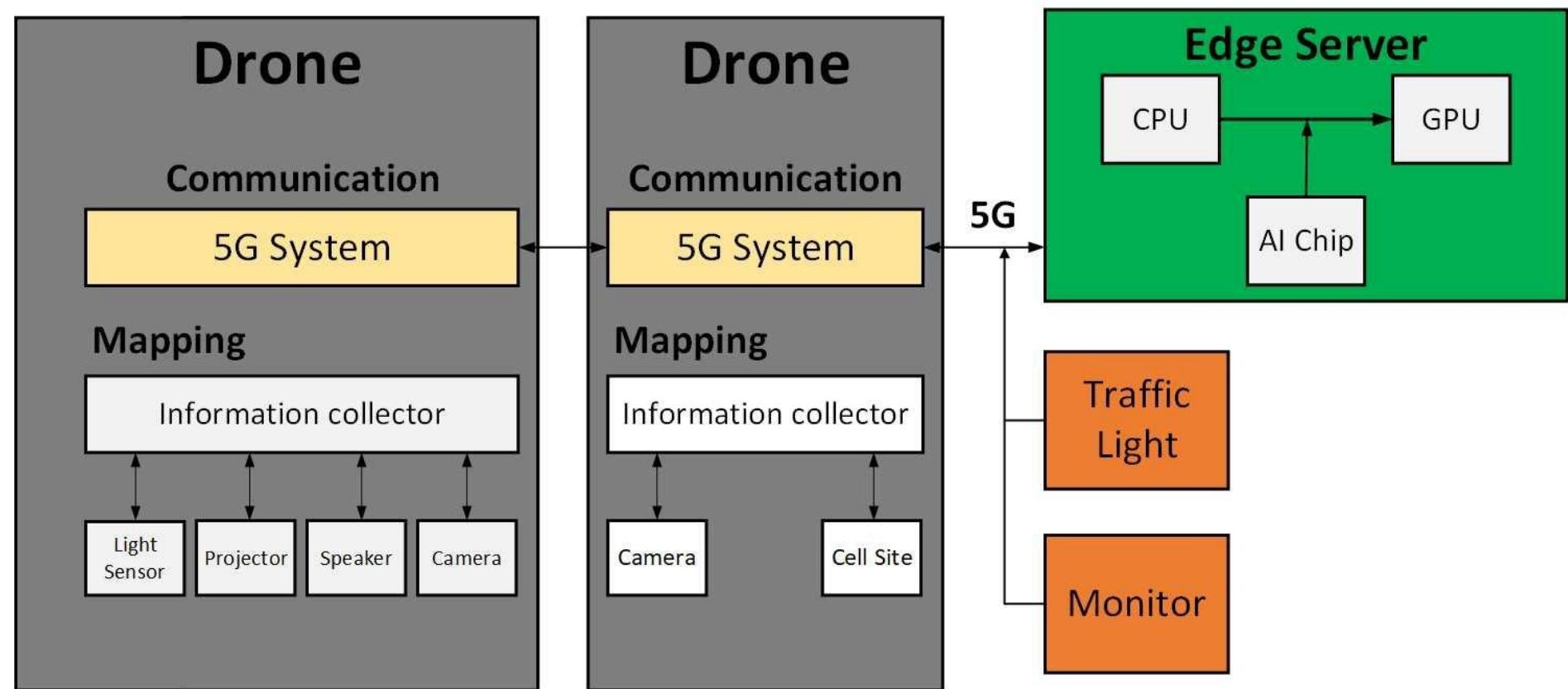




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System Architecture





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Drone System (1/10)

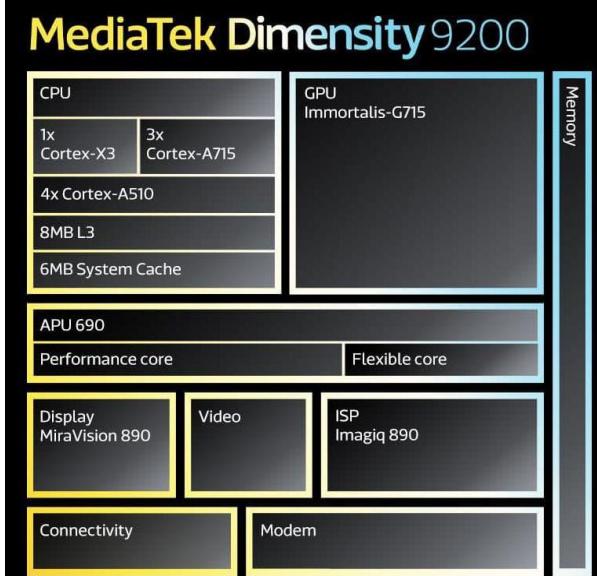
SoC specification

- We adopt the 5G solution from Mediatek

- MediaTek Dimensity 9200

- Camera

- CMOS sensor: 1/1.2 inch, 12MP
 - Angle of view: 82.1 degree
 - Aperture: f/1.7



MediaTek Dimensity 9200 specification

Process	TSMC 4nm (N4P)
Prime core	1 x Cortex-X3 @ 3.0 Ghz
Performance cores	3x Cortex-A715 @ 2.85GHz
Efficiency cores	4x Cortex-A510 cores @ 1.8GHz
GPU	ARM Immortalis-G715
RAM	LPDDR5x at up to 8,533Mbps
Storage	UFS 4.0
Connectivity	5G Sub-6 GHz, mmWave, Wi-Fi 7 and Bluetooth 5.3
Display	5K (2.5Kx2) @ 60Hz, WHQD @ 144Hz, 1080p @ 240Hz

Drone System (2/10)

- 5G radio band: 4.4GHz ~ 4.7 GHz
 - This frequency band is exclusive to the police
- MediaTek Dimensity 9200's powerful performance ensure the quality of videos
 - Its cutting-edge display technology supports FHD+ up to 240Hz
 - MediaTek AI-SR/MEMC provides best-in-class video streaming

The central image shows the MediaTek Dimensity 9200 chip, which is a square with a central octagonal core. A blue and yellow glowing signal emanates from the top-left corner of the chip, extending upwards and to the left. The background is dark with a subtle grid pattern.

Incredible Performance
- 2nd Generation TSMC 4nm-class

Packed with industry firsts, this chip powers a new era of flagship smartphones.

- 1st Arm Cortex-X3 and Cortex-A715
- 1st LPDDR5X-8533, with 13% more bandwidth
- 1st UFS 4.0 + MCQ - fastest-ever smartphone storage
- TSMC N4P + MediaTek-optimized IC design

Cameras & Imaging - MediaTek Imagiq 890

Capture brighter, sharper images with the industry's leading AI-ISP architecture.

- 1st RGBW sensor native support for 30% brighter captures
- Second-Gen AI-Video Engine with APU+ISP fusion
- Capture and stream HDR video from multiple cameras
- Up to 12.5% power savings for 8K30 video with EIS
- Fastest AI-NR photo capture

AI - MediaTek APU 690

Enjoy better AI performance with the new 6th-Gen AI featuring eXtreme Power Saving Technology.

- 35% higher performance (ETHZ 5.0)
- 25% lower power 4K AI-NR video vs 5th Gen APU
- 45% improved video SR efficiency
- Upgraded DLA processor with mixed precision mode
- Upgraded shared memory efficiency

Gaming - MediaTek HyperEngine 6.0

Hardware-based raytracing and exclusive gaming technologies ensure incredible visuals with smooth high frame-rate gameplay.

- 1st Arm Immortals-G715 GPU with hardware raytracing
- MediaTek Adaptive Game Technology
- Motion Blur Reduction
- Frame Rate Smoother 2.0

Connect Everywhere

Never skip a beat with wireless audio for premium earbuds, the fastest Wi-Fi, and the most reliable 5G connectivity.

Wi-Fi 7

- 1st Wi-Fi 7 ready smartphone chip with up to 6.5Gbps downlink
- MediaTek Wi-Fi UltraSave provides up to 70% power savings

Bluetooth 5.3

- 1st Studio-grade Bluetooth Audio (24-bit / 192kHz)
- LE Audio Auracast with hearing aid support

5G

- Sub-6GHz + mmWave ready
- 4CC-CA sub-6GHz 5G R16 modem
- MediaTek 5G UltraSave 3.0
- Industry-leading Multimode Dual SIM Dual Active

Display - MediaTek MiraVision 890

We added the most impressive display technologies, including extreme performance gaming displays to ensure movies and videos always show their best.

- MediaTek Intelligent Display Sync 3.0
- Motion Blur Reduction
- EnergySmart Screen 2.0
- MediaTek AI-SR/MEMC video

System Chip on

Drone System (3/10)

Sensors

■ Gyroscope

- Calculate the tilt angle of the body and is an indispensable sensor stabilizing

■ Barometer

- Sense the relative and absolute height of an object through changes in air pressure

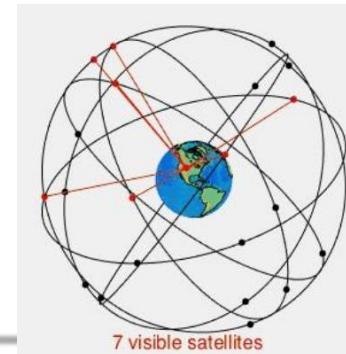
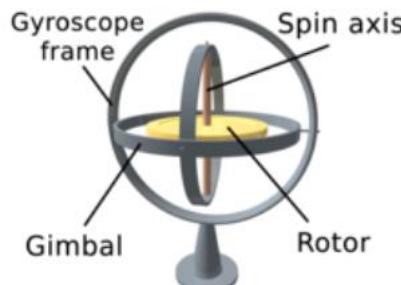
■ Accelerometer

- Sense the magnitude and direction of combined linear and gravitational acceleration

■ GPS

■ Magnetic field orientation sensor (magnetometer or compass)

- Sense the earth's magnetic field (geomagnetism), so as to know the direction of the drone face to

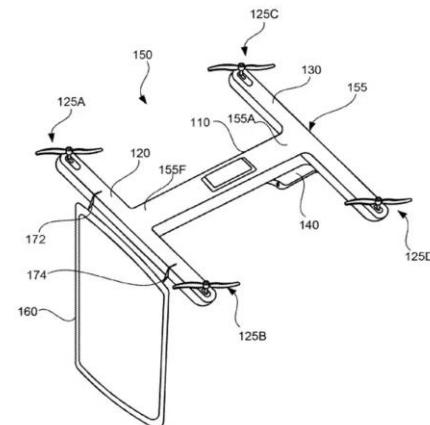


Drone System (4/10)

- Consists of three kinds of drone
 - Drone equipped with projector, flash light, speaker, and 5G small cell, respectively

Projector

- Inspired by the Google patent – placing a screen on a drone
- We placed a outdoor projector screen rather than a screen
 - To reduce the loading of the drone
- We adopt the product from Elite Screens
 - The Yard Master Electric



- Product features
 - Designed for outdoor use without compromising its home theater visual appeal
 - Wide diffusion uniformity allows viewers to enjoy a clear and bright picture from any angle

Drone System (5/10)

- The screen provide the information to evacuate



Video resolution:

4K: 3840x2160@25/25/30fps
2.7K: 4096x2160@24/25/30/48/50/60fps
FHD: 1920x1080@24/25/30/48/50/60fps

Camera

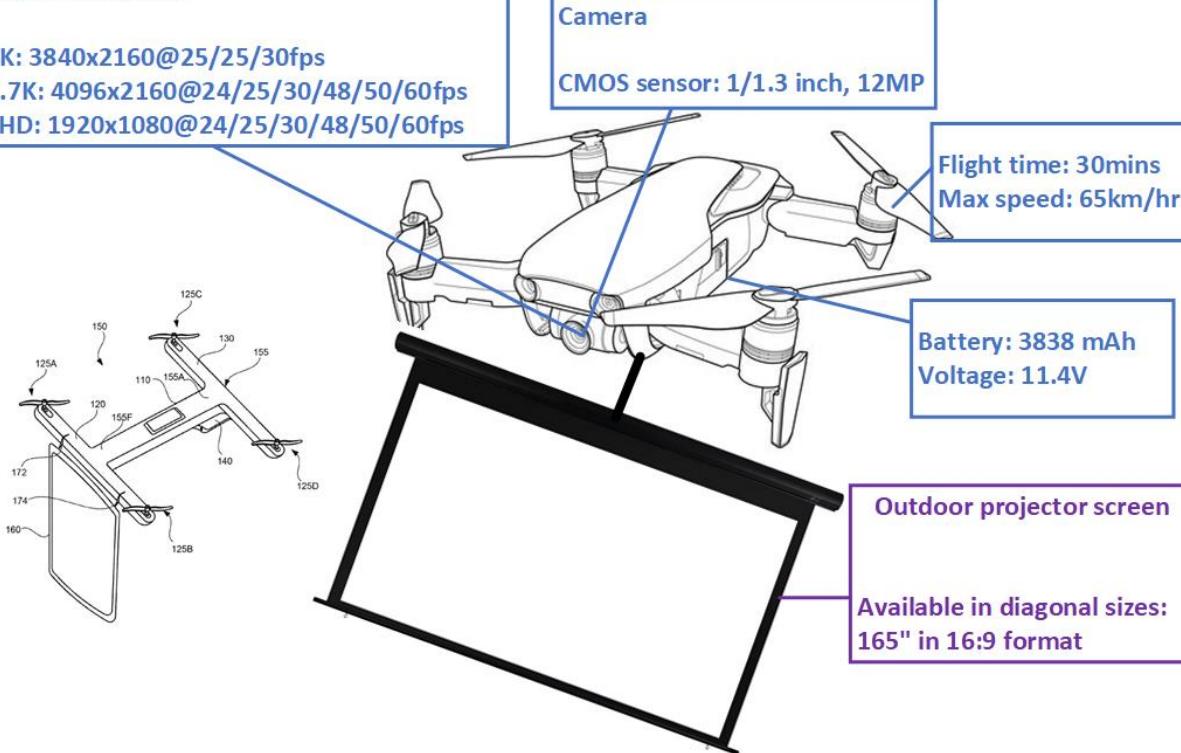
CMOS sensor: 1/1.3 inch, 12MP

Flight time: 30mins
Max speed: 65km/hr

Battery: 3838 mAh
Voltage: 11.4V

Outdoor projector screen

Available in diagonal sizes:
165" in 16:9 format



Drone Projector

Drone System (6/10)

Flash Light

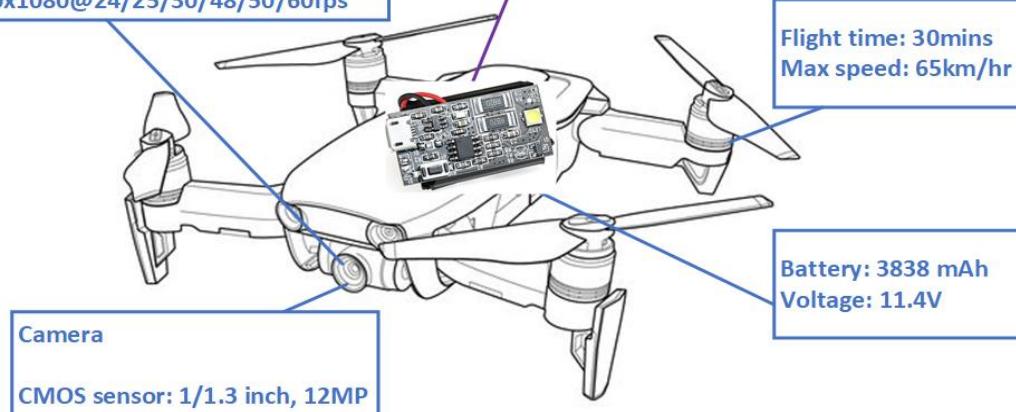
■ DJI Mavic air 2 mini pro flash light

- Maximum power: 10 W
- Battery Capacity: 380 mAh
- Working time:
 - Single flash: 6h
 - Dual flash: 3h
- Brightness (lumens): 1000 Lm



Video resolution:
4K: 3840x2160@25/25/30fps
2.7K: 4096x2160@24/25/30/48/50/60fps
FHD: 1920x1080@24/25/30/48/50/60fps

DJI Mavic air 2 mini 2 pro flash light
Maximum power: 10W
Battery capacity: 380mAh
Brightness (lumens): 100Lm





Drone System (7/10)

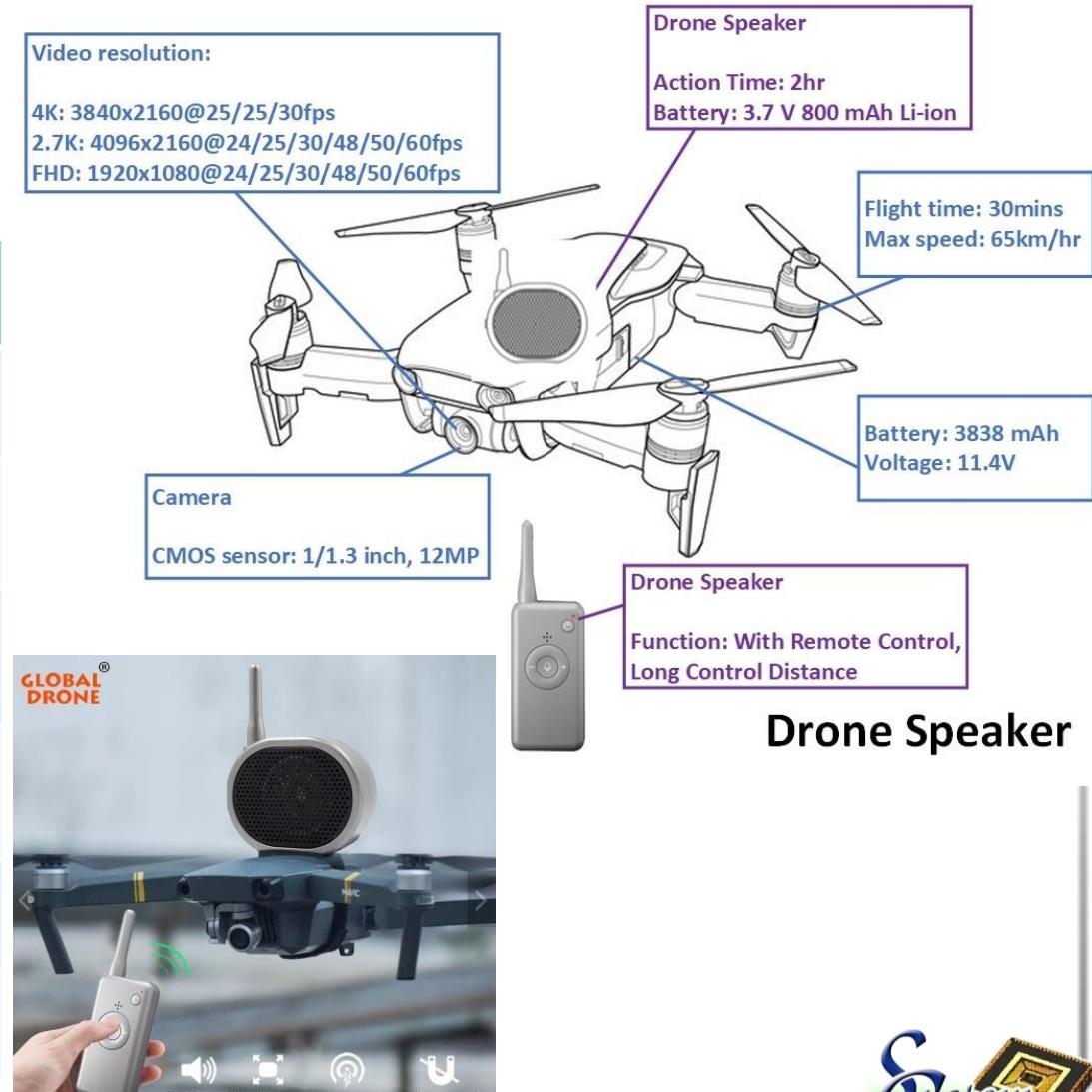
- Combine multiple drone's LED to generate different pattern
- Simp4live Records (a musical group)
 - Specializing in light sculpture shows
- The pattern generate by the drones can guide the crowd where to evacuation
 - E.g., form an arrow shape to navigate the direction



Drone System (8/10)

Speaker Specification

	Spec
Brand name	Global Drone
Speaker controller battery	3.7 V, 800mAh
Speaker action time	About 2 hours
Speaker size	13.5 *10.2* 3.8 (cm ³)
Speaker weight	95g
Control distance	1000m





Drone System (9/10)

5G Small Cell

- Due to the physical characteristic of high frequency signal and the demand of 5G signal
 - It is necessary to extend the signal coverage for 5G network to achieve low latency, high data rate
- Small cell is a major feature for 5G network
 - To deal with the short communication range of 5G network
 - It enables network to extend coverage and to deliver low latency



Drone System (10/10)

- Cell on Wings (COW) – Flying COW
 - Increase the coverage of mobile signal from the sky
- AT&T launched their COW technology in 2022 – 5G Flying COWs
 - The drones with a tether to the ground that provides power and fiber optic cable to broadcast data
- Chunghwa Telecom (CHT) and THUNDER TIGER have proposed COW application



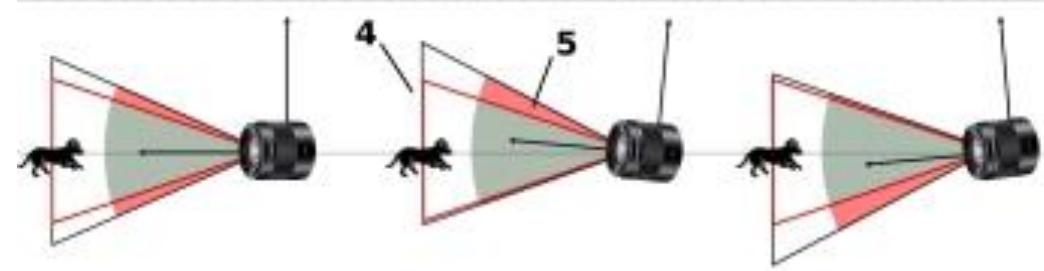


Camera - Electronic Image Stabilization (EIS) (1/2)

- An image enhancement technique that effectively adjusts and balances the captured image
- The system includes a sensor integrated into the camera
 - Reducing jittering and capturing the best stable photos
- EIS incorporates two techniques to make the image stable
 - It digitally zooms in to capture a more prominent image
 - It incorporates a larger sensor to resize the image to fit the available space (hardware-based)
- Compare with the optical image stabilization (OIS) method
 - EIS has a better stabilize performance
 - EIS keeps improving the appearance through equal shifting, whereas the gimbal stabilizer works only drone has shifted

Camera - Electronic Image Stabilization (EIS) (2/2)

■ How EIS work?

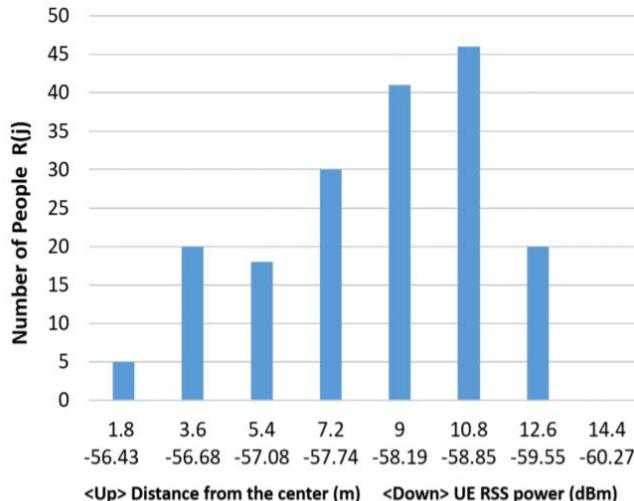


- 1 - Camera movement up
- 2 - Camera movement down
- 3 - Camera movement up and right
- 4 - Image plan
- 5 - Camera movement

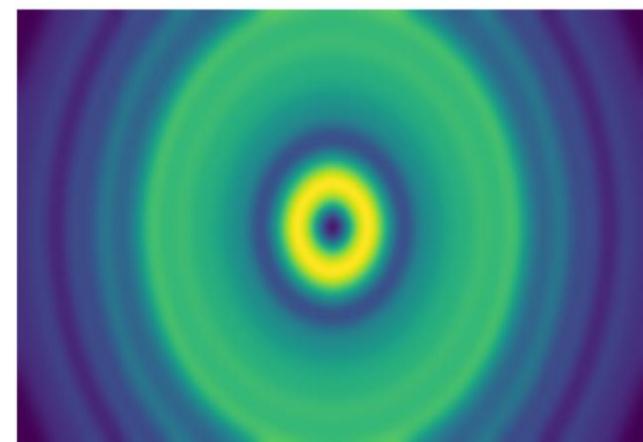


AI Algorithms - Crowd Density Recognition (1/3)

- Combined both RGB image and received signal strength (RSS)
 - To deal with the low quality images, such as occlusion, or poor light condition
- Received signal strength (RSS)
 - A measurement of the power in a received radio signal
 - It can be measures from each received packet in the MAC layer
 - It can be described how far a person is from the UAV
- The original RSS is transform into the human density map (RDM)



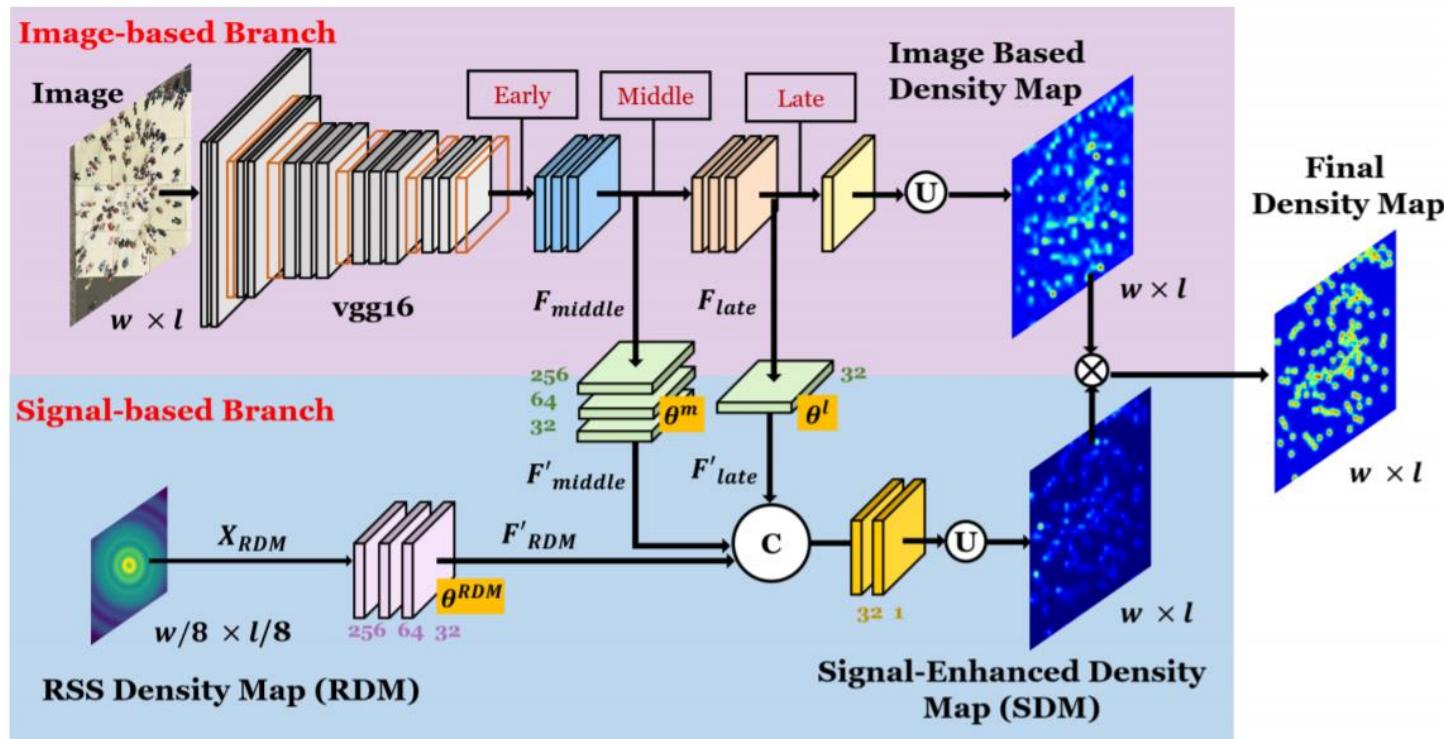
(a) Distance Histogram



AI Algorithms - Crowd Density Recognition (2/3)

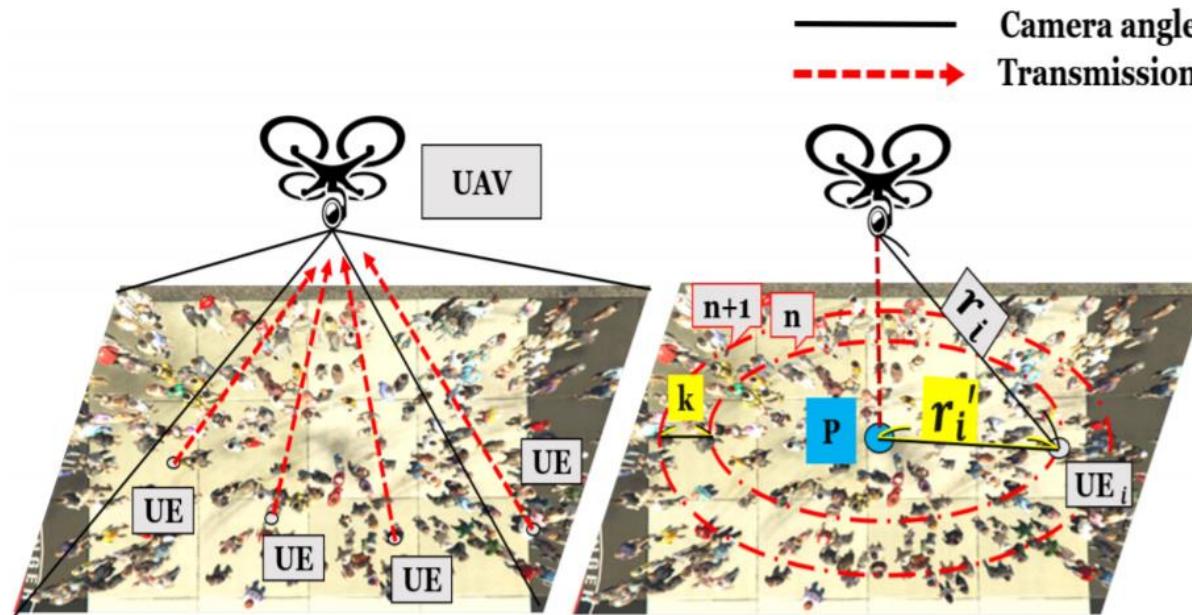
- The model (RIFNet) has been divided into two branch
 - The image-based branch and the signal-based branch
- The overall architecture

© Concatenate U Upsample



AI Algorithms - Crowd Density Recognition (3/3)

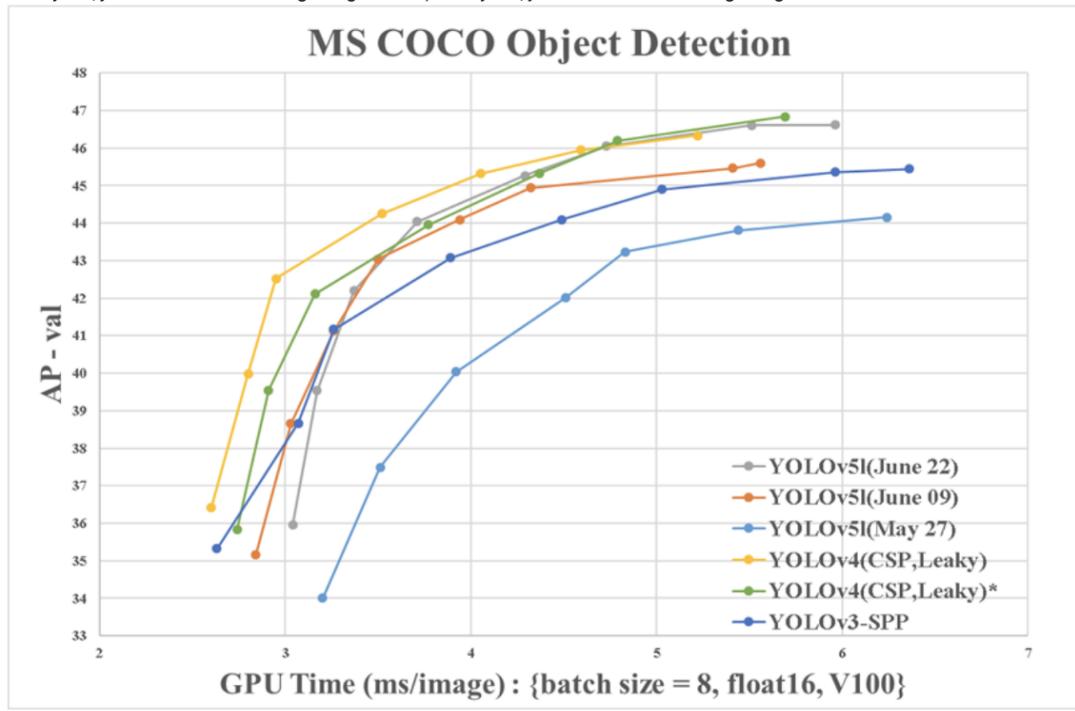
- The performance of RIFNet is better than the state-of-the-art methods
- The scenario is as follows:



- After obtain the crowd density
 - We set a threshold to decide whether the density is overloaded or not to prevent a crowd crush

AI Algorithms - Traffic Analysis (1/2)

- The system can analyze the traffic
 - Based on the video captured by drone and deep learning method
- We adopt the You Look Only Once version 5 (YOLOv5) model
 - To deal with the object detection task
 - It identifies objects more rapidly and more precisely than other recognition systems



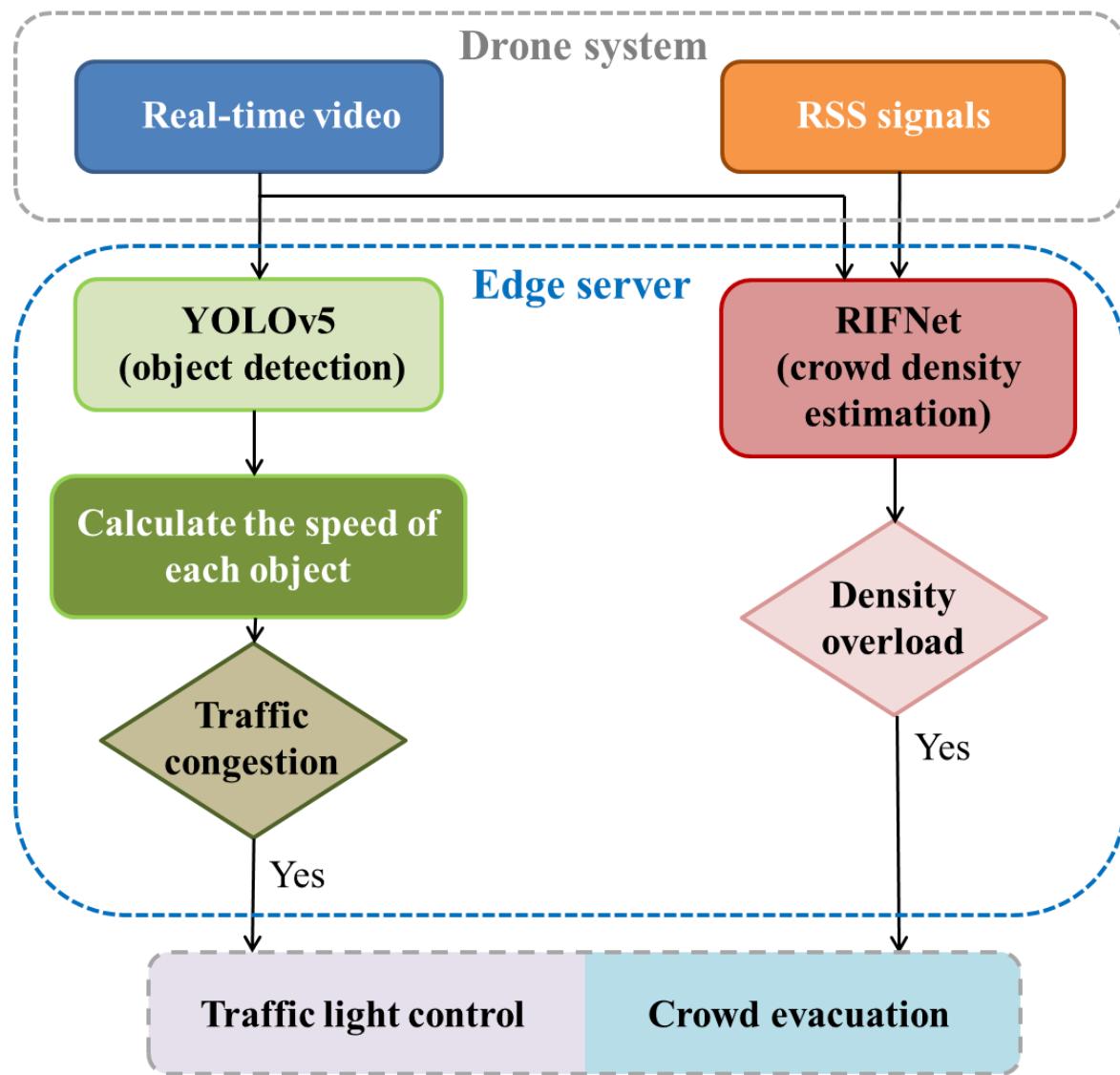


AI Algorithms - Traffic Analysis (2/2)

- We estimate the speed of each object from the object detection results
- If several objects' speed is lower than a threshold, a traffic jam may occur
 - Adjust the duration of the traffic light

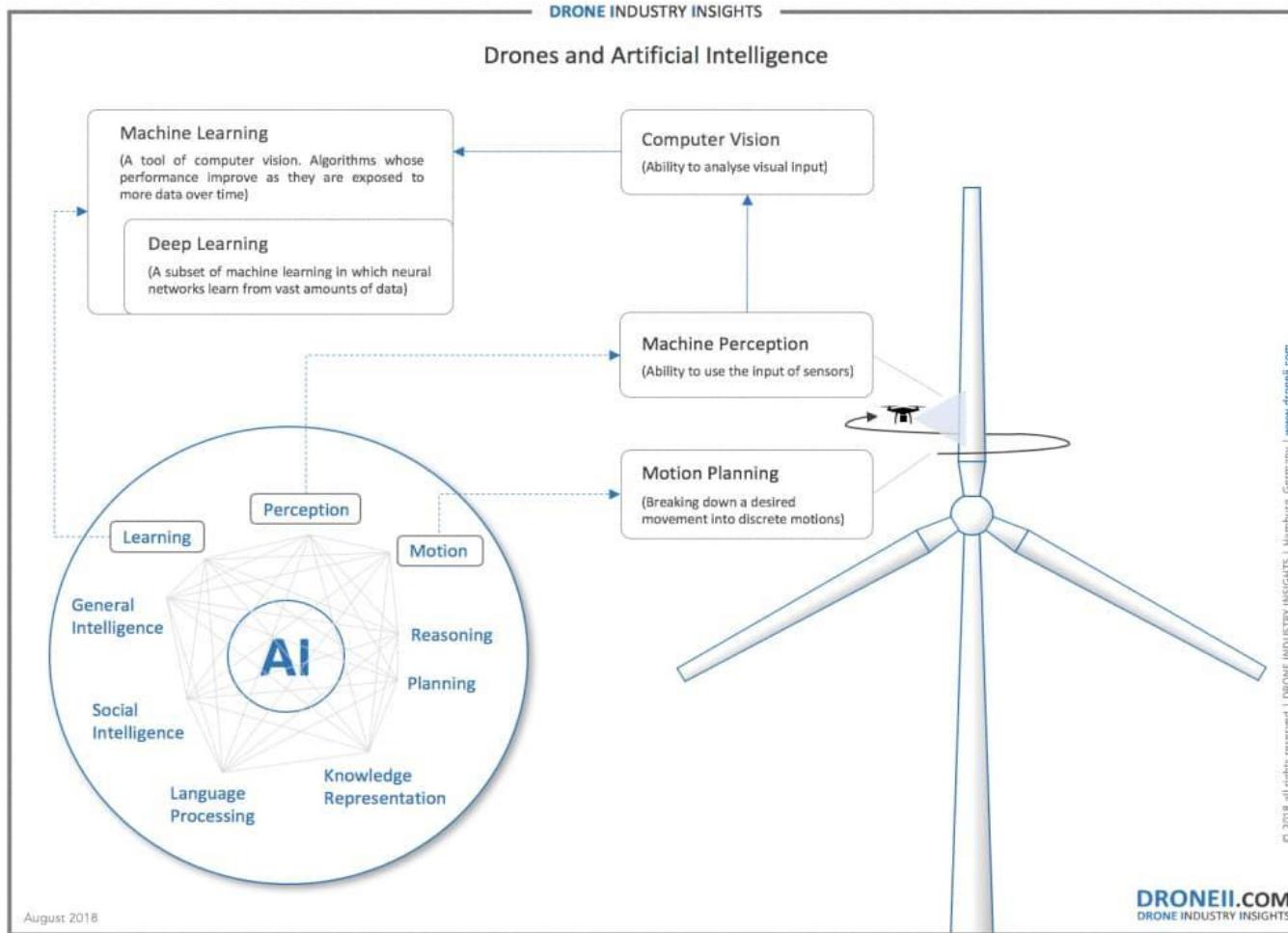


Processing Flow



AI Algorithms - Drone Management (1/3)

- The advantages of AI-based autonomous drone
 - The system is cheaper and safer since no human error



AI Algorithms - Drone Management (2/3)

AI-powered flight controller

- An AI-powered flight controller is necessary that has the right types of sensor
- Capable of following a preprogrammed flight path and therefore perfect for autonomous navigation

Positioning system

- Depend on our GPS and vision-based methods

Path planning for multi-drone system

- By considering several information

- Battery recharge time
- Battery capacity
- Arrival time at each node
- Position
- Crowd density
- Objectives of other drones

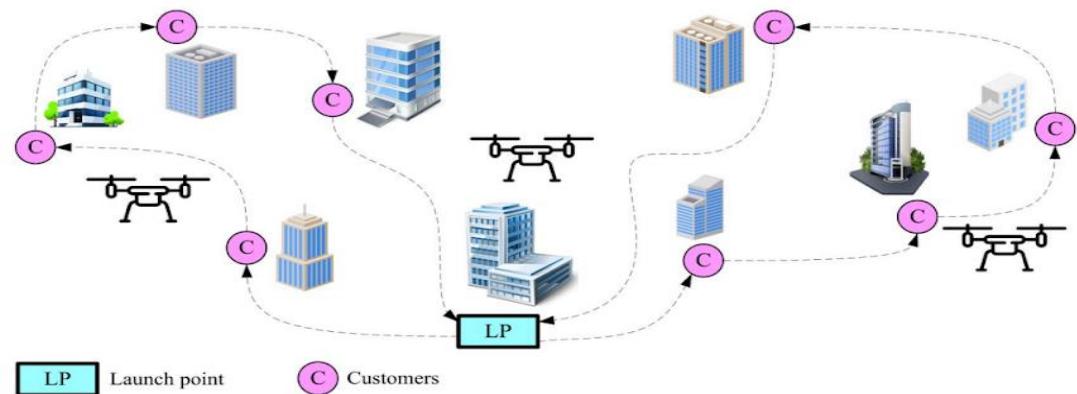


Fig. 2. Typical flight paths of drones.



AI Algorithms - Drone Management (3/3)

General Drone Scheduling Problem (GDSP)

- One of the key problems that have received increasing attention over the last decade
- Associate with several features
 - Such as launch points, nodes, objectives, monitoring, and battery capacities
- Under the limited amount of the flying time
 - The drone is designed to served the designated customers and return the launch point
- We plan to use GDSP to help with the task of calculating flight paths
- GDSP is basically a set of rules and constraints
 - That make sure the path planning is in the most optimized way



Edge Server

- The AI algorithms is computed by the edge server
- Upgraded from W332-Z00 AMD Ryzen™ Tower Entry Workstation

Specification	
Motherboard	MC13-NB0
Memory	256gb DDR5
CPU	AMD EPYC™ 9004
GPU	NVIDIA A100 40/80GB PCIe GPU
Power Supply	Cosair AX1600i





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Porter's 5 Force Analysis

Bargaining power of customers

- Low, our product is very innovative and is specifically designed for use by the police.

Bargaining power of suppliers

- High, many patents or technologies are only offered by a single manufacturer.

Threat of new entrants

- Low, our product is mainly designed for the police and is not easily accessible for the general public to purchase.

Threat of substitutes

- Low, our product is designed by combining the technologies and patents of different manufacturers and is mainly for use by the police.

Competitive rivalry

- None, there are no competitors in the market.



S.W.O.T Analysis

■ Strength

- Product is unique
- Applications such as Sim4live Records first been used on evacuation
- A variety of option for different scenarios (speaker, projector, and LED)

■ Weakness

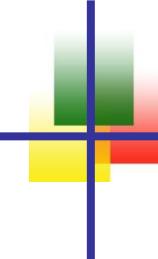
- Only suitable for the police
- Expensive

■ Opportunities

- The product can be sold to police in other countries
- Military surveillance applications
- Rent to the organizer of big event

■ Threat

- Privacy and security issues
- DJI rescue services



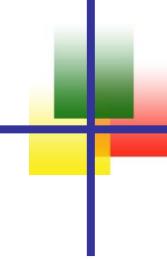
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Conclusion

- In this work, we propose a drone-aided police control system to assist the police task
- The system provides a way to evacuate the crowd when an emergency occurs
- It broadcast the alert by speaker, projector, etc.
 - Everyone can notice the alert from the sky and the crowd can be evacuated with a more clear instruction
- The system also provide a traffic analysis in real-time
 - Control the traffic light when a traffic jam is appear
- The industrial analysis shows the novelty of the proposed system
- The weight of the drone and the battery life is the points that can improve in the future



Task Partition

- Proposal - All
 - SoC specification - 許芷毓
 - Technology analysis
 - Drone - 陳俊翰
 - Camera - 楊士緯
 - LED, projector, speaker - 楊智勝
 - Edge server - 郭義安、陳俊翰
 - 5G communication - 許芷毓
 - Drone management and path planning algorithm - 郭義安
 - Monitoring system (crowd density) and traffic analysis algorithm - 楊士緯
 - Industrial analysis - 楊智勝
 - Organize report - 楊智勝、許芷毓
 - Presentation - 楊士緯、郭義安、陳俊翰
- Note that the task partition is described with more detail in the final report



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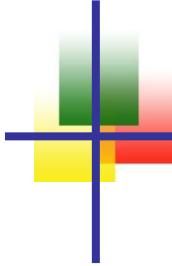
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Thank You!