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IT Convergence

LiDAR SmartCAR

LiDAR SmartCAR is a moving robot equipped with LiDAR sensor which is a training device for learning about LiDAR, various sensors, autonomous driving, ROS and SLAM.

ARDUINO

Since 1984

IT Convergence

LiDAR SmartCAR

LiDAR SmartCAR is a moving robot equipped with LiDAR sensor which is a training device for learning about LiDAR, various sensors, autonomous driving, ROS and SLAM.

- Adopts Arduino, an open hardware platform for controlling robot sub-systems such as motors and sensors
- LiDAR sensor configuration for autonomous driving
- Robot Operating System (ROS) training, a robot middleware
- Simultaneous localization and mapping (SLAM) training
- Obstacle detection using multi-ultrasonic sensor
- Line tracer drive using infrared sensor
- Control of driving part operation using DC Encoder Motor
- Providing Java-based OpenCV solution to utilize Android for vision robot research
- Intelligent control using Accelerometer, Gyroscope sensor
- Using smartphones and tablets as robots' brains
- C programming support using CodeVision
- Provide AndroX Studio™ integrated development environment for robotic system service development

Product Overview

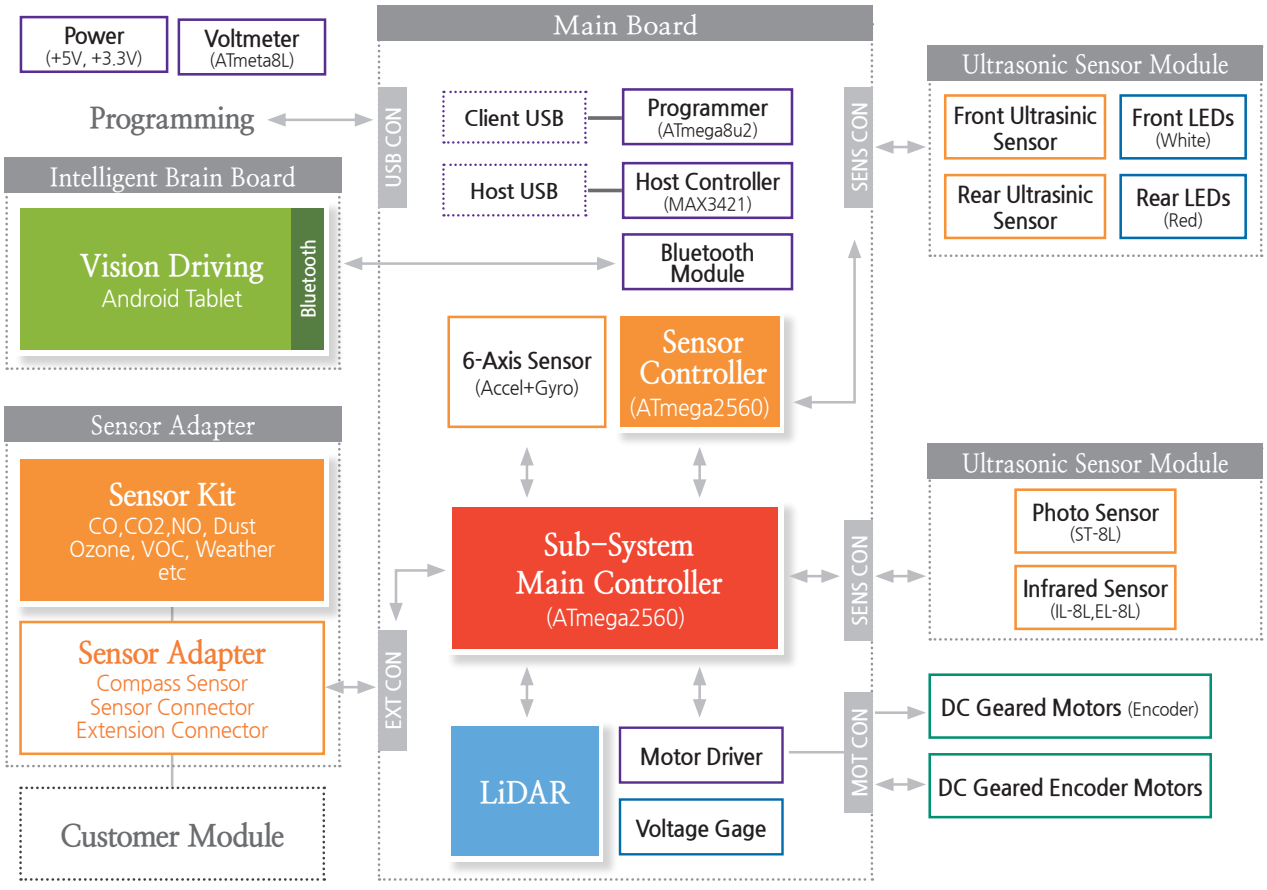
LiDAR SmartCAR is developed to support the research of ICT convergence service using intelligent mobile robot and the training of high value human resources. With LiDAR sensor, it is educational device to learn about LiDAR, various sensor, autonomous driving, ROS (robot operating system) and SLAM (Simultaneous localization and mapping).

Designed to enable smart phone and PC to be used as robots' brains for high-performance vision processing, it combines data from acceleration, magnetic, and gyroscope sensors with vision, including 12 ultrasonic sensors and 8 infrared sensors, It can be used to develop innovative autonomous navigation algorithms and application services for mobile robots.

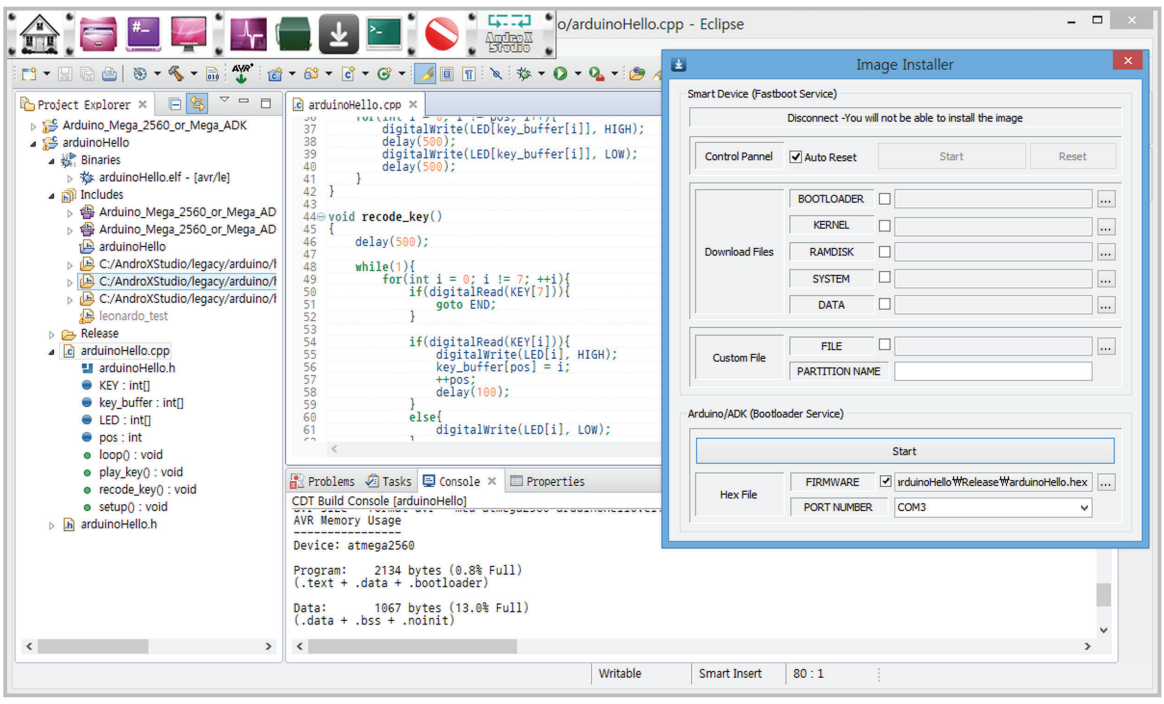
Product Features

- This is a moving robot with an autonomous LiDAR sensor. It contains examples of collision avoidance and examples of position tracking, so you can learn about ROS and SLAM.
- With the integrated development environment, anyone can easily and quickly implement firmware for electronic device control. The Arduino integrated development environment is based on the environment using processing / wiring language which is effective for developing interactive objects, easy operation of microcontroller, and easy programming via USB.
- By supporting the ADK-based electronic device development environment, the Google Smart Device Peripheral Design Platform, you can quickly and easily develop applications that work with Smart Devices with the Google Android platform.
- With 12 ultrasonic sensors and 8 infrared sensors, obstacles can be avoided and missions can be performed on a given route.
- By incorporating acceleration and gyroscope sensors, it is possible to develop intelligent robots that autonomously travel by detecting and judging the acceleration, vibration, shock and motion information of the robot by itself.
- Two of the four independently driven DC geared motors have built-in encoders that can detect the motor's operating status and calculate the direction and speed of rotation.
- Built-in Bluetooth communication module enables remote control based on SPP profile through PC, notebook, smartphone, tablet etc. that support Bluetooth communication
- Smart phones and tablets can be used as the brain of mobile robots, enabling the implementation of mobile robot-based ICT convergence services using high-performance processors and Wi-Fi communication environments provided by smartphones and tablets.
- We provide AndroX Studio™, an integrated development environment for Android-based robot image processing and high-end service development.

Block Diagram



Integrated Development Environment AndroX Studio™



Configuration and Name

LiDAR SmartCAR

Hardware Specifications

Category	Specification
Main Body	
Size	245mm x 380mm x 70mm
Weight	5Kg
Material	Iron + aluminum, powder coating
Sub-System Main Controller	
Controller	ATmega2560 (Google ADK Platform with Arduino Mega2560)
Driving Clock	16MHz
Flash Memory	256 KB
EFPROM Memory	4 KB
SRAM Memory	8 KB
ADC	10bit 16Channel
USB Host Controller	MAX3421E USB 2.0 With SPI Bus
Buzzer	5V Sound Pressure Level: 88 dB
Connectivity	
Bluetooth	On-Board Bluetooth (FB155BC)
	v2.0+EDR
	SPP, A2DP, HSP
Sensor Controller	
Controller	ATmega128
Driving Clock	7.3278MHz
Flash Memory	128 KB
EFPROM Memory	4 KB
SRAM Memory	4 KB
Ultrasonic Tx Sensor	MA40S4S (40KHz / 20 Vp-p) 12EA
Ultrasonic Rx Sensor	MA40S4R (40KHz / 20 Vp-p) 12EA
Infrared Sensors	
Light Emitter	3mm, 940nm Infrared Emitter Diode 8EA
Receiver	3mm, Photo Transistor 8EA
6-Axis Physical Sensors	
Acceleration, Gyroscope Sensor	MPU-6050
	3-Axis MEMS Gyroscope
	3-Axis MEMS Accelerometer
Motor	
DC Motor	1RB35GM 13Type 1/30 DC12V 2EA
	RB35GM 13Type 1/30 DC12V with Encoder 2EA
Motor Driver	L298P
Digital Voltmeter	
Controller	ATmega8
Display	3Digit 7-segment

Category	Specification
Programmer	
USB Controller	ATmega8U2 16MHz (include bootloader)
Interface	Programed as USB-to-Serial converter with DFU mode
External Interface	
USB Host	USB 2.0 1Port
USB B type Port	Micro USB 1Port
Expansion Port	2x10 Header 2EA (Power, I²C, UART 2Port, GPIO)
Sensor Adaptor	
3-Axis Compass Sensor	AK8975C
	3-Axis Electronic Compass
Sensor Connector	2x25 1.27mm Pitch Header
Expansion Connector	UART 1Port, GPIO 5EA, Power(3.3v, 5v, 12v)
Power	
Battery	Lithium-ion Battery 5200mA (~12.6V)
Charger	DC 12.6V 1.2A Battery Charger

LiDAR Specification

Item	Unit	Min	Typical	Max	Comments
Distance Range	Meter(m)	TBD	0.15 - 6	TBD	White objects
Angular Range	Degree	n/a	0-360	n/a	
Distance Resolution	mm	n/a	<0.5 <1% of the distance	n/a	<1.5 meters All distance range*
Angular Resolution	Degree	n/a	≤1	n/a	5.5Hz scan rate
Sample Duration	Millisecond(ms)	n/a	0.5	n/a	
Sample Frequency	Hz	n/a	≥2000	2010	
Scan Rate	Hz	1	5.5	10	Typical value is measured when LiDAR takes 360 samples per scan

LiDAR Power and Other Specification

Item	Unit	Min	Typical	Max	Comments
Scanner system voltage	Volt(V)	4.9	5	5.5	If the voltage exceeds the max value, it may damage the core.
Scanner system voltage ripple	Millivolt(mV)		20	50	High ripple may cause the core working failure.
Scanner system start current	Milliampere(mA)	TBD	500	600	Underpower may cause the startup failure.
Scanner system current	Milliampere(mA)	TBD	80	100	Sleep mode, 5V input
		TBD	300	350	Work mode, 5V input
Motor system voltage	Volt(V)	5	5	10	Adjust voltage according to speed
Motor system current	Milliampere(mA)	TBD	100	TBD	5V input
Weight	Gram(g)	TBD	190	TBD	Weight

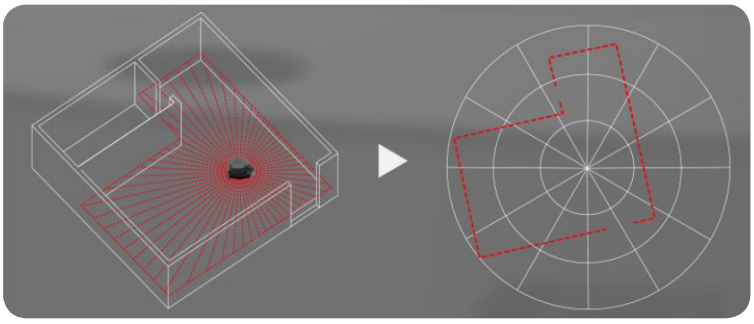
Software Specifications

Category	Specification
Robot Subsystem Arduino Firmware	
Arduino Integrated Development Environment	AndroX Studio™, Arduino IDE, ArduBlock
User Library	Arduino Private Library by Hanback Electronics
Functional Test Firmware	Motor / Encoder, Ultrasonic Sensor, Infrared Sensor, LED, Compass Sensor, Gyro Sensor, Accelerometer, Buzzer, UART / Bluetooth
Intelligent Robot Test Firmware	Remote Control between Smart Device and HBE-SmartCAR based on Bluetooth Automatic Obstacle Avoidance using Ultrasonic Sensor Autonomous Driving that Recognizes Objects using Vision Specified Route Driving using Infrared Sensor Specified Route Driving using Encoder, Acceleration, Gyro Sensor
Robot Subsystem AVR Firmware	
AVR Integrated Development Environment	CodeVision
Functional Test Firmware	Motor / Encoder, Ultrasonic Sensor, Infrared Sensor, LED, Compass Sensor, Gyro Sensor, Accelerometer, Buzzer, UART / Bluetooth
Intelligent Robot Test Firmware	Remote Control between Smart Device and HBE-SmartCAR based on Bluetooth Automatic Obstacle Avoidance using Ultrasonic Sensor Autonomous Driving that Recognizes Objects using Vision Specified Route Driving using Infrared Sensor Specified Route Driving using Encoder, Acceleration, Gyro Sensor
Robot System Vision / Service Program	
Smart Device Integrated Development Environment	AndroX Studio™
Vision Library	OpenCV for Android
Vision Application	YUV to RGB Conversion, Pixel based Image Processing, Mask based Image Processing, Color Recognition, Feature Recognition, Face Recognition, Motion Recognition
Smart Device Applications	HBE-SmartCAR Sensor Value Reception and Direction Remote Control Obstacle Avoidance Autonomous Driving Remote Monitor using Ultrasonic Sensor Object Recognition Autonomous Driving Monitor using Vision Specified Route Driving Monitor with Infrared Sensor Specified Route Driving Monitor with Encoder, Acceleration, Gyro Sensor Wi-Fi based Smart Device Video Real-time Reception

LiDAR

You can create digital 2D or 3D representations of objects using reflection time and wavelength differences by measuring the distance and shape to the object based on reflected pulses using infrared light.

12	8000	1 *	0.2 **	5
meters	Se / s	Degree	cm	Volt
Detection Range	Sample Rate	Angular Res.	Distance Res.	Power Supply



ROS

Robot Operating System (ROS) is robotics middleware (i.e. collection of software frameworks for robot software development). Although ROS is not an operating system, it provides services designed for heterogeneous computer cluster such as hardware abstraction, low-level device control, implementation of commonly used functionality, message-passing between processes, and package management.

SLAM

Simultaneous Localization and Mapping (SLAM) is a concept used in robotics and so on. It is a technology that the mobile robot moves around in arbitrary space, searches for the surrounding area, and maps the space and estimates the current position.

LiDAR SmartCAR Configuration

CAMERA

The most cost-effective type of sensor. Camera data is very good for detecting the texture and color of lane markings, signs and traffic lights.

LIDAR

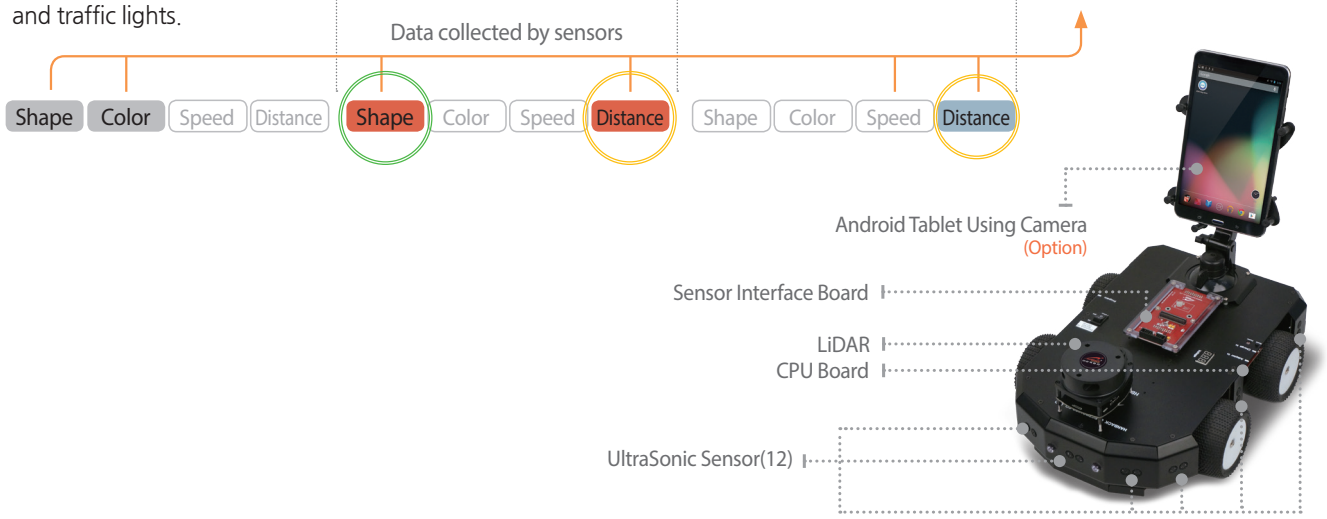
A laser-based sensor that can accurately detect the shapes of cars, pedestrians, curves, undrivable areas and other structures.

ULTRASONIC

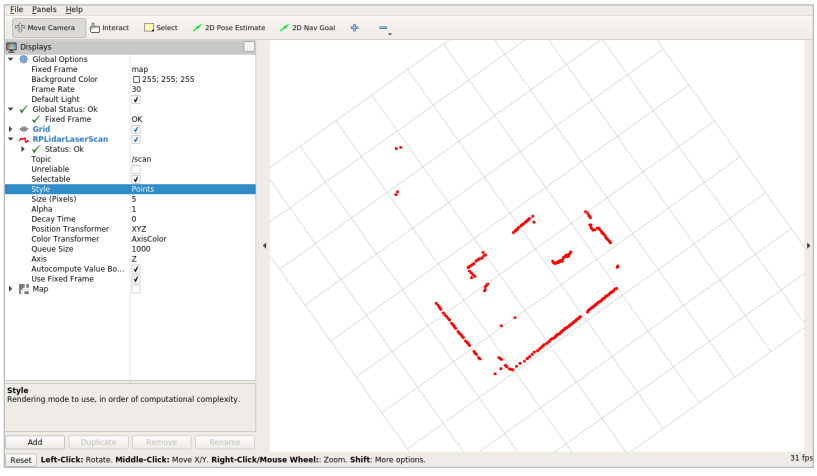
Detects the position of the obstacle. Uses ultrasonic waves to determine the distance to obstacles.

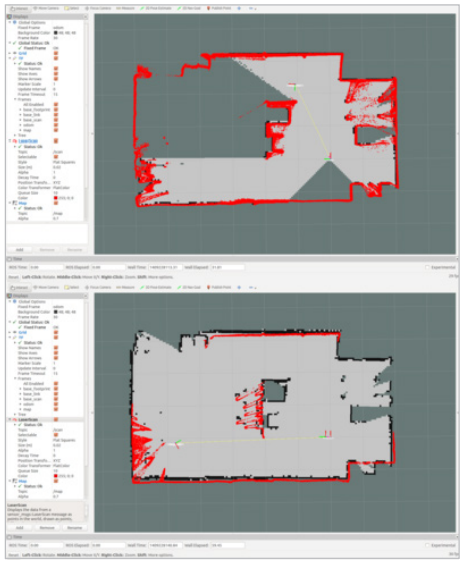
CPU

Analyzes LiDAR and other sensors using the ATmega2560 CPU board and performs autonomous operation.



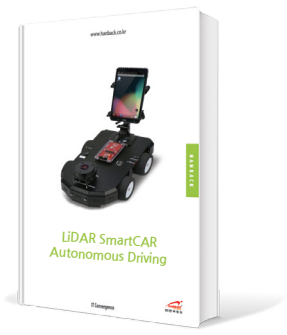
ROS / SLAM Driving Screen





Training Contents

Teaching Material	Textbook Index
	**HBE-SmartCAR Firmware Design (Arduino)** - Overview of Mobile Robot - Characteristics and Control Method of Motor - Understanding Processor AVR for Mobile Robot - LED Control of Mobile Robot (SmartCAR) - Mobile Robot Remote Control through UART - Control of Wheel Rotation of Mobile Robot - Movement Direction Control of Mobile Robot - Mobile Robot Speed Control using PID Control - Robot Posture Recognition using 6 Axis Sensor (MPU-6050) - Line-Tracer Implementation using Infrared Sensor - Autonomous Driving using Ultrasonic Sensor - Geomagnetic Measurement using Compass Sensor - Automatic Positioning of SmartCAR
	**HBE-SmartCAR Control and Vision App Design (Android)** - HBE-SmartCAR Control - Android Camera Control - OpenCV-based Camera Image Processing - HBE-SmartCAR Control with Camera Image Processing - Wi-Fi based Camera Video Transmission

Teaching Material	Textbook Index
	**LiDAR SmartCAR Autonomous Driving** - Overview of LiDAR - LiDAR A1 Description - ROS Programming - SLAM and Navigation - Distance Detection and LED Display using LiDAR Sensor - Autonomous Driving with LiDAR Sensor - ROOM Mapping using LiDAR Sensor - Autonomous Driving of MecanumWheel using LiDAR Sensor

Textbook Chapter

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1-3 Types of Car LiDAR Technology
1-3-1 Rotary LiDAR Technology
1-3-2 Compound Array LiDAR Technology
1-3-3 Silicon Array LiDAR Technology
1-3-4 Stud type LiDAR technology
1-4 Future Outlook

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2-2 Explanation of Operation
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2-4 Data Output
2-5 Applications
2-6 Measurement Data
2-7 Communication Interface
2-8 SDK and SUPPORT

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3-1-1 Components of the Platform
3-1-2 Robot Software Platform
3-1-3 Necessity of Robot Software Platform

3-2 Robot Operating System (ROS)
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3-2-2 Purpose of ROS
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3-3 Building ROS Development Environment
3-3-1 Installation of ROS
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3-4-8 Coordinate Transformation (TF)

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3-5-1 ROS Shell Command
3-5-2 ROS Execution Command
3-5-3 ROS Information Command
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3-5-5 ROS Package Command

3-6 ROS Tools
3-6-1 3D Visualization (RViz)
3-6-2 ROS GUI Development (rqt)

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3-7-4 Creating and Executing Action Server and Client Node
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3-7-6 How to use Roslaunch

3-8 SLAM and Navigation
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4-3 Interface Pin Arrangement of LiDAR Sensor
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Chapter 7. Autonomous Driving of SmartCAR-Mecanumwheel using LiDAR Sensor

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LiDAR SmartCAR

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