



GHIT



IEIE
The Institute of Electronics
and Information Engineers

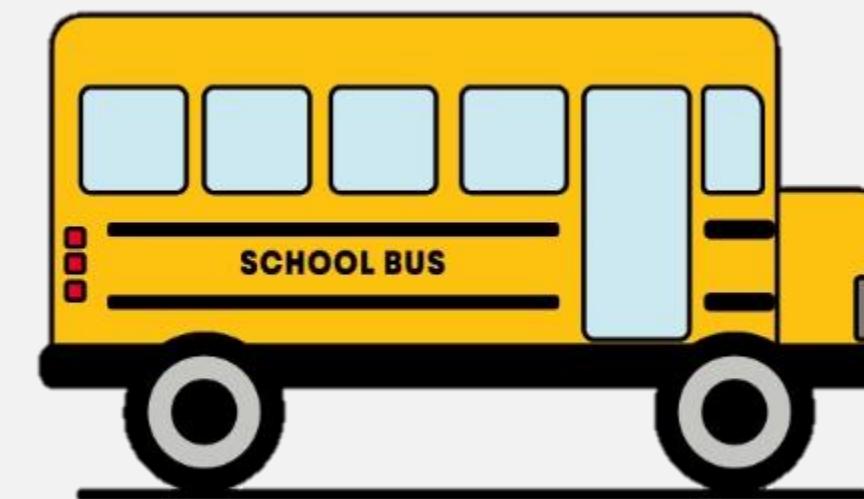


SsangYong
Information & Communications Corp.



TDTU
BAN HỌC TỐN ĐỨC THẮNG
TON DUC THANG UNIVERSITY

Intelschoolbus - The system for counting controlling students on school buses

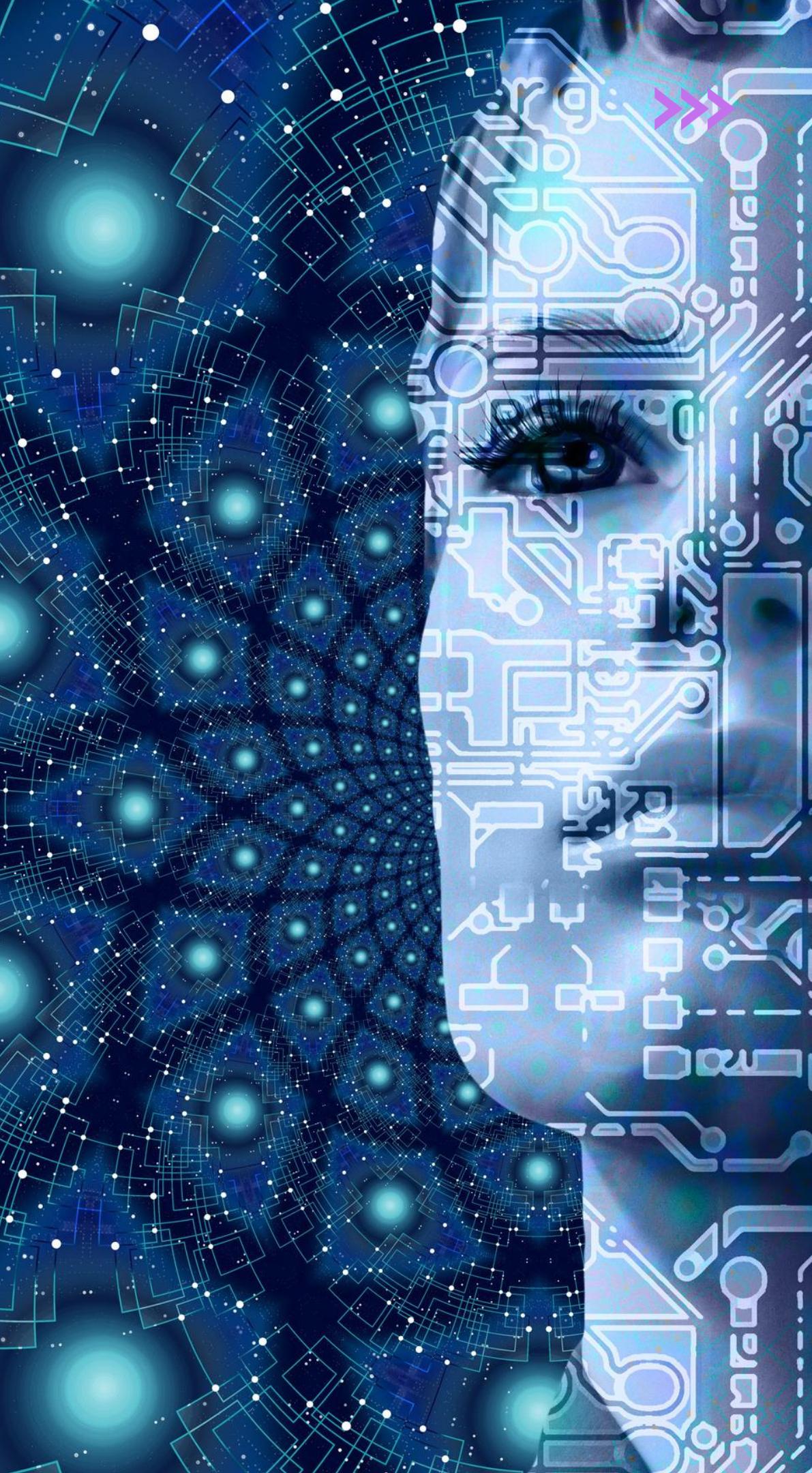


1/ OBJECTIVES

- Lightweight model running in real-time on low-cost hardware
- GPS for tracking
- Monitoring via IoT



Figure 1. Illustration of a school bus





2/ PROBLEMS

Since 2020, there have been at least 5 serious incidents involving students being left behind on school buses



Figure 2. Vietnamese students



As of the 2023-2024 school year, the total number of students across all three education levels in Vietnam is approximately 18.5 million

Figure 3. Students getting on bus

- Decree No. 86/2014/NĐ-CP
- Road Traffic Law 2008
- Circular No. 12/2017/TT-BGTVT
- Resolution No. 88/NQ-CP
- Directive No. 31/CT-TTg from the Prime Minister



Figure 4. Schoolbus in Vietnam

2/ PROBLEMS

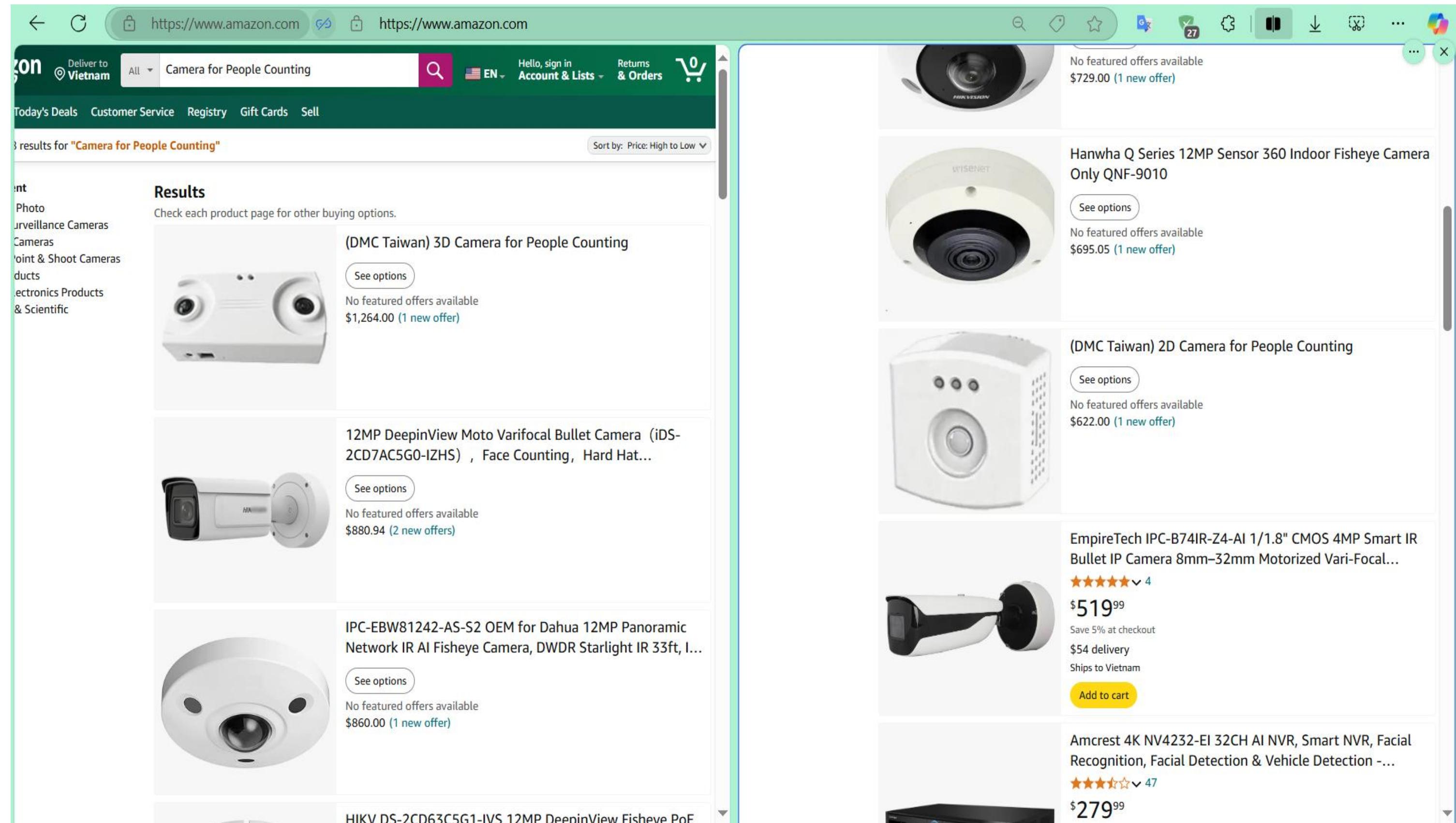


Figure 5. Camera 3D price

2/ PROBLEMS

EMIN
Testing & Measuring Everything

Camera nhiệt UNI-T UTi120P (120x90 pixel, -20~400°C)
5,509,275 VND

Có sẵn: 5 Cái

EMIN
Testing & Measuring Everything

Camera đo nhiệt cầm tay Guide P120V (-20°C-400°C; ±2°C/±2%)
6,609,855 VND

Có sẵn: 5 Cái

EMIN
Testing & Measuring Everything

Camera nhiệt UNI-T UTi120T (120x90pixels,-20~400°C)
7,358,025 VND

Có sẵn: 5 Cái

EMIN
Testing & Measuring Everything

Camera ảnh nhiệt dùng cho smartphone FLIR ONE PRO (Android, 400°C, 160x120 pixels,USB-C)
11,188,125 VND

Có sẵn: 5 Cái

EMIN
Testing & Measuring Everything

Camera ảnh nhiệt UNI-T UTi730E (-40~400°C, 320x240 pixels, 3mrad)
15,529,500 VND

Có sẵn: 5 Cái

EMIN
Testing & Measuring Everything

Camera ảnh nhiệt bỏ túi FLUKE FLK-PTI120 9HZ 400C (120 x 90, 9Hz)
25,571,400 VND

Có sẵn: 5 Cái

EMIN
Testing & Measuring Everything

Camera đo nhiệt độ FLUKE FLK-TIS75+ 9HZ (-20~550°C; 384x288 pxls; 1.91mRad; IP54)
132,549,000 VND

EMIN
Testing & Measuring Everything

Camera đo nhiệt độ FLUKE FLK-TIS55+ 9HZ (256 x 192 pixels, 1.91 mRad, -20 °C đến 550 °C)
Liên hệ

Figure 6. Thermal camera price

2/ PROBLEMS

Table 1. Requirements of the work

Feature	People Counter Using IR Sensor	People Counter Using Thermal Camera	People Counter Using 3D Camera
Technology	Uses infrared sensor	Uses thermal sensor	3D camera with depth sensor
Counting Performance	Performance decreases if many people move simultaneously or overlap	High accuracy in dark environments but struggles with multiple people simultaneously	Accurate but requires more complex processing
Investment Cost	Costs around \$260	Average cost starts from \$190, depending on sensor quality	High cost (over \$630) due to complex technology and specialized installation

3/ PROPOSED SYSTEM



Figure 7. Transmitter

Hardware



MQTT



Software

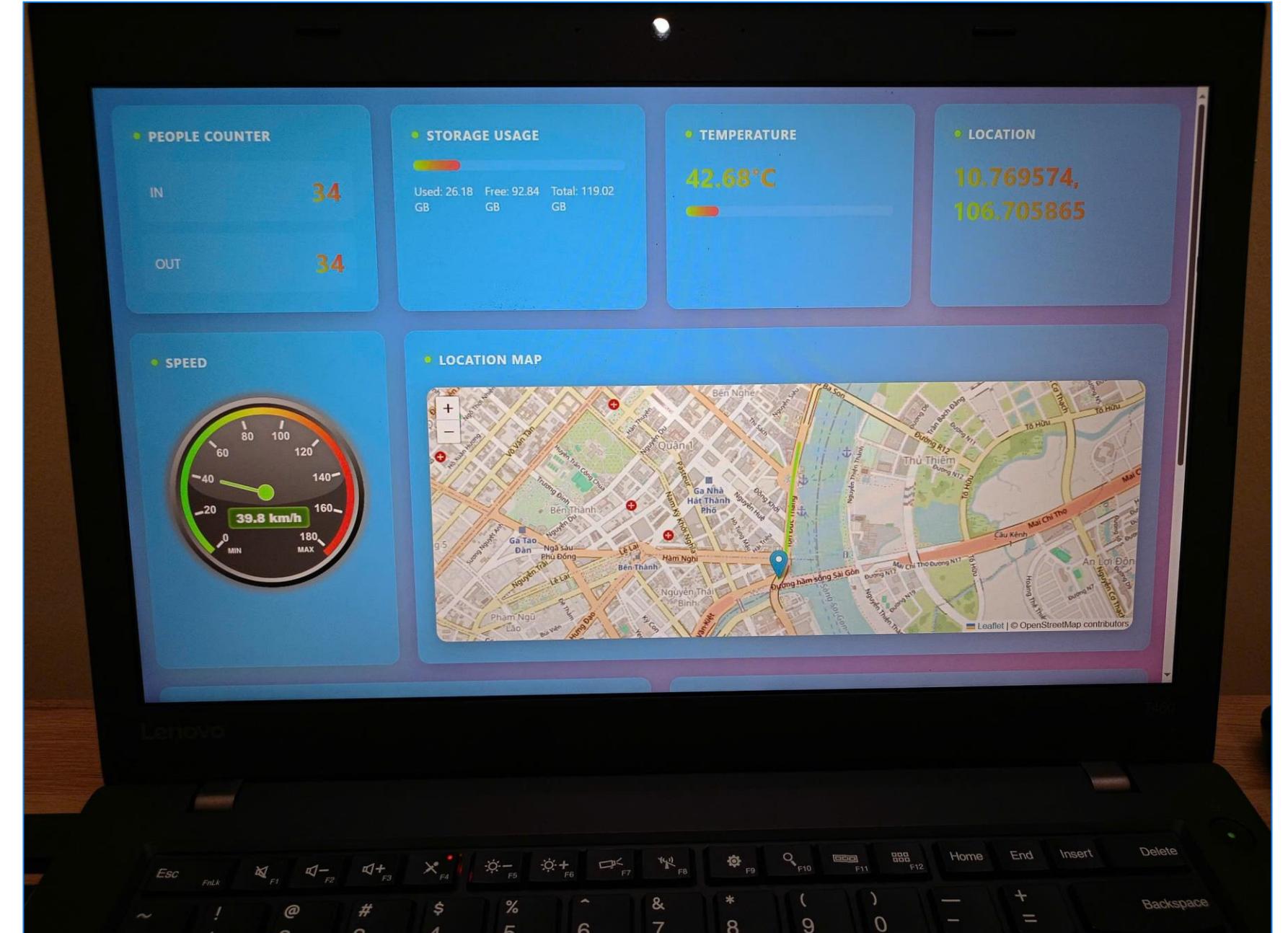


Figure 8. Receiver

3/ PROPOSED SYSTEM



Figure 9. The system's position



Figure 10. The system's exterior

3/ PROPOSED SYSTEM

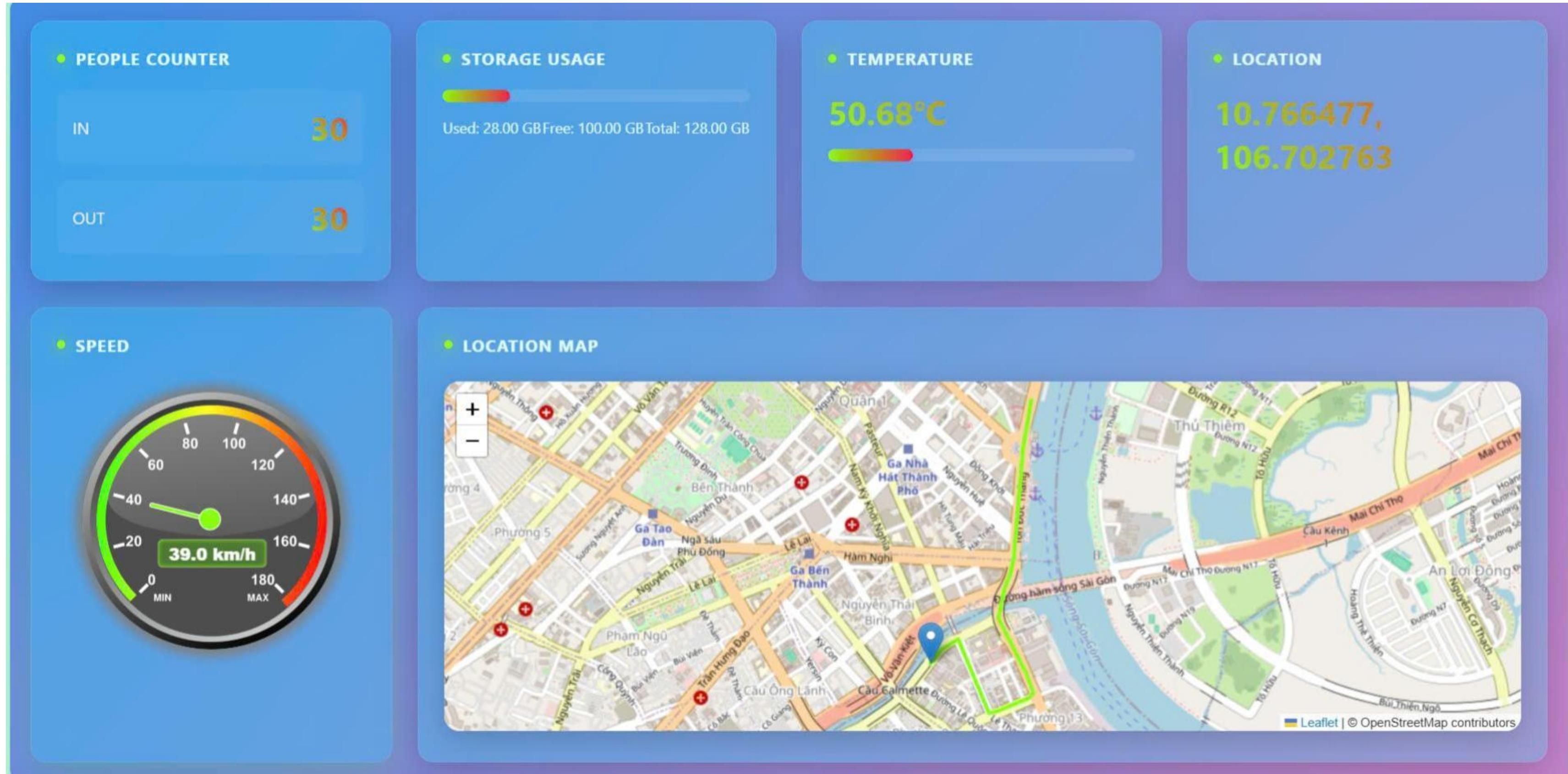


Figure 11a. Website for monitoring

3/ PROPOSED SYSTEM

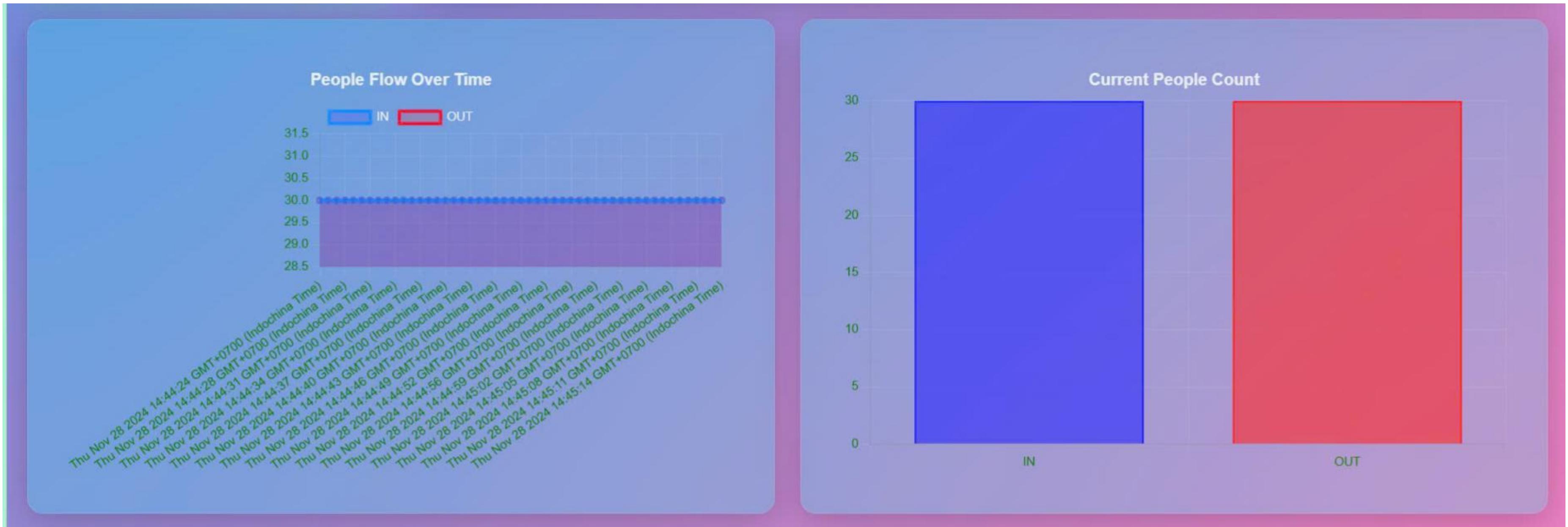


Figure 11b. Website for monitoring

3/ PROPOSED SYSTEM

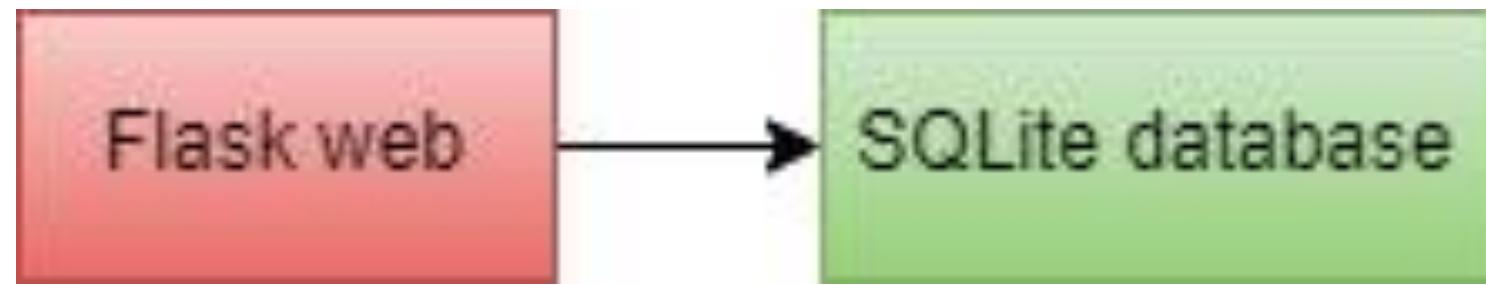


Figure 12. The block flow diagram of receiver

```
data = {
    "latitude": current_lat,
    "longitude": current_lon,
    "speed": current_speed,
    "up_down_count": up_down_count,
    "down_up_count": down_up_count,
    "total_gb": total_gb,
    "used_gb": used_gb,
    "free_gb": free_gb,
    "usage_percent": round(memory_usage_percent, 2),
    "storage_full": storage_full,
    "temperature": cpu_temp,
    "gps_status": "OK" if gps_serial else "N/A"
}
```

4/ EXPERIMENTAL RESULTS

Table 2. Experimenting with models and algorithms on Raspberry Pi 4

Input Resolution	Model and Method	People counting integration	FPS	Performance and Issues
Webcam 300x300	Pre-trained MobileNet_v1 converted to TFLite	Yes	6-8	Stable for counting individuals
Webcam 640x480	Pre-trained MobileNet_v1 converted to TFLite	Yes	5-7	Stable for counting individuals
Video 1920x1080 & 640x480	Pre-trained MobileNet_v1 converted to TFLite	Yes	~5	Some counting errors, misidentification
Video 1920x1080 & 640x480	Fine-tuned YOLOv9 (350 images, 79 epochs, mAP = 0.96) converted to TFLite16/32	Yes	<1	Poor performance
Webcam 640x480	Pre-trained YOLOv8n converted to TFLite16/32	No	<1	Poor performance
Webcam 640x480	Pre-trained YOLOv8n converted to TFLite with Deep Sort (real-time)	No	<1	Poor tracking, errors
Webcam 640x480	Pre-trained YOLOv8n converted to TFLite with Deep Sort	No	<1	Poor tracking, errors
Webcam 640x480	Pre-trained MobileNet_v2 using PyTorch + FasterRCNN	No	<1	Poor performance

Webcam 640x480	Pre-trained SSD300_VGG16 using PyTorch	No	<1	Poor performance
Webcam 1920x1080	OpenCV-based color detection	Yes	~30	Used for testing webcam
Video 640x480	MOG2 for separating moving objects from the background	Yes	~12	Limited application, suitable for ideal inputs
Video 1080x1920	Pre-trained YOLOv8s with 1/3 frame processing rate (skipping 66.67% of frames). Tracks centroid, matches based on Euclidean distance, assigns and manages IDs	Yes	0-6	~50% errors
Video 1080x1920	Pre-trained YOLOv8n, tracks centroid, matches based on Euclidean distance, assigns and manages IDs	Yes	0-6	Accurate
Webcam 1080x1920	Pre-trained YOLOv8n, tracks centroid, matches based on Euclidean distance, assigns and manages IDs	Yes	<1	Poor performance
Webcam 640x640	Object tracking with CamShift using OpenCV	No	12-16	Inaccurate tracking

4/ EXPERIMENTAL RESULTS

Table 3. Experimenting with models and algorithms on RICS-V

Model	Tracker	Number of Objects in Frame	FPS	Accuracy Rating
Pre-trained yolov5s	ByteTrack	0	34	v8>v5>11
		1	30	
		1-5	19	
		5-10	14	
		>10	12.5	
Pre-trained yolov8n	ByteTrack	0	35	v8>v5>11
		1	29	
		1-5	19	
		5-10	16	
		>10	14	
Pre-trained yolo11n_32o24_int8	ByteTrack	0	34	v8>v5>11
		1	29	
		1-5	20	
		5-10	18	
		>10	14	

4/ EXPERIMENTAL RESULTS

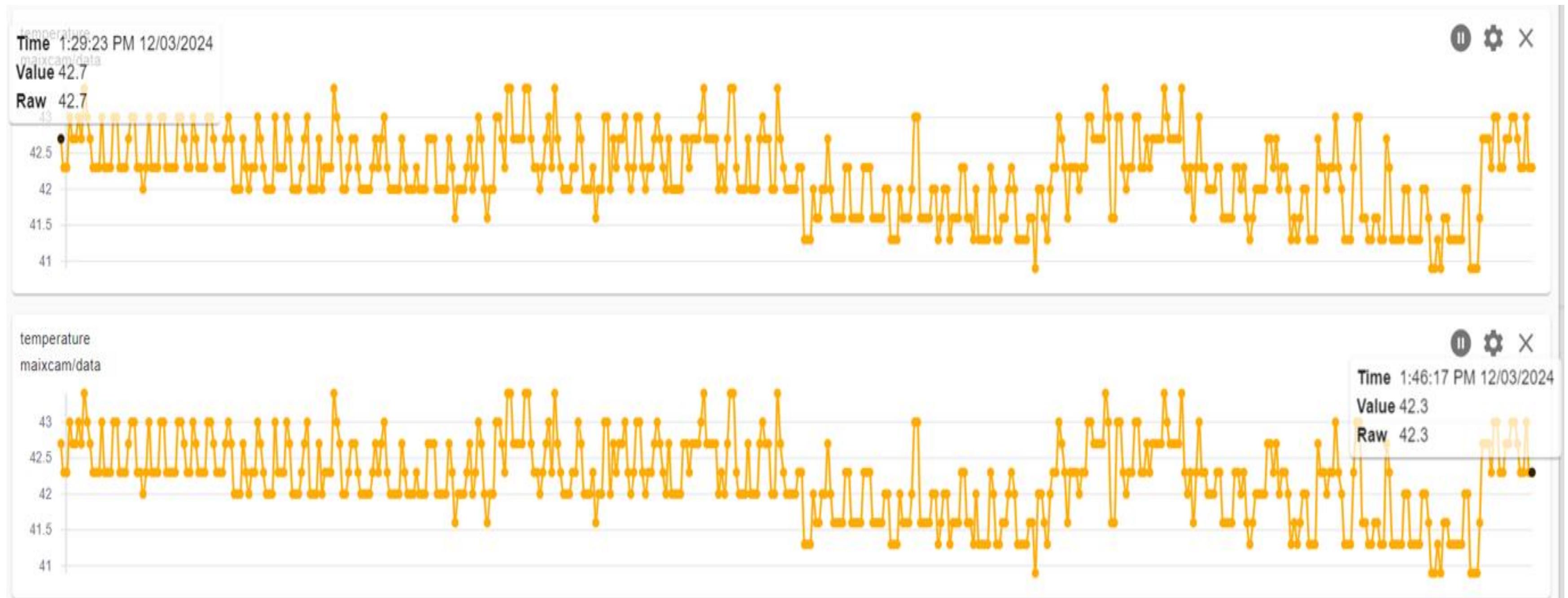


Figure 13. Observe the average temperature through MQTT Explorer on the computer

4/ EXPERIMENTAL RESULTS

Table 4. Statistics of collected images

Time	Number of images
04/11 – 10/11	792
11/11 – 17/11	629
16/11 – 22/11	1379
30/11 – 05/12	668
Total	3468

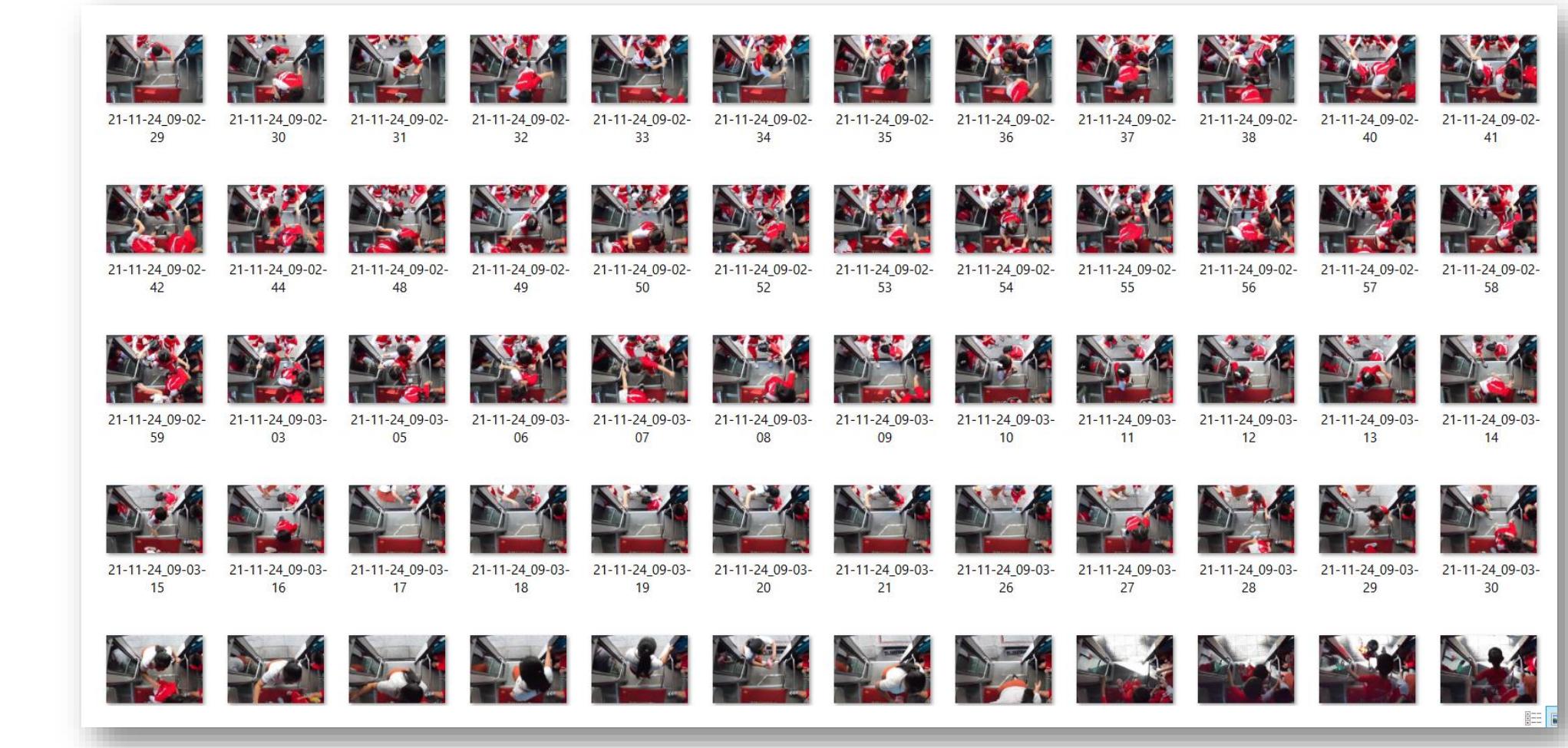


Figure 14. Collected images

4/ EXPERIMENTAL RESULTS



(a)

(b)

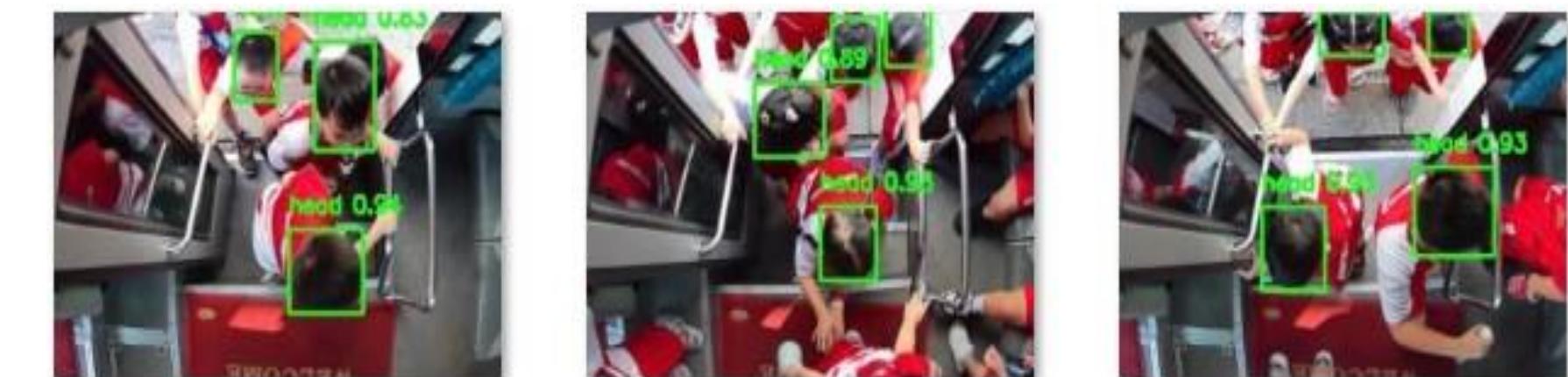
(c)

(d)

(e)

(f)

Figure 15. YOLOv8n pretrained



(a)

(b)

(c)

(d)

(e)

(f)

Figure 16. Custom YOLOv8n

4/ EXPERIMENTAL RESULTS

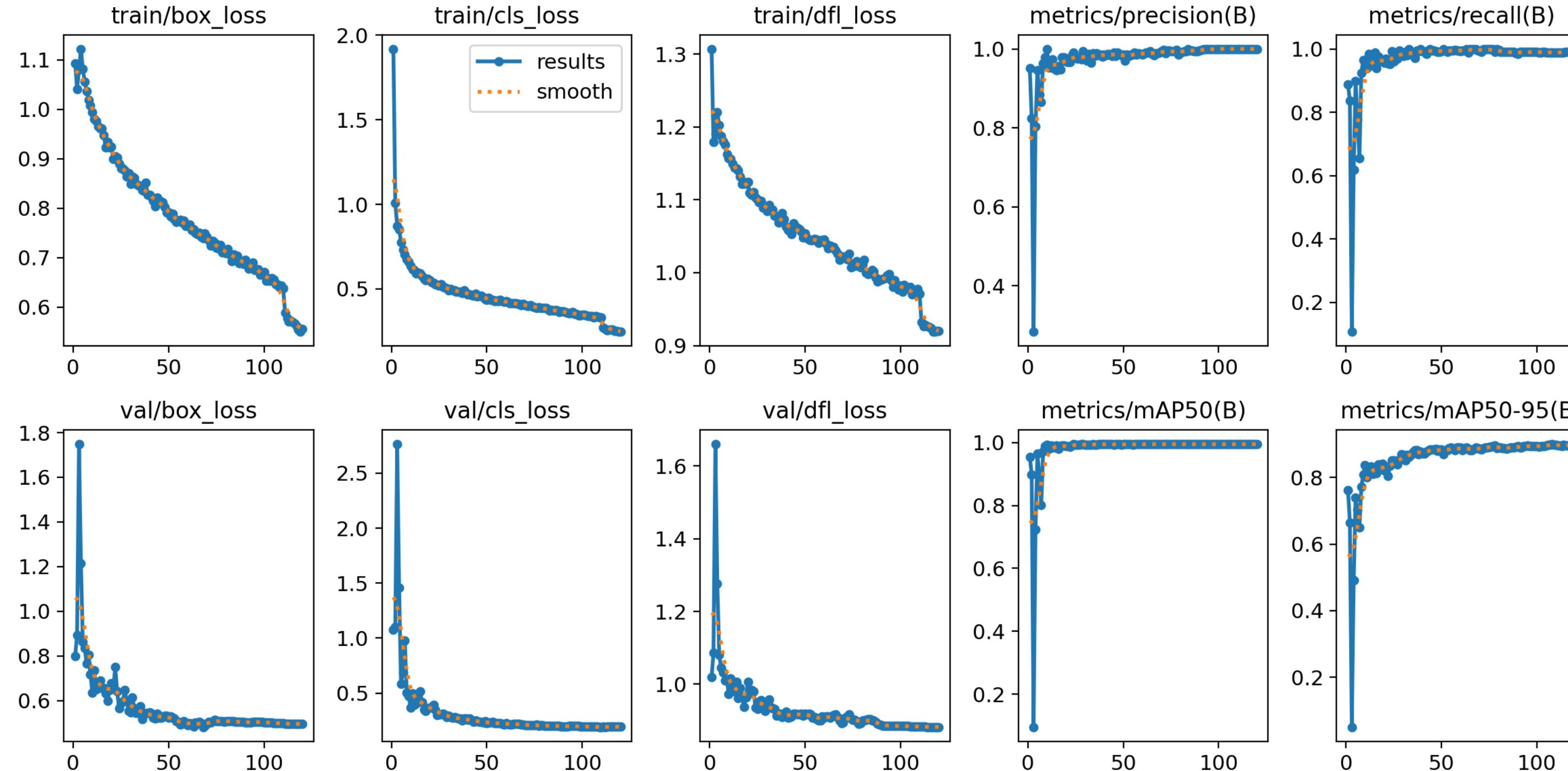
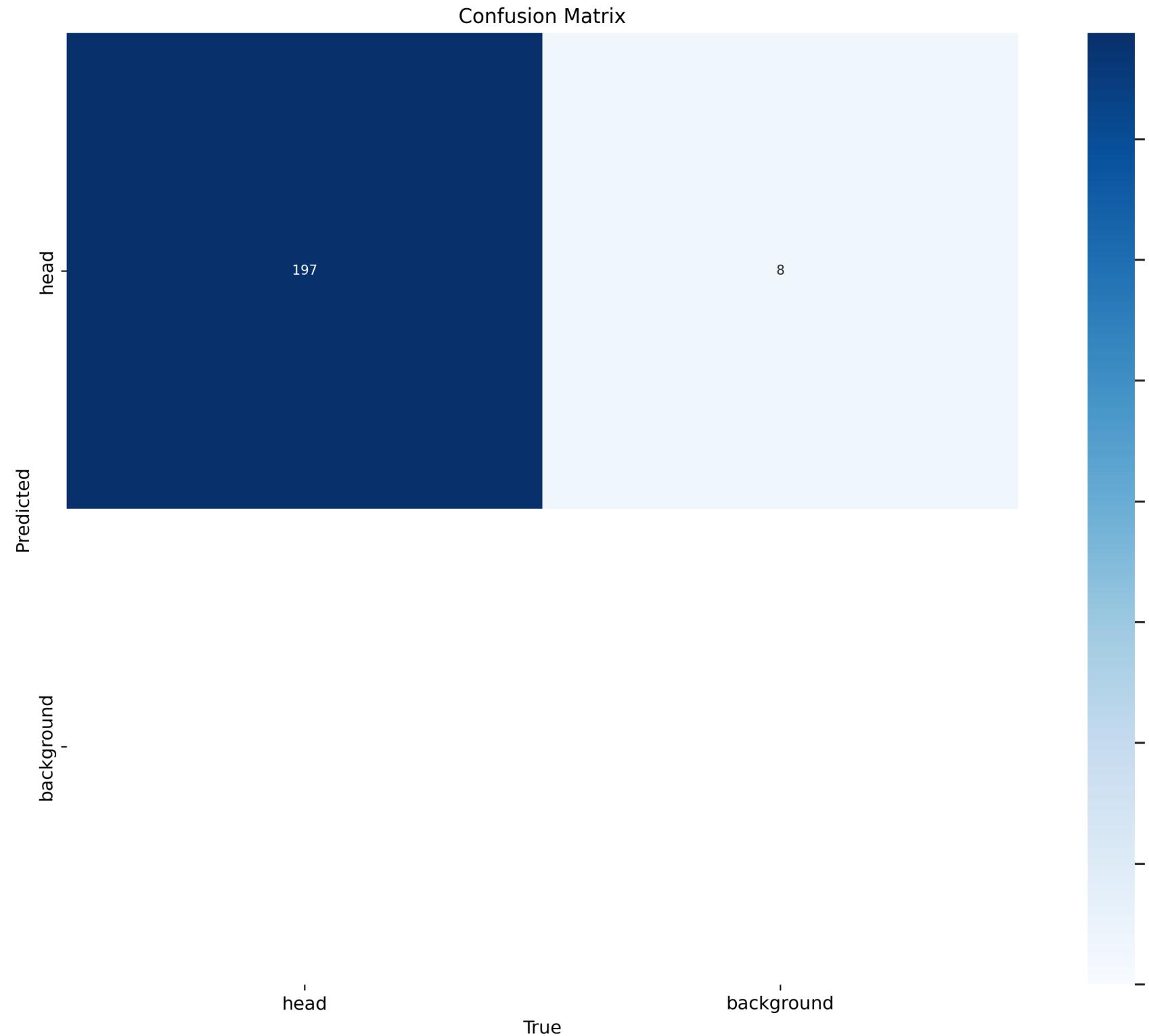


Figure 17. Results

4/ EXPERIMENTAL RESULTS



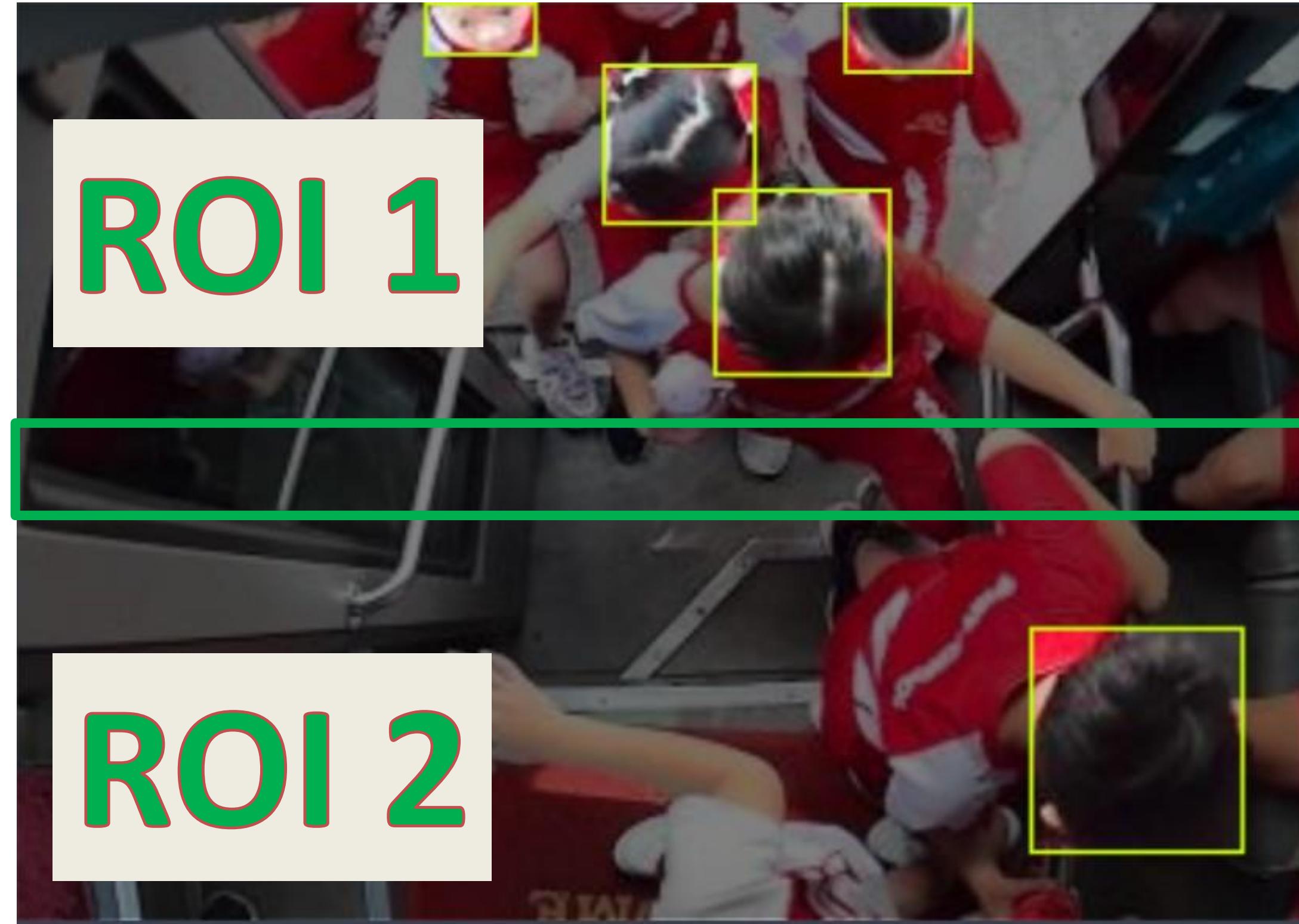
$$\text{Accuracy } (A) = \frac{tp + tn}{tp + fp + tn + fn} = \frac{197 + 0}{197 + 8 + 0 + 0} = 0.961$$

Estimated Accuracy = 96.1%

Figure 18. Confusion Matrix

4/ EXPERIMENTAL RESULTS

ROI



IN: ROI 1 → ROI 2

OUT: ROI 2 → ROI 1

Figure 19. Counting method

5/ CONCLUSION

Table 5. Results achieved compared to the initial requirements

Property	The completed product	Required Specification
Accuracy	96%	Over 95%
FPS (Frames per Second)	Over 10	Over 10
Cost	\$108	Below \$150
Weight	150 grams	Below 200 grams
Average operating temperature measured	Below 50°C	Below 80°C
Operating Time	12 hours continuously	Minimum 12 hours continuously
System Size	115x90x55 mm	Smaller than 200x200x100 mm
Other Standards	Industrial-grade wired connection, dustproof, and water-resistant IPX22	Industrial-grade wired connection, dustproof, and water-resistant IPX22

5/ CONCLUSION

Table 6. Total price of product

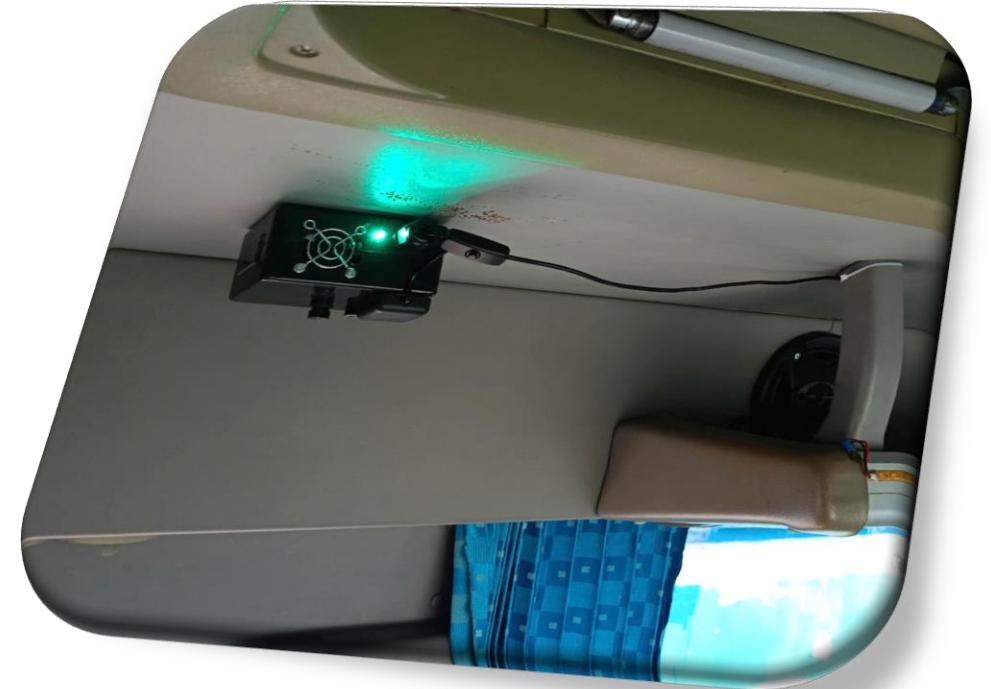
Item No.	Component	Price (VND)	Price (USD)
1	RICS-V device	700000	27.552
2	GPS module	288000	11.33568
3	GPS Antenna 1575.42 MHz SMA 3m Length	59000	2.32224
4	4G Mobile Wi-Fi	900000	35.424
5	Nidec DC fan	27000	1.06272
6	Plastic box 115x90x55 mm	11000	0.43296
7	3W Infrared light	25000	0.984
8	USB-Type C Cable with Switch	27000	1.06272
9	Energizer 20000mAh / 3.7V Li-Polymer Power Bank (UE20010)	420000	16.5312
10	Mobifone 4G SIM, 3GB/month, 1-year validity	176000	6.92736
11	PCB Board and other components	100000	3.936
TOTAL		2733000	107.57088

5/ CONCLUSION



RUBY SCHOOL
KINDERGARTEN - PRIMARY - SECONDARY
KẾT HỢP GIỮA KHÁM PHÁ VÀ KHÁM PHÁ

5/ CONCLUSION



Thank you
for your attention!