

# AI Autonomous Driving Vehicle Training Equipment

## AIoT AutoCar 3



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- AI & IoT Convergence Training Equipment based on autonomous driving platform
- Artificial intelligence development platform composed of brain module and operating module
- Makes easy programming through block coding possible and provides function of automatic conversion into Python codes
- Fulfills software packages and desired service types through ROS2-based development environment
- Supports real-car-like mechanism and deep-learning-based autonomous driving technology by adopting the steering system
- Its main module is Edge Super Computer which supports all popular AI frameworks
- Provides the module of 8M-pixel, 180° wide-angle camera that can be freely movable
- Provides Gigabit Ethernet, dual-band Wi-Fi and Bluetooth
- Supports commands of speech-to-text & text-to-speech and voice by digital microphone and speaker
- Supports various IoT sensor modules through dedicated extension interface
- High-capacity battery is adopted and continuous training is possible even while battery is being charged
- Supports Soda OS and Pop Library which are AIoT dedicated operating system
- Supports development environment for Python 3 and interpreter-based C/C++ that is optimal for introductory programming
- Supports web-browser based learning environment in which one can learn Python 3 and C/C++ simultaneously in PC or Tablet
- Supports the dispersion name identification based on mDNS/DNS-SD and the network service posting & detection
- Supports open integrated development environment based on Visual Studio Code for professional applied development
- Provides the learning contents of artificial intelligence and the learning models of autonomous driving based on deep learning



## © Operating Program

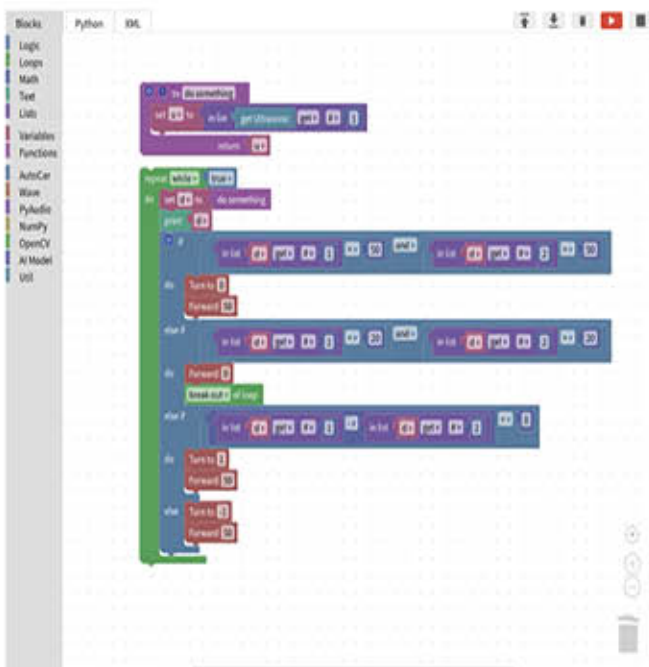
| List                               | Specifications                                                                                                                                                                                                                                 |
|------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Linux Kernel                       | aarch64 4.x                                                                                                                                                                                                                                    |
| Lightweight Desktop                | X-Server, Openbox, lxdm, Tint2, blueman, network-manager, conky, pcmanfm, lxterminal                                                                                                                                                           |
| CLI                                | Zsh with Oh-My-Zsh, Tmux, Peco, powerlevel9k thema, Powerline fonts                                                                                                                                                                            |
| Tool Chain                         | GCC (c, c++), JDK, Node JS, Python3, Cling, Clang                                                                                                                                                                                              |
| Soda OS                            | IDE                                                                                                                                                                                                                                            |
|                                    | Visual Studio Code, NeoVim, Geany                                                                                                                                                                                                              |
| Connectivity                       | SSH Server, Samba Server, Remote Desktop Server, mDNS(avahi), Bluez, MQTT Server(Mosquitto), Blynk Server                                                                                                                                      |
| Multimedia                         | PulseAudio, sox (lame, oggenc), snowboy, Google Assistant, OpenGL ES, CUDA, OpenCV 4                                                                                                                                                           |
| Data Science & AI                  | Numpy, Matplotlib, Pandas, Scipy, Seaborn, Scikit-learn, TensorFlow, Keras, PyTorch, TorchVision, OpenAI Gym                                                                                                                                   |
| Output Object                      | Led, Laser, Buzzer, Relay, RGBLed, DCMotor, StepMotor, OLed, PiezoBuzzer, PixelDisplay, TextLCD, FND, Led Bar                                                                                                                                  |
| Input Object                       | Switch, Touch, Reed, LimitSwitch, Mercury, Knock, Tilt, Opto, Pir, Flame, LineTrace, TempHumi, UltraSonic, Shock, Sound, Potentiometer, Cds, SoilMoisture, Thermistor, Temperature, Gas, Dust, Psd, Gesture, Co2, Thermopile, Microwave, Lidar |
| Pop Library                        | Multimedia Object                                                                                                                                                                                                                              |
|                                    | AudioPlay, AudioPlayList, AudioRecord, Tone, SoundMeter                                                                                                                                                                                        |
|                                    | Voice Assistant Object                                                                                                                                                                                                                         |
|                                    | GAssistant, create_conversation_stream                                                                                                                                                                                                         |
|                                    | AI Object                                                                                                                                                                                                                                      |
|                                    | Linear Regression, Logistic Regression, Perceptron, ANN, DNN, CNN, DQN, Pilot with AutoCar & SerBot                                                                                                                                            |
| PC Linkage Development Environment | Jupyter Lab                                                                                                                                                                                                                                    |
|                                    | Python3 and Cling support, IPython Widgets, Terminal support, Pop Library support                                                                                                                                                              |
|                                    | Visual Studio Code                                                                                                                                                                                                                             |
|                                    | Remote SSH, Python3 and Debugging support, Terminal support, Pop Library support                                                                                                                                                               |
|                                    | Insiders                                                                                                                                                                                                                                       |
|                                    | Pop Library support                                                                                                                                                                                                                            |

## Hardware Specifications

| List        | Specifications                                                                                                                                                                                                                                                                                  |
|-------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Body        | Size : 200 x 320 x 148mm   Weight : 3Kg(About)   Battery : 14.8V/7000mA / Temperature Monitoring                                                                                                                                                                                                |
|             | Wheels : 4 Wheels   Motor (Rear WheelMotor) 2ea : RPM 500, Gear Rate 1:30, Max Speed 1.5m/s                                                                                                                                                                                                     |
|             | Steering (Servo Motor) : Stall torque: 9.4 kgf-cm (4.8 V), 11 kgf-cm (6 V), Operating speed: 0.17 s/60° (4.8 V), 0.14 s/60° (6 V)                                                                                                                                                               |
|             | Ultrasonic sensor : Front 1ea, Rear 1ea   LED : Front 2ea, Rear 2ea                                                                                                                                                                                                                             |
| Main Module | CPU : Quad-core ARM A57 @ 1.43 GHz   GPU : Maxwell Core 128ea                                                                                                                                                                                                                                   |
|             | Memory : 4GB 64-bit LPDDR4 25.6 GB/s   Storage : microSD (64GB)                                                                                                                                                                                                                                 |
|             | Video Encoder : 4K@30   4x 1080p@30   9x 720p@30 (H.264/H.265)                                                                                                                                                                                                                                  |
|             | Camera : MIPI CSI-2 DPHY lanes   Display : HDMI and DisplayPort   USB : 4x USB 3.0, USB 2.0 Micro-B                                                                                                                                                                                             |
|             | Connectivity : Dual Band Wireless WiFi 2GHz/5GHz Band, 867Mbps, 802.11ac, Bluetooth 4.2, Gigabit Ethernet                                                                                                                                                                                       |
|             | Driver and Measure Part : 32bit Cortex-M4 Processor, Motor Driver 2ea, Ultrasonic Tx/Rx 2 pair, CAN Communication                                                                                                                                                                               |
|             | Voltage Meter : DC 2.4~28V measurement, Accuracy : 3% Measurement rate $\geq$ 200ms / times                                                                                                                                                                                                     |
| Base Board  | Sensor Module Interface : Sensor Block: +5V, +3.3V, GND, I2C, ADC, GPIO, SPI                                                                                                                                                                                                                    |
|             | IMU Sensor : Gyroscope Range: $\pm 125^\circ/\text{s}$ to $\pm 2000^\circ$<br>Accelerometer Range: $\pm 2g/\pm 4g/\pm 8g/\pm 16g$<br>Magnetic field range: $\pm 1300\mu\text{T}$ (x-, y-axis), $\pm 2500\mu\text{T}$ (Z-axis)<br>Interface: I2C, Supply Voltage: 3.3V                           |
|             | Camera : Image Sensor: Sony IMX219<br>Resolution: 8M pixel native resolution sensor (3280 x 2464 pixel static images)<br>Video: 1080p30, 720p60 and 640x480p90<br>Linux integration: V4L2 driver available<br>Focal length: 3.04 mm<br>Angle of view: 160 degrees<br>Focal ratio (F-Stop): 2.35 |
|             | Sound : 1ch Microphone, Omni-directional, Sensitivity: -42dBV, Stereo Speaker 2W   LED : Front/Rear LED 4ea                                                                                                                                                                                     |
|             | Illuminance Sensor : Sensor : CdS, Operating Voltage : 3.3V, Interface : Analog Output                                                                                                                                                                                                          |
|             |                                                                                                                                                                                                                                                                                                 |
|             |                                                                                                                                                                                                                                                                                                 |
|             |                                                                                                                                                                                                                                                                                                 |

## [Supporting Google Block-based Programming]

Soda Block Code Generator



| List                                                                                                                                                                                                                       | Specifications                                                                                                                             |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------|
| LCD Touch Screen                                                                                                                                                                                                           | Size: 5 inch, Resolution: 960x544, Touch: 5-Points, Capacitive, Interface: HDMI                                                            |
| Track                                                                                                                                                                                                                      | Track Layout Size : 3660*4800 mm<br>Wall height : 233mm<br>Traffic light : 2ea<br>Outbreak : 2ea<br>Traffic Signs : 5ea<br>Tablet PC : 1ea |
| Base                                                                                                                                                                                                                       | Bread Board: 470 Tie-point (Terminal Strip, Distribution Strips)<br>+5V, +3.3V, GND, I/O Connector                                         |
| Tiny MCU Module : ARM®32-bit Cortex®-M4 CPU, CAN, ADC, I2C, SPI, GPIO etc, USB OTG Port 1ea                                                                                                                                |                                                                                                                                            |
| CAN FD Module : Mixed CAN 2.0B and CAN FD, Conforms to ISO 11898-1:2015                                                                                                                                                    |                                                                                                                                            |
| LiDAR : Distance Range : 12m, Angular Range : 0 ~ 360degree, Distance Resolution : <0.5(0.15 ~ 1.5meters)<br>Angular Resolution : 0.9degree, Sample Duration : 0.25 millisecond, Sample Frequency : 4KHz, Scan Rate : 10Hz |                                                                                                                                            |



## © Training Contents

### 1. Artificial Intelligence and Autonomous Driving

- 1.1. Components of Autonomous Driving
- 1.2. Autonomous Driving Overview

### 2. Environment for Experiment

- 2.1. AIoT AutoCar III
- 2.2. Communication between PC and AutoCar III
- 2.3. Development Environment

### 3. AutoCar Control

- 3.1. Vehicle Control
- 3.2. Ultrasonic Sensor
- 3.3. Battery
- 3.4. Buzzer

### 4. CAN Protocol

- 4.1. CAN Network
- 4.2. CAN Communication
- 4.3. CAN Communication in Linux

### 5. Vehicle Location and Surrounding Environment

#### Positioning Method

- 5.1. 9-Axis Sensor
- 5.2. 9-Axis Sensor and Position Coordinate

#### 6. Driving by Calculation Algorithm

- 6.1. Number 8-Shaped Driving
- 6.2. Wheel Alignment Adjustment
- 6.3. Vehicle Posture Control
- 6.4. Parallel Parking

#### 7. LiDAR

- 7.1. LiDAR Sensor
- 7.2. LiDAR Control
- 7.3. Avoidance Driving using LiDAR

#### 8. Image Processing

- 8.1. Color Space
- 8.2. Image Processing using OpenCV
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### 9. Understanding Machine Learning for Autonomous Driving

- 9.1. Machine Learning
- 9.2. Deep Learning
- 9.3. Deep Learning Framework

### 10. Convolutional Neural Network and Resnet Structure

- 10.1. Structure of Convolutional Neural Network
- 10.2. Color Image and Convolutional Neural Network
- 10.3. ResNet

### 11. Object Detection and Moving Object Control using YOLO

- 11.1. Object Detection
- 11.2. YOLO

### 12. Sensor Fusion

- 12.1. Strategy for Sensor Fusion
- 12.2. Measure Object Size using Camera and Ultrasound
- 12.3. Distance Measurement and Avoidance Driving using LiDAR and Ultrasonic Sensor

### ROS2

1. ROS (Robot Operating System)
2. ROS2 Development Environment Configuration
3. ROS2 Basics
4. Subscription and Publishing
5. Services Application
6. Action Interface
7. Parameter Application
8. Multi Launching
9. Advanced ROS2 Programming

### Appendix

- A. rosp API
- B. pop\_ros and pop\_interfaces
- C. Rviz2
- D. LiDAR Visualization

## © Layout



## © Components



AutoCar 3



USB to Ethernet Adapter 1EA



Ethernet Cable 1EA



User Guide book 1EA