

AI-FCW Forward Collision Warning System



Supervisory Unit: Industrial Development Administration, MOEA

Executive unit: Institute for Information Industry



Hardware Architecture

Controller

HUB 8735 ultra
Responsible for AI vehicle recognition and algorithm judgment

HUB 8735ultra · Smart AI CAM is a highly integrated module with multi-functional image processing and built-in NPUAI computing engine to accelerate AI model processing and 802.11 a/b/g/nDual-band Wi-Fi and BLE low-power Bluetooth transmission can be widely used in various applications combined with image recognition or AI computing in the IoT field.

GPS satellite positioning

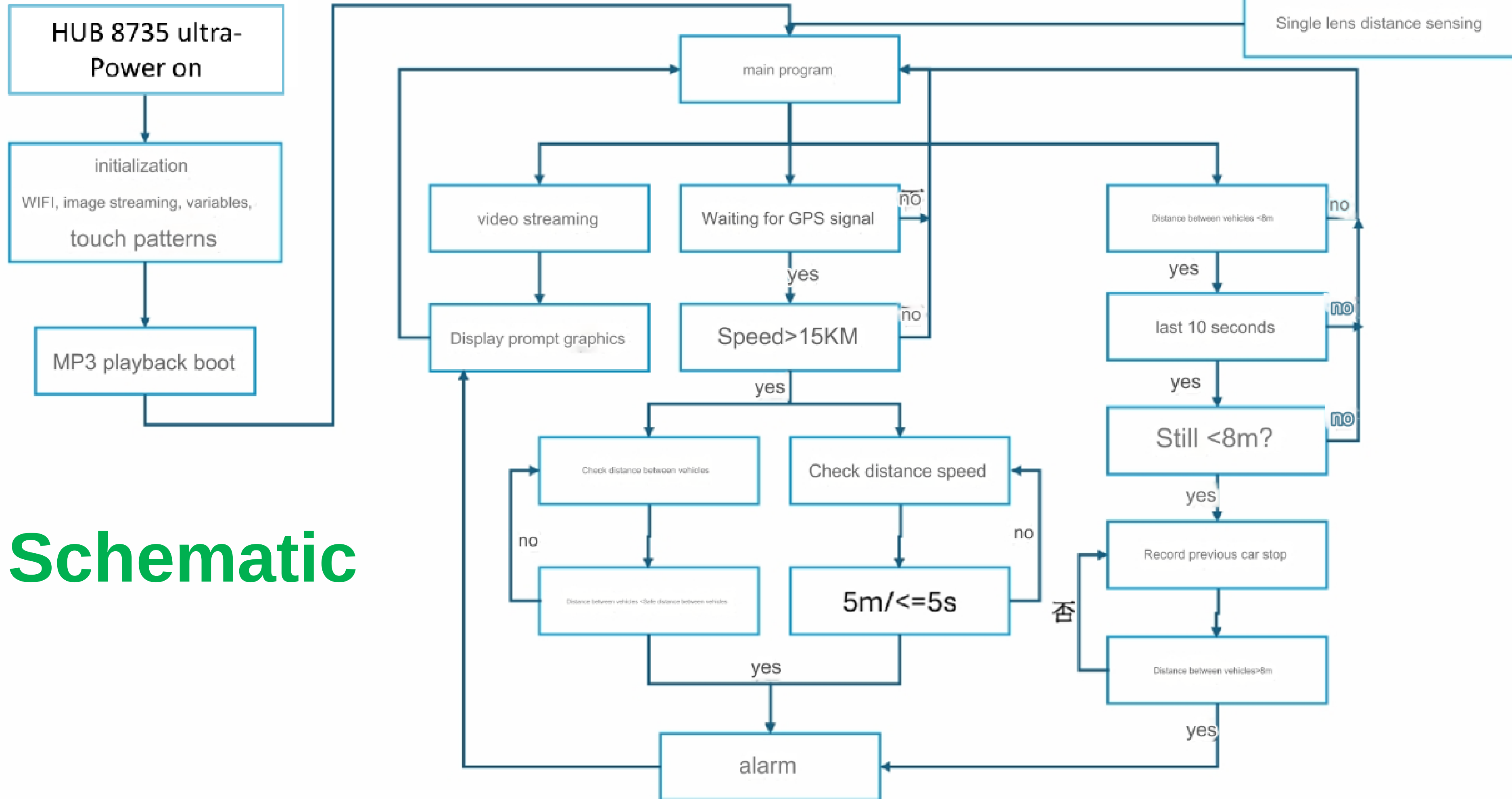
Neo-6m-v2 GPS
Responsible for vehicle speed measurement and positioning

NEO-6M GPS Satellite positioning module Can With passive ceramic antenna and passive antenna amplifier circuit, it works better when used alone. With IPX interface, it can directly connect to IPX active antenna 5. Add MAX2659 signal amplification, satellite search signal is stronger. NEO-6M GPS module has high sensitivity, low power consumption, miniaturization, and its extremely high tracking sensitivity greatly expands its positioning coverage.

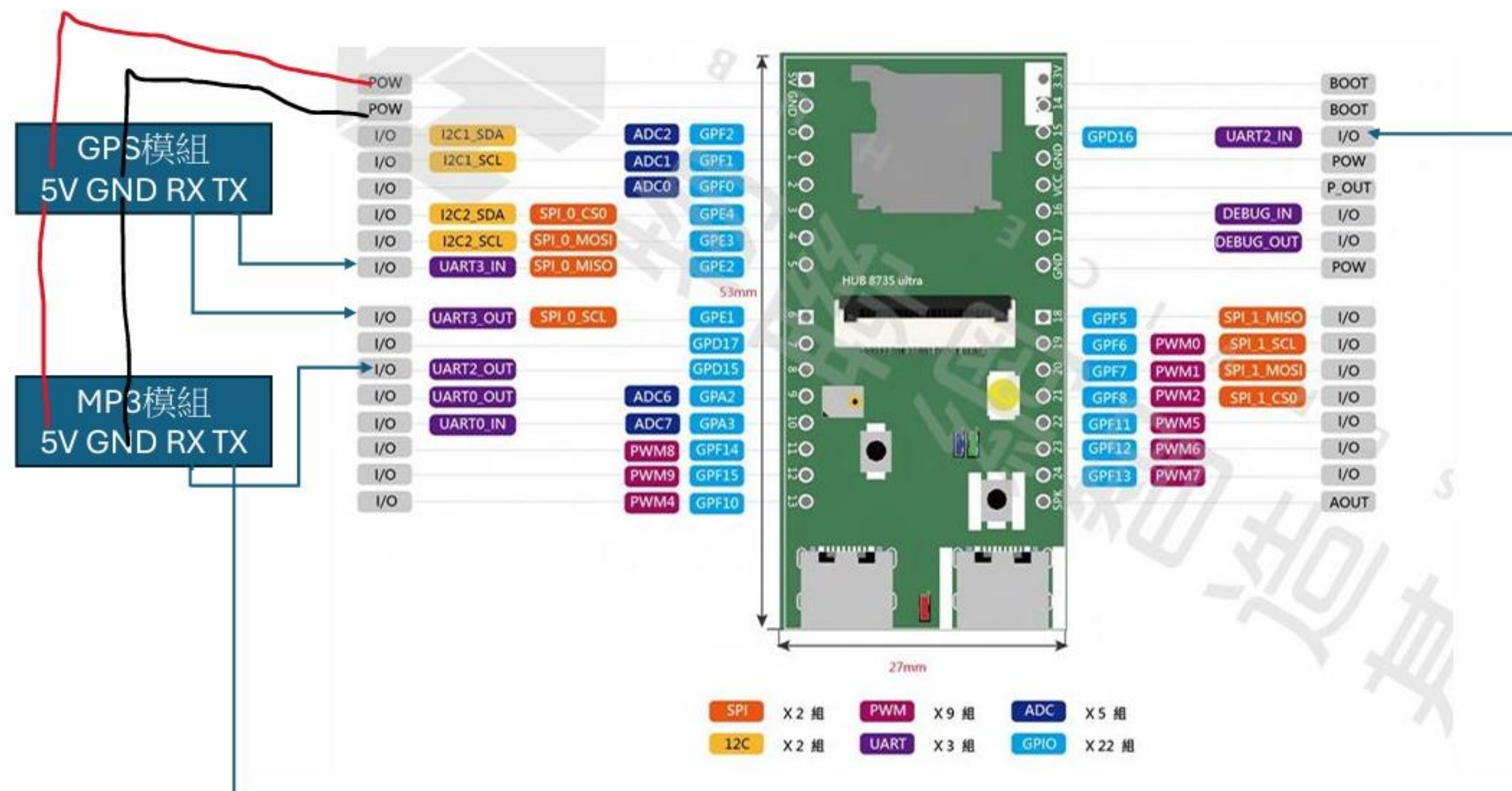
MP3 Module

MP3-TF-16P
Responsible for sound prompts and notifications

MP3-TF-16P It is a voice module that provides a serial port and is well integrated MP3, WAV, WMA Hardware decoding. Software support TFCard drive, support FAT16, FAT32 File system. Through simple serial port commands, you can complete the functions of playing specified music and how to play music, without complicated underlying operations, and it is easy to use. Stability and reliability are the main features of this product



Schematic



Wiring diagram

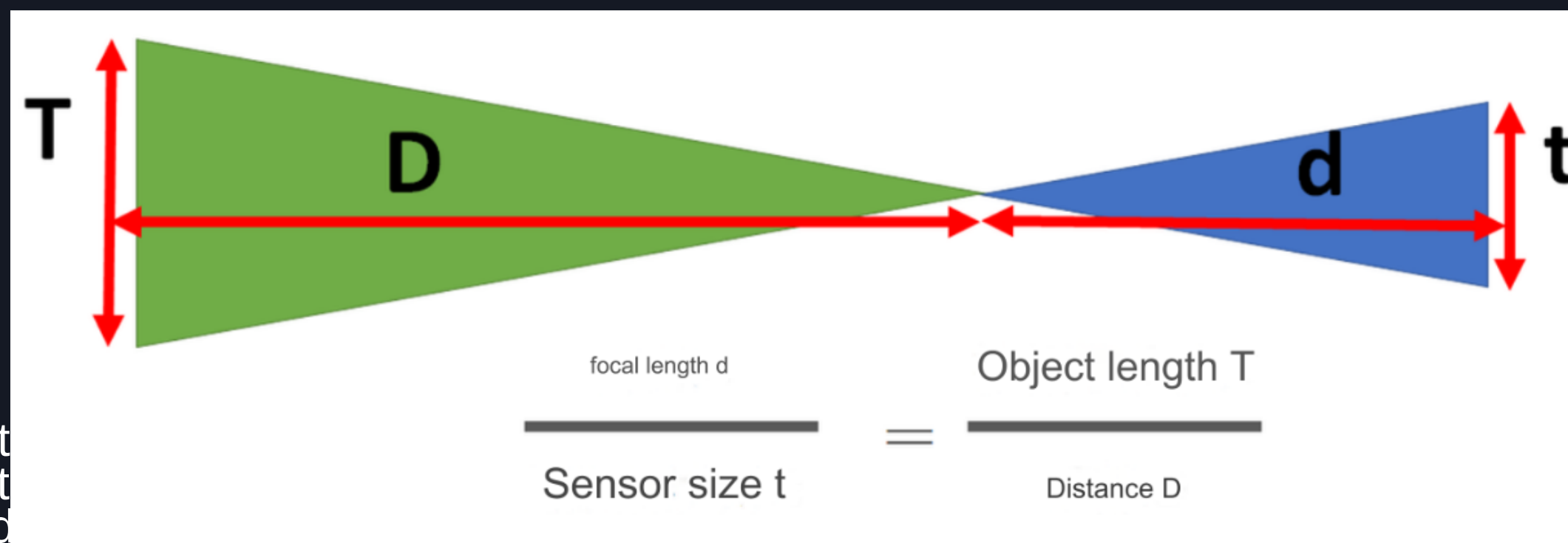
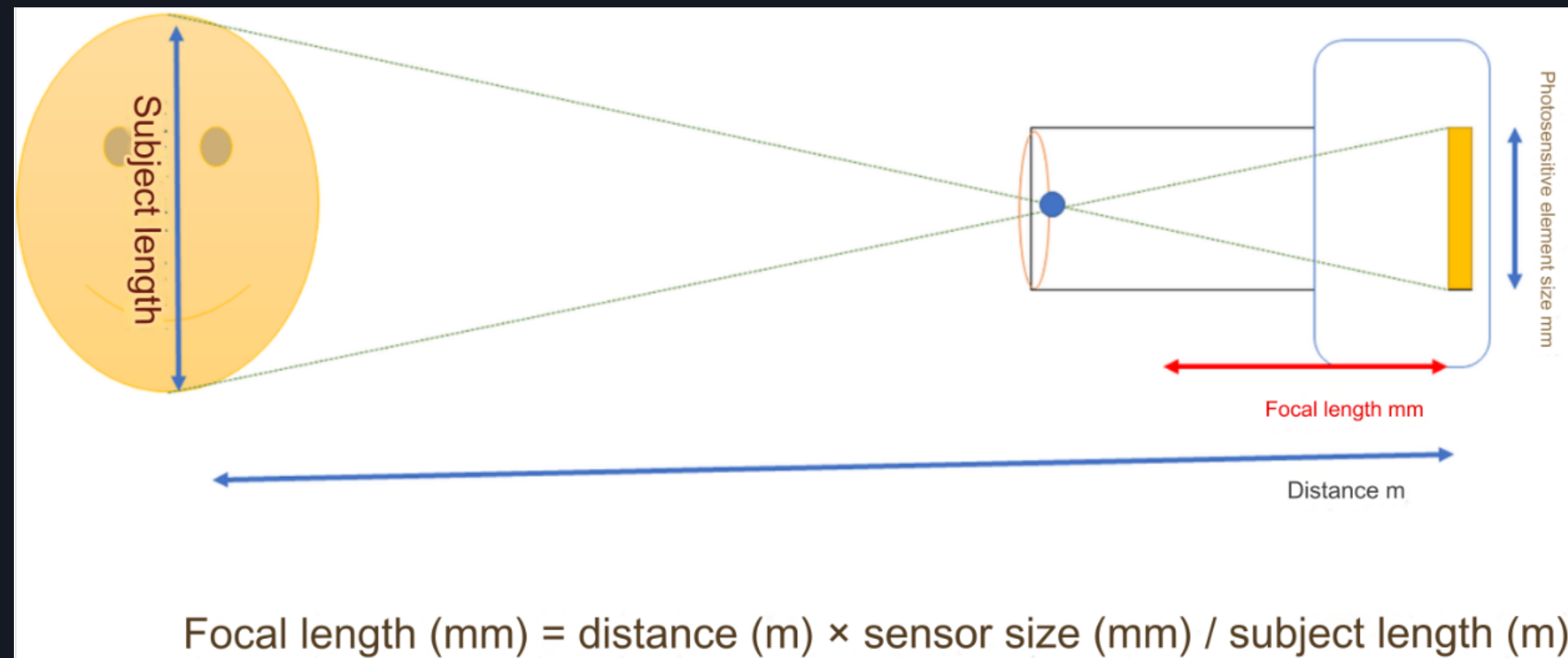
YOLO V7Object Model

We used Anaconda+ to train AI with YOLOV7 on 4,000 car images, paired with HUB 8735 ultra Object detection API to achieve vehicle identification.

YOLOv7, its speed and accuracy in the range of 5 FPS ~ 160 FPS exceed all known object detectors. The optimization is mainly divided into two aspects: model architecture optimization and training process optimization. For model architecture optimization, the author proposes extended and scaling methods to effectively utilize parameters and computational complexity. method, and for the optimization of the training process, YOLOv4 Lieutenant General Modules or methods that improve accuracy at the expense of increased training cost but do not increase inference cost.



Single lens distance measurement



$$\text{Distance (m)} = \text{focal length (mm)} \times \text{subject length (m)} / \text{image size (pixels)}$$

Assuming we know the focal length of the camera, we can also calculate the distance between the object and the camera. We just need to shift the above formula slightly to the left and right, and then replace the sensor size with the number of pixels of the object in the image, and we can calculate the distance.

We all know that combining two cameras (stereo camera) allows us to simulate the human eye and calculate the distance of the object in front of us through parallax when the focal length of the camera and the distance between the two cameras are known. Can a single camera calculate the distance to an object in front of it? Yes, if we only want to use one camera to calculate the distance, we only need to know the actual size (width or height) of the object and the focal length of the camera. Then we can calculate the distance based on the size (pixels) of the object in the photo. Calculate how far away the object is.

GPS -Speed tracking

Neo-6m-v2 GPS Provide UART interface for real-time feedback, we will directly capture the speed feedback value. GPS data follows the NMEA-0183 protocol. The unified standard format NMEA-0183 output uses ASCII code. Its serial communication parameters are: baud rate = 4800bps, data bit = 8bit, start bit = 1bit, stop bit = 1bit, no parity check.

Sequence	Order	instruction	Maximum frame rate
1	\$GPGGA	GPSPositioning information	72
2	\$GPGSA	Current satellite information	65
3	\$GPGSV	Visible satellite information	210
4	\$GPRMC	Recommended location information	70
5	\$GPVTG	Ground speed information	34
6	\$GPGLL	Coordinate information	
7	\$GPZDA	Current time(UTC)message	

(Track Made Good and Ground Speed - VTG, ground speed information)

Format: \$GPVTG, <1>,T, <2>,M,<3>,N, <4>,K, <5>*hh

Field \$GPVTG statement meaning——Value range

<1> Ground heading based on true north——000.000~359.999

<2> Ground heading with magnetic north as reference——000.000~359.999

<3> Ground speed——000.000~999.999 knots

<4> Ground speed——0000.0~1851.8 km/h

<5> Mode indication——A=Autonomous positioning, D=Differential, E=Estimation, N=Invalid data (only NMEA0183.00 version output)

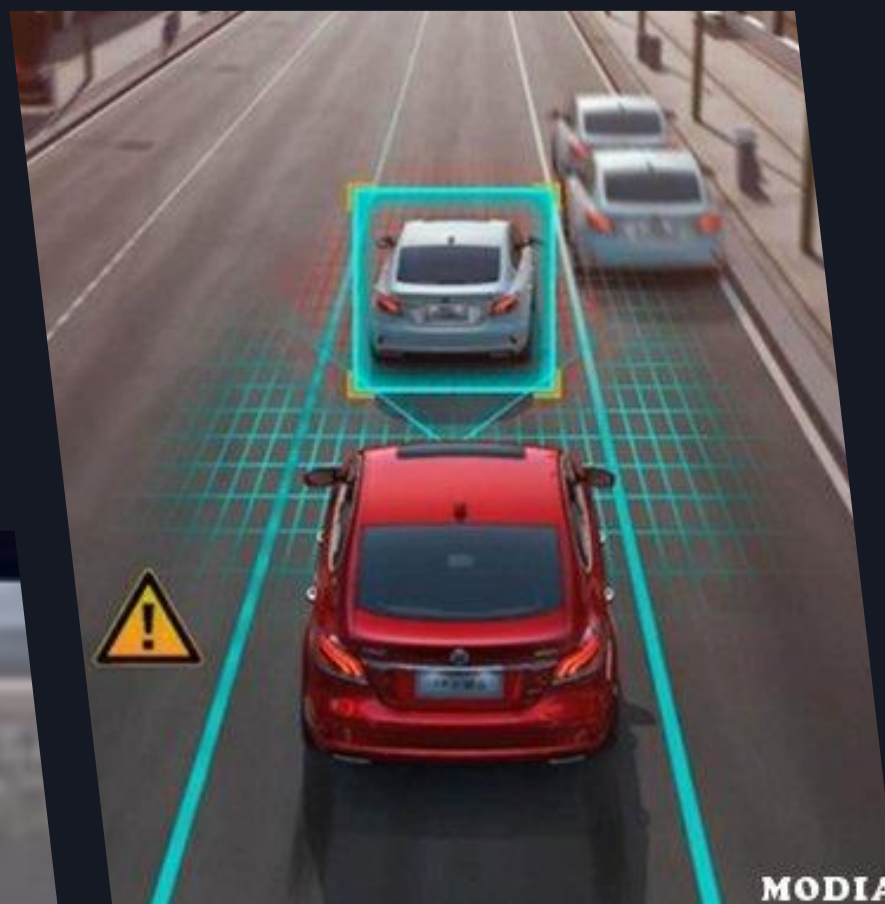
<6> hh calibration bit

\$GPVTG,257.314,T,257.314,M,10.739,N,19.888,K,A*2F



Front car start reminder

Sometimes when you are distracted while waiting for a red light or swiping your phone without noticing, if the car in front of you starts, you will get a voice prompt!



Speed safe distance warning

According to Taiwan's road traffic regulations, the safe driving distance is maintained at: distance $m = (\text{vehicle speed KM/h}) \div 2$. If the AI determines that the distance to the vehicle in front is too close, a voice prompt will be given!

Front vehicle collision warning

When the safety distance with the vehicle ahead is not reached and the speed change rate reaches 0.5s/-4m, it will be judged that there is a risk of rear-end collision. A voice prompt will be given!



Speeding warning

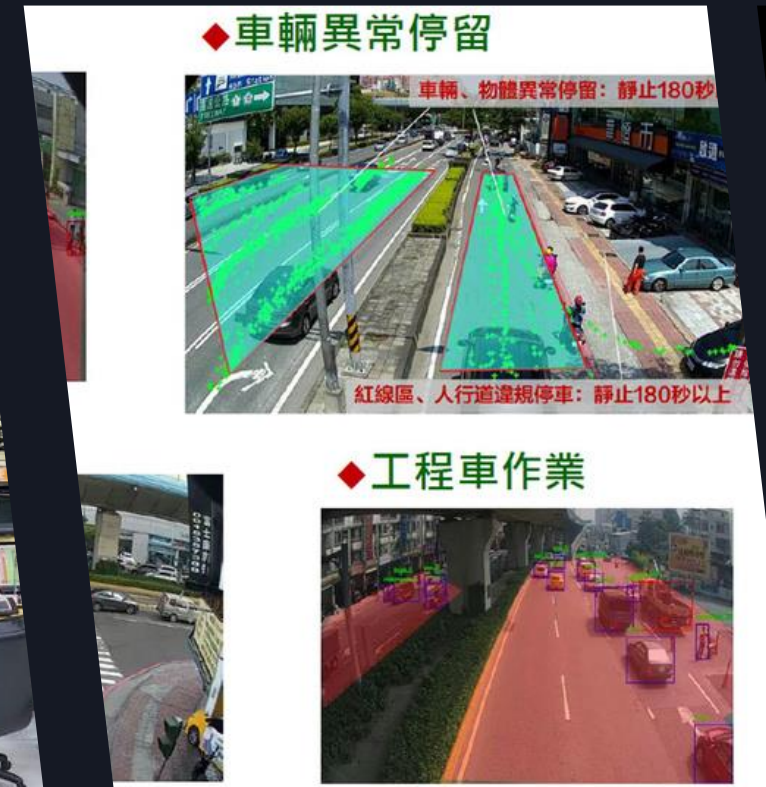
Based on Taiwan's public road speed limit data, combined with GPS vehicle speed and positioning, a warning reminder will be issued when the vehicle speed exceeds the road speed limit.

IoT Applications



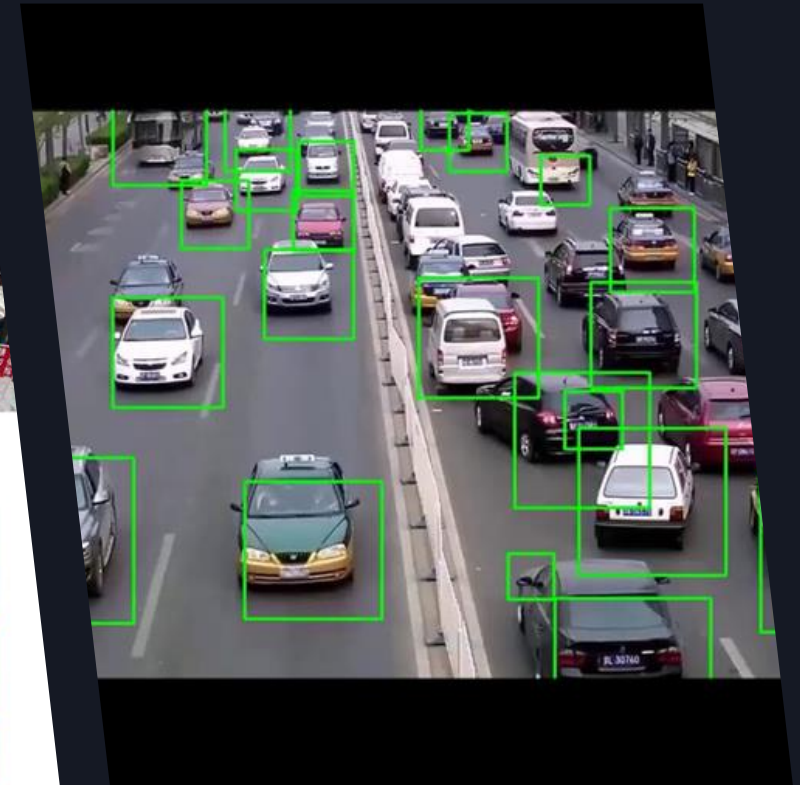
Traffic control at intersections

Can On Multiple intersection planning equipment, real-time analysis of intersection traffic through the network background. The background computer is connected in series to synchronize possible disasters to the traffic control center and real-time traffic relief policies..



Cloud Connection

Buses and other car dealerships can connect to the back-end computer to instantly synchronize possible disasters to the central console and conduct real-time driving behavior analysis to determine whether the driver is engaging in healthy driving behavior..



Front car starts



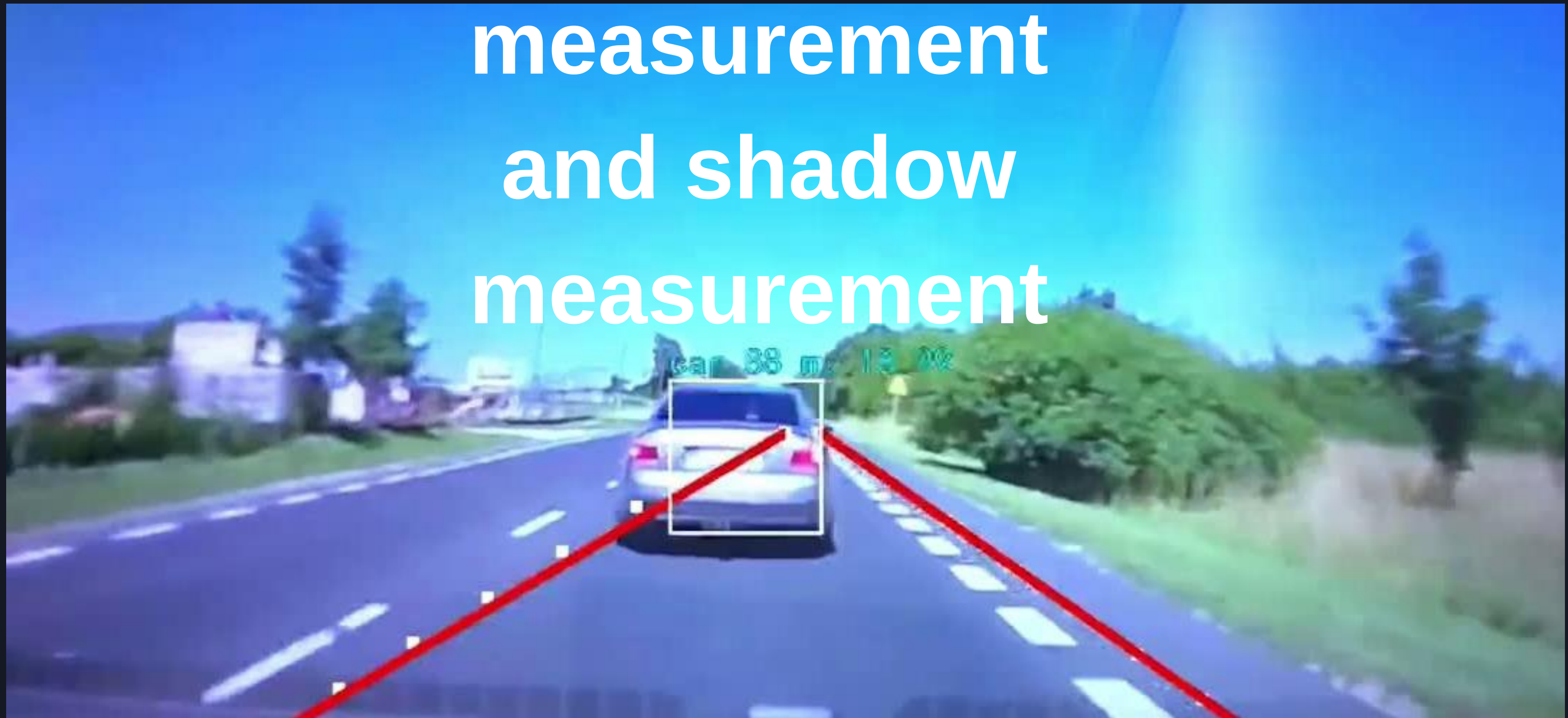
Road measurement and shadow measurement



Front vehicle collision warning,
speed safety distance warning

Road

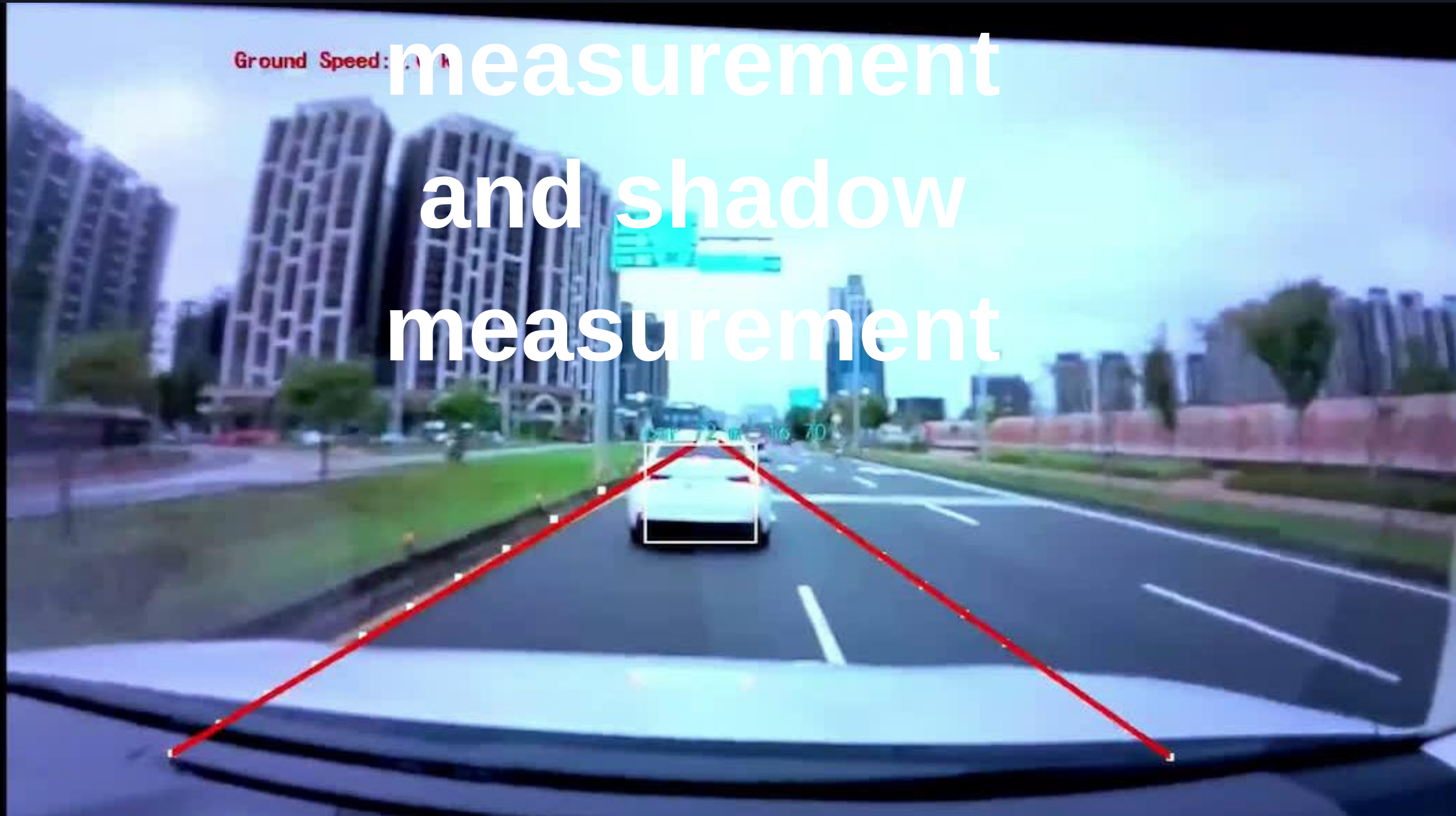
measurement and shadow measurement



Front vehicle collision warning,
speed safety distance warning

Road

measurement
and shadow
measurement



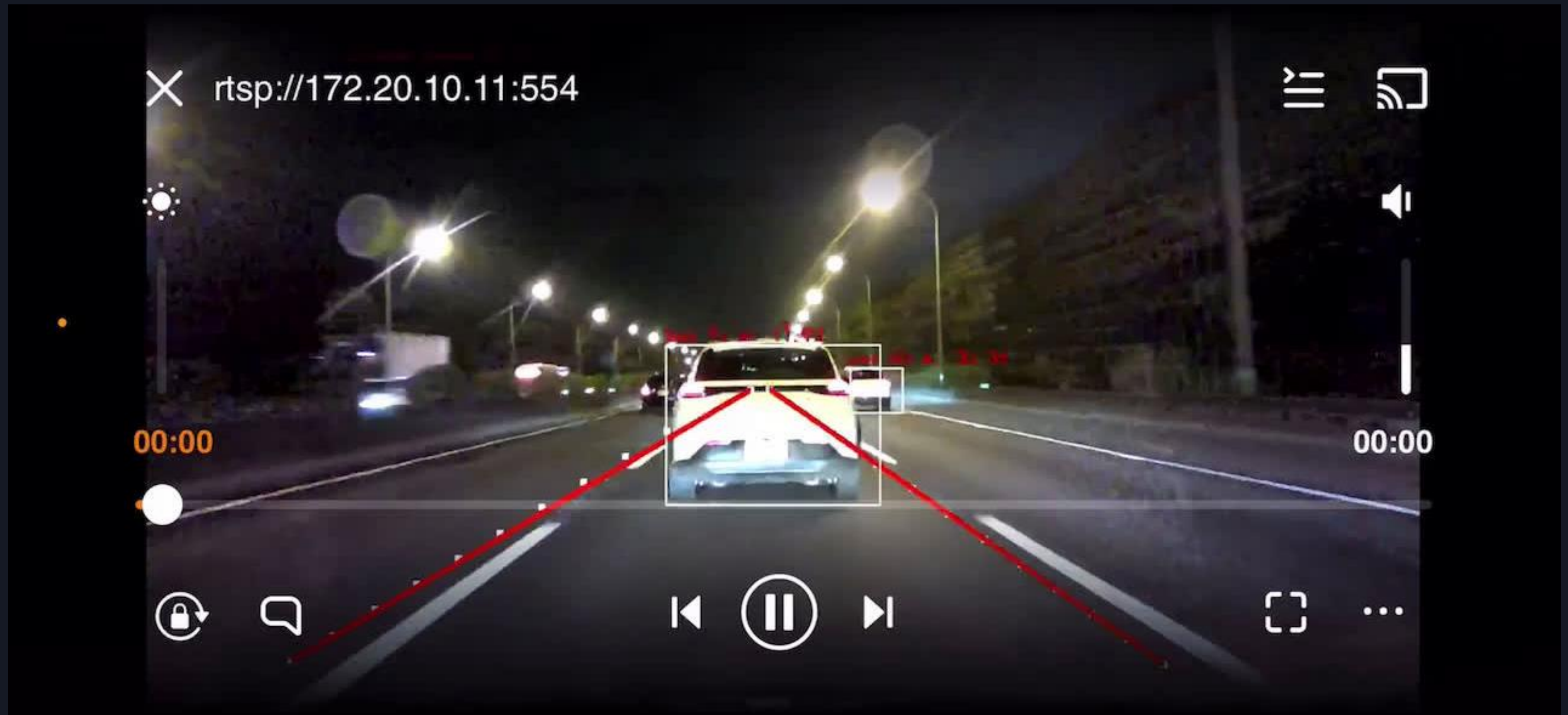
Front vehicle collision warning,
speed safety distance warning

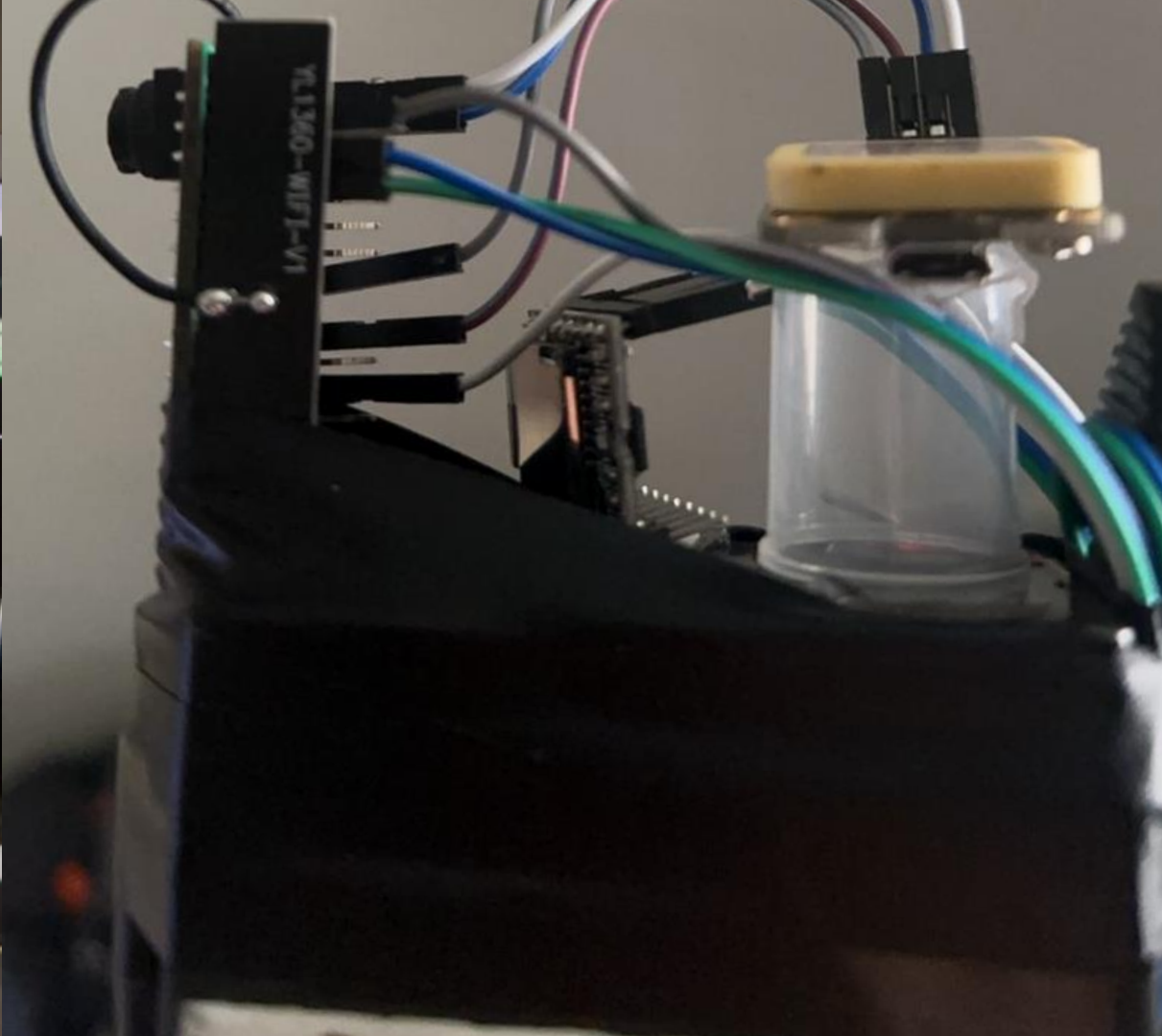
Road measurement and shadow measurement



Front vehicle collision warning,
speed safety distance warning

Road measurement and shadow measurement





Practical Proof