

# Intelligent Robot

## >>HBE-RoboEX Series



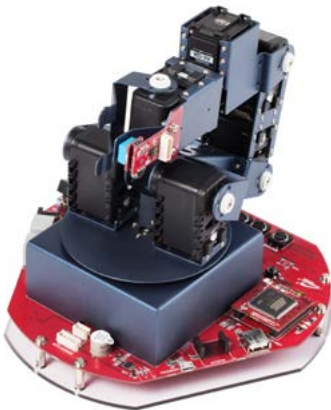
### HBE-RoboEX-Main : Main Controller Module

- Support of Integrity Serial Bus System, CAN to Build Intelligent Device Network
- Use of Open Hardware Platform, Arduino, to control Robot sub-Systems of motor-sensor
- Bluetooth Communication Test
- Use and Test Graphic LCD & Menu Configuration for RoboEX Series
- AndroX Studio Integrated development environment provided for Robot host System service development



### HBE-RoboEX-Motor : Intelligent Robot Motor Study Module

- Support of Integrity Serial Bus System, CAN to Build Intelligent Device Network
- Use of Open Hardware Platform, Arduino, to control Robot sub-Systems of motor-sensor
- DC-Motor control and operation by Infrared sensor
- Actuator operation control by DC Encoder Motor
- Servo Motor control and operation by Accelerometer
- Step motor control and operation by PWM
- AndroX Studio™ Integrated development environment provided for Robot host System service development



### HBE-RoboEX-ARM : Intelligent Robot ARM Module

- Support of Integrity Serial Bus System, CAN to Build Intelligent Device Network
- Use of Open Hardware Platform, Arduino, to control Robot sub-Systems of motor-sensor
- Dynamic Cell Servo Motor Control
- Daisy Chain Motor connect and Own ID Packet communication control
- Study of Haptics by Pressure sensor
- Servo Motor control and operation by Accelerometer and Gyro sensor
- Inter-connected with RoboEX-3WD, Application of Intelligent Robot
- AndroX Studio™ Integrated development environment provided for Robot host System service development



### HBE-RoboEX-Brain : Intelligent Robot Intelligence Module

- Support of Integrity Serial Bus System, CAN to Build Intelligent Device Network
- Use of Open Hardware Platform, Arduino, to control Robot sub-Systems of motor-sensor
- Dynamic Cell Servo Motor Control
- Daisy Chain Motor connect and Own ID Packet communication control
- Multi-media application and Robot control
- OpenCV based Image Processing application
- Inter-connected with RoboEX-3WD, Application of Intelligent Robot
- AndroX Studio™ Integrated development environment provided for Robot host System service development

## Intelligent Robot

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### HBE-RoboEX Series

 HBE-SmartCAR  
 HBE-RoboCAR-Embedded II  
 HBE-ROBONOVA-AI II  
 HBE-RoboCAR  
 HBE-MCU-Robot  
 HBE-RoboBuilder-MSRDS


## HBE-RoboEX-3WD : Intelligent Robot Actuator Module

- Support of Integrity Serial Bus System, CAN to Build Intelligent Device Network
- Use of Open Hardware Platform, Arduino, to control Robot sub-Systems of motor-sensor
- Use of movable Omni Wheel of Omni-Directional
- Actuator operation control by DC Encoder Motor
- DC-Motor control and operation by Accelerometer , Gyro, Ultrasonic and PSD sensor
- AndroX Studio™ Integrated development environment provided for Robot host System service development



## HBE-RoboEX-Pendulum : Intelligent Robot Pendulum Control Module

- Support of Integrity Serial Bus System, CAN to Build Intelligent Device Network
- Use of Open Hardware Platform, Arduino, to control Robot sub-Systems of motor-sensor
- Inverted Pendulum Control by PID control
- PWM Duty operation and Motor control by Encoder counter
- Inverted Status Monitoring by Emulation
- AndroX Studio Integrated development environment provided for Robot host System service development

### Introduction

HBE-RoboEX-Series is Intelligent Robot Study Modules which can design Prototype(Engineering) operated by Mathematics of ideas obtained from Technology and Science, and this provides Arduino programming environment, Modular type and Open Electronic Device Control Platform.

### Features

#### 2-1. Common Features

- This uses Modular design for Technology and Science, and this is available for individual study and cooperative study.
- HBE-RoboEX Series uses Cortex-M3 based 32bit late Microprocessor, which can be operated independently.
- This uses CAN communication used to build Intelligent Device Network which needs Integrity in order to inter-connect necessary modules to operate it as cooperative model.
- This includes CAN communication and Powers in one cable so it is possible to build effective Network when operating it as inter-connected cooperative model.

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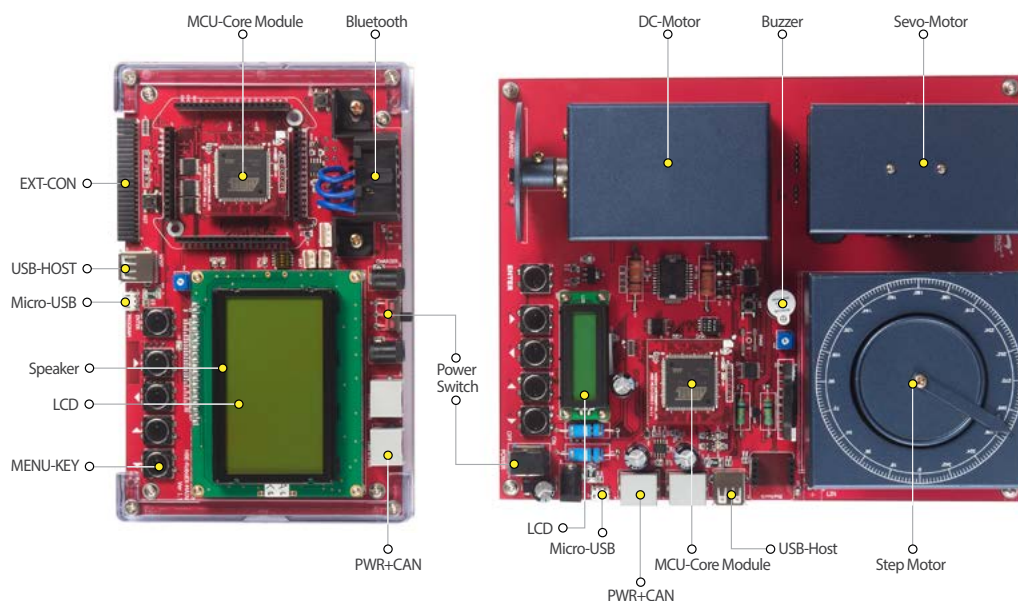
- This uses Arduino, Open Electronic Device Control Platform, as Programming Environment, so this can minimize Specialty for Hardware control. Therefore, this can normalize how to get Status information from sensor and control Motor for operation definition.
- This supports Google ADK(Accessory Development Kit) in order to control the operation of Motor Study Module and monitor Sensor value from Smart phone or Tablet.
- This supports Bluetooth in order to control the operation of HBE-RoboEX Series and monitor Sensor value from Smart phone or Tablet.

### 2-2. Features of each Modules

Item	Specifications
HBE-RoboEX-Motor	<ul style="list-style-type: none"> <li>• It is possible to study how to control DC-motor, Servo motor and Step motor for Robot design.</li> </ul>
HBE-RoboEX-ARM	<ul style="list-style-type: none"> <li>• It is possible to get Dynamic Cell Servo-motor control technology to design Robot System.</li> <li>• Dynamic Cells of Dynamic Cell Servo Motor have their own ID, operated by Network, which are controlled by Packet communication on a Bus.</li> <li>• Dynamic Cell Servo Motor is connected by Daisy Chain, which has simple wiring and easy expandability.</li> </ul>
HBE-RoboEX-Brain	<ul style="list-style-type: none"> <li>• It is possible to get Dynamic Cell Servo-motor control technology to design Robot System and to use OpenCV based Image Processing technology.</li> <li>• This uses Samsung Exynos 5 high-advance Application Process based and Cortex-M3 32bit based late Microprocessor, which can be operated independently.</li> </ul>
HBE-RoboEX-3WD	<ul style="list-style-type: none"> <li>• It is possible to control Omni Wheel of omni-directional mobility and DC-motor for Robot design.</li> <li>• It is possible to learn various application such as obstacle detection and object recognition with Ultrasonic and PSD sensor for intelligent robot.</li> </ul>
HBE-RoboEX-Pendulum	<ul style="list-style-type: none"> <li>• It is possible to study how to control DC-motor, Encoder counter and PID for Inverted Pendulum system design.</li> </ul>

### Configuration and Names

#### • HBE-RoboEX-Motor



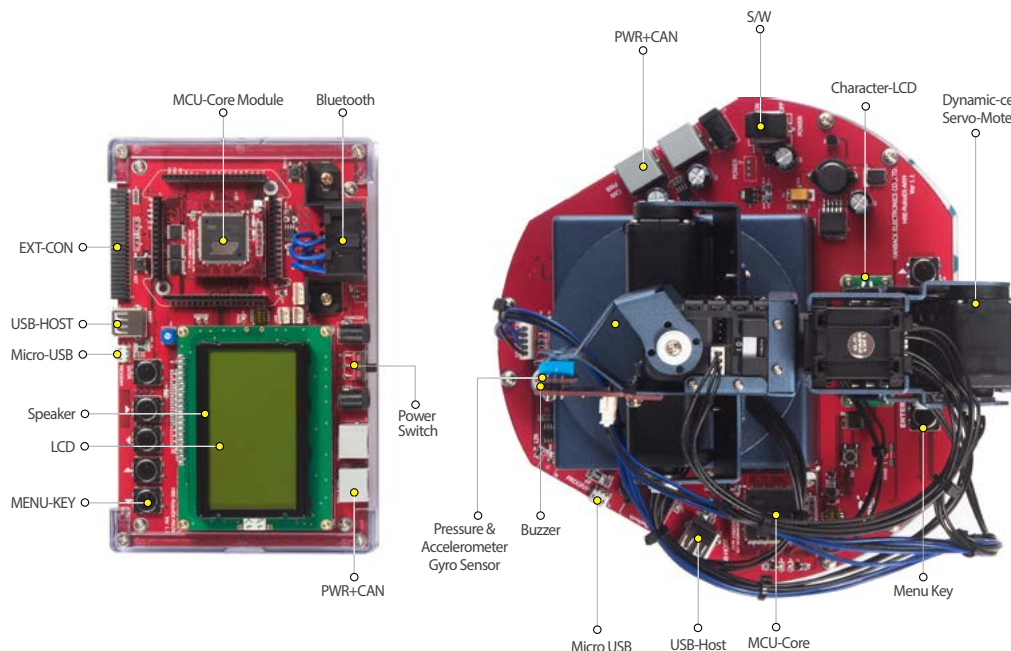
## Intelligent Robot

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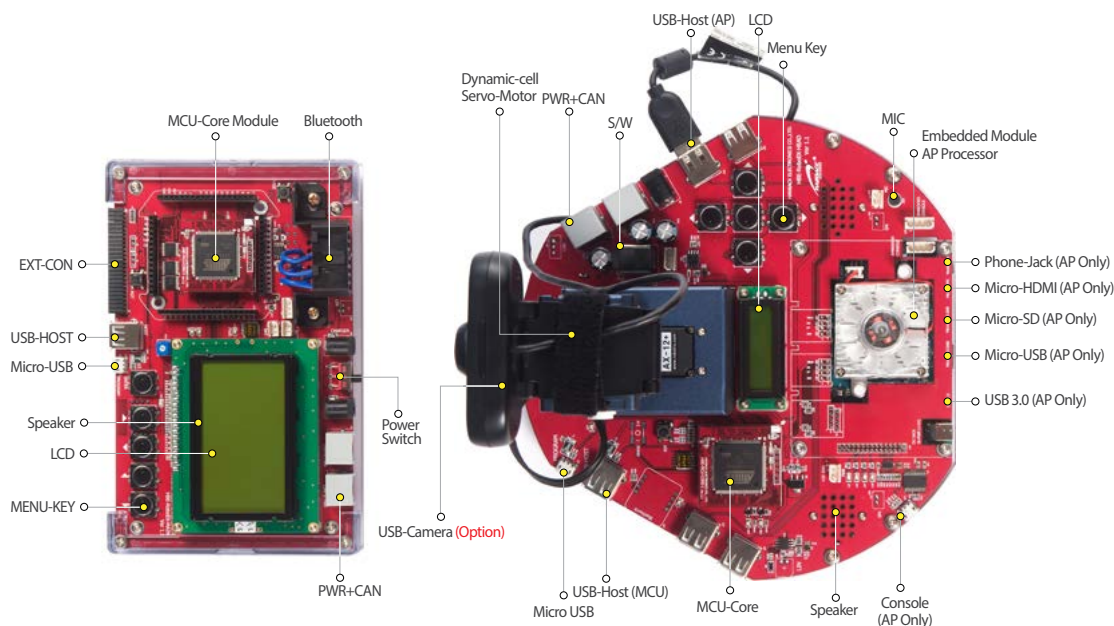
### HBE-RoboEX Series

- HBE-SmartCAR
- HBE-RoboCAR-Embedded II
- HBE-ROBONOVA-AI II
- HBE-RoboCAR
- HBE-MCU-Robot
- HBE-RoboBuilder-MSRDS

### • HBE-RoboEX-ARM



### • HBE-RoboEX-Brain

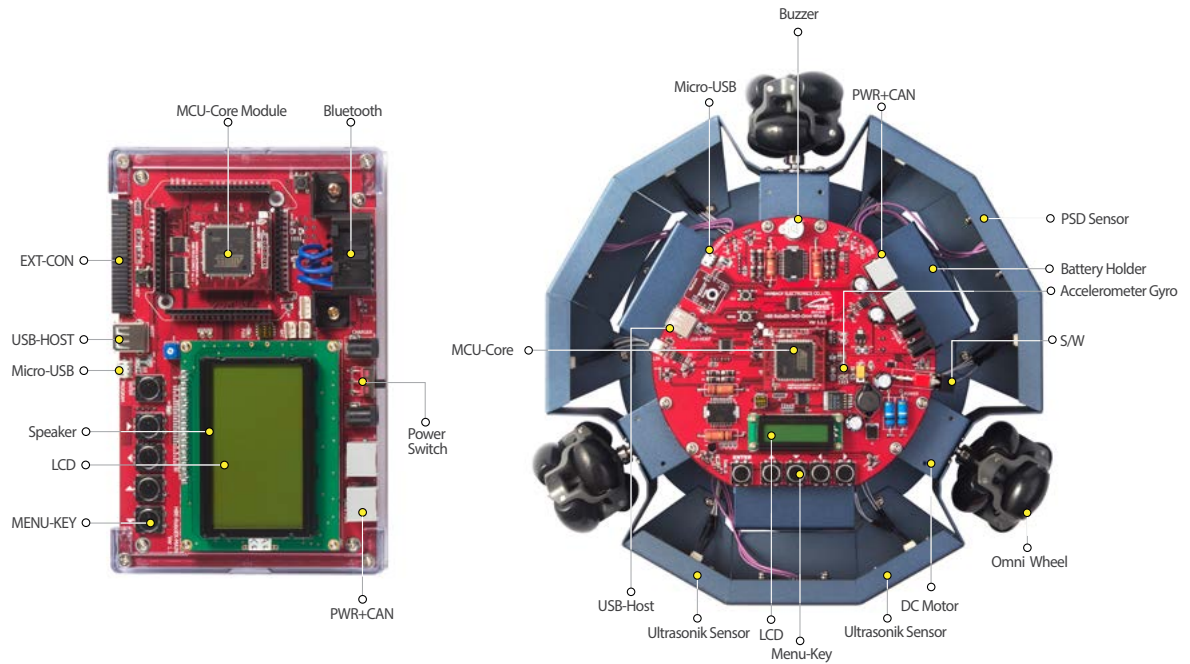




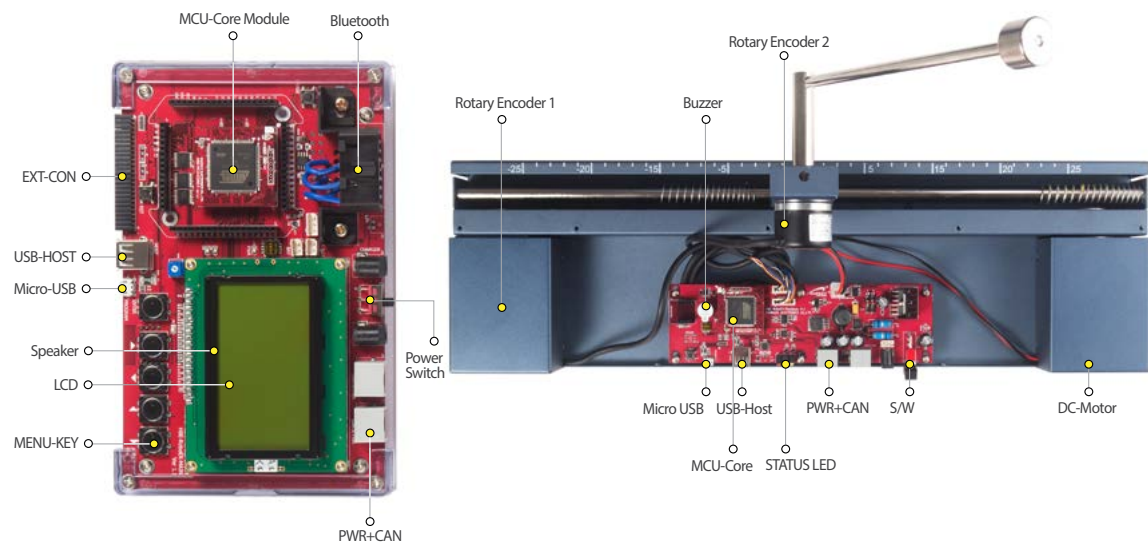
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## >> HBE-RoboEX Series

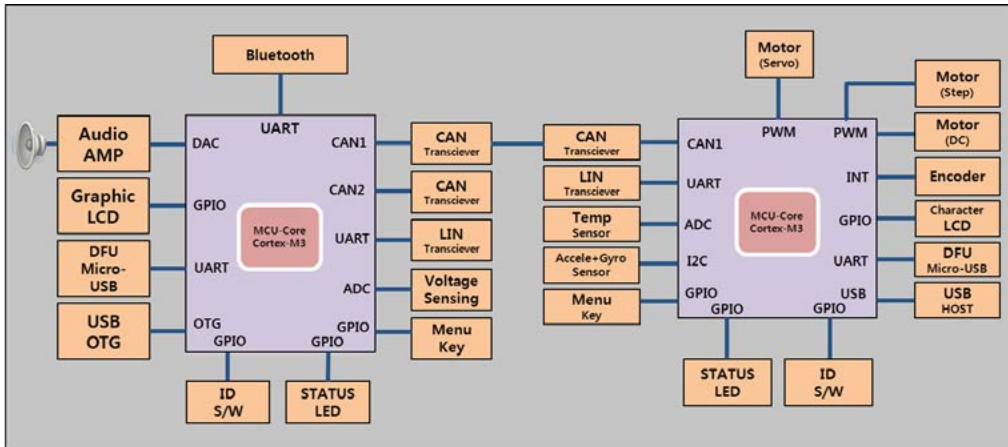
### • HBE-RoboEX-3WD



### • HBE-RoboEX-Pendulum

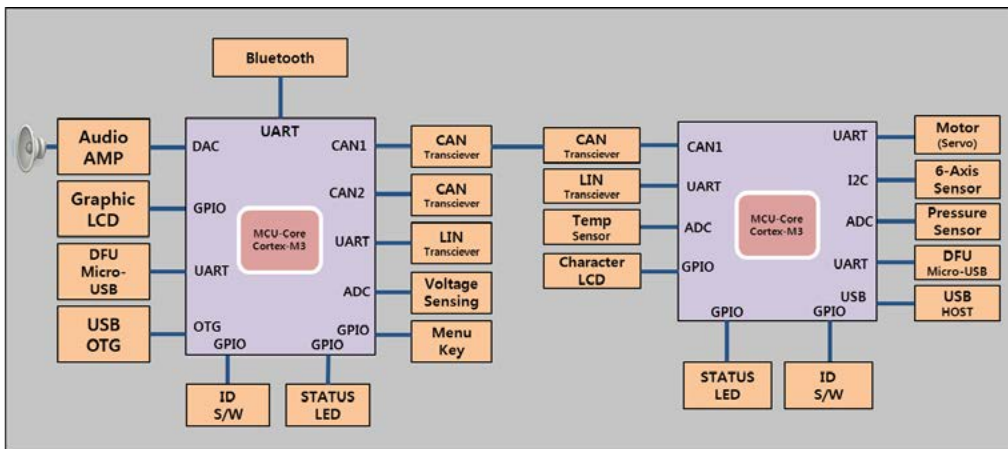


## Block Diagram



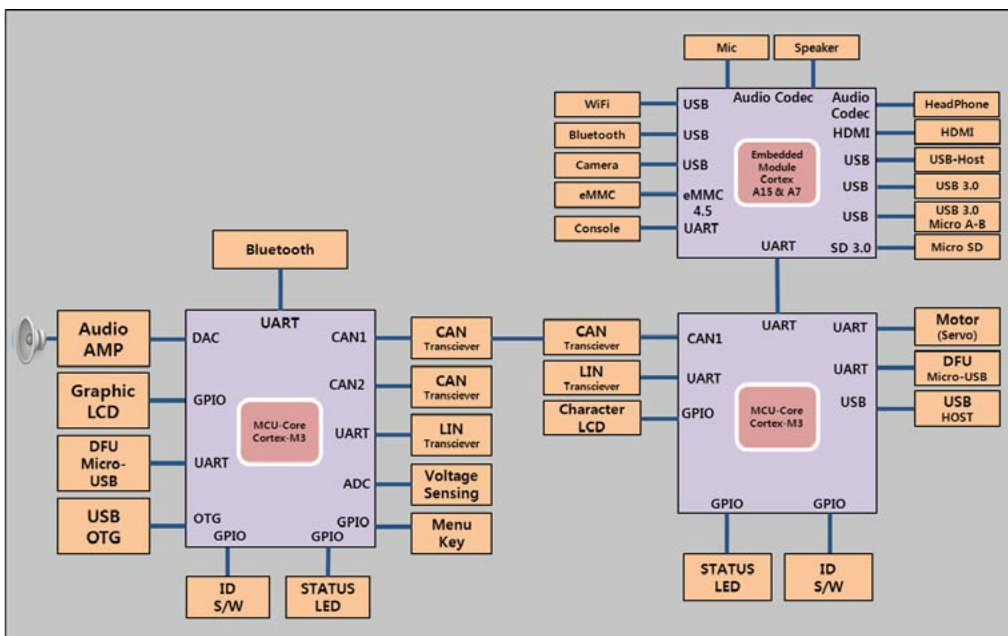
<Control System Module>

<Motor Study Module>



<Control System Module>

<Robot ARM Module>



<Control System Module>

<Robot Intelligence Module>

## Intelligent Robot

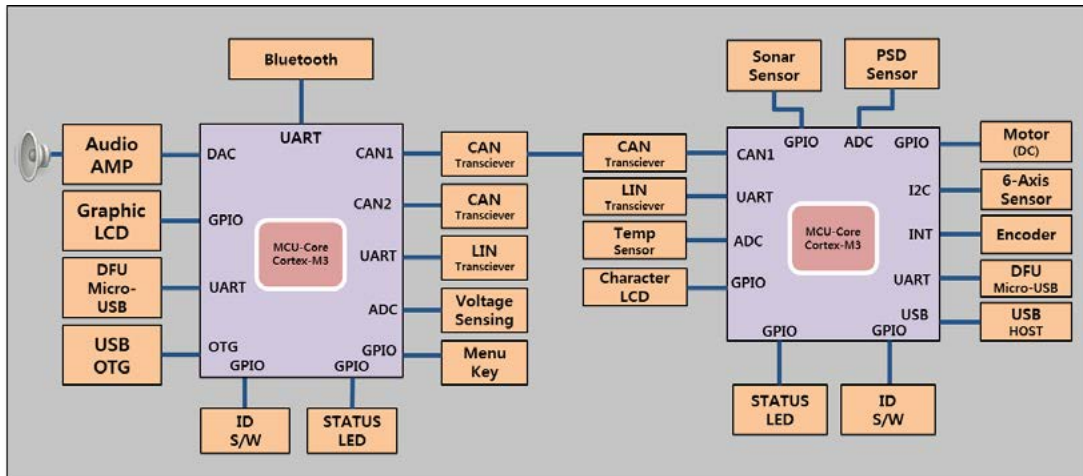
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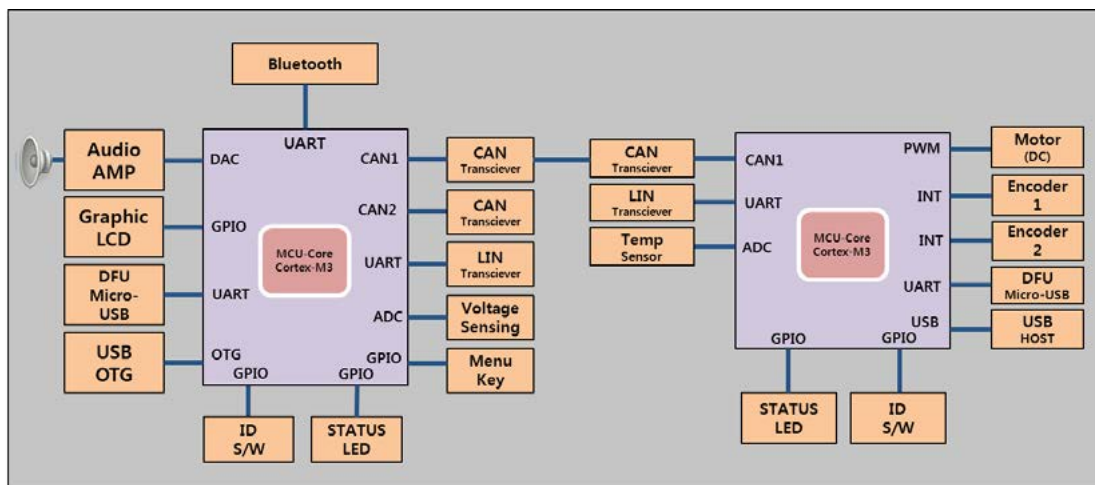
# Intelligent Robot

## >> HBE-RoboEX Series



<Control System Module>

<Robot Actuator Module>



<Control System Module>

<Pendulum Control Module>

### Hardware Specifications

#### RoboEX-Main (Control System Module)

Item	Specifications	
Core Module	Controller	32bit ARM Cortex-M3 ATSAM3X8EA-AU MCU up to 84MHz
	Flash Memory	512KB
	SRAM	64 + 32 KB
	DFU Controller	Low Power AVR 8bit Microcontroller ATmega16U2-AU
	EXT-Interface	0.8MM 2Raw 40Pin Connector 2EA (Plug)
Core-Module Interface	0.8MM 2Raw 40Pin Connector 2EA (Receptacle)	
Program-Interface	Micro-USB Type (DFU)	
User-Interface	Graphic LCD 128 X 64 STN / Yellow/Green Backlight	
	Speaker 1EA	
	Function Button 5EA	
Communication	Status LED 2EA, Power LED 1EA	
	Bluetooth 2.0+EDR (FB155BC)	
	CAN 2.0 Part A & CAN 2.0 Part B	
EXT-Interface	LIN 1.3 & 2.0	
	USB-Host	
	2x25Pin Connector 1EA	
Size	1x15Pin Socket 2EA, 1x18Pin Socket 2EA	
	185MM X 115MM	

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HBE-RoboBuilder-MSRDS

#### RoboEX-Motor (Motor Study Module)

Item	Specifications	
Core Module	Controller	32bit ARM Cortex-M3 ATSAM3X8EA-AU MCU up to 84MHz
	Flash Memory	512KB
	SRAM	64 + 32 KB
	DFU Controller	Low Power AVR 8bit Microcontroller ATmega16U2-AU (DFU)
	EXT-Interface	0.8MM 2Raw 40Pin Connector 2EA (Plug)
Core-Module Interface	0.8MM 2Raw 40Pin Connector 2EA (Receptacle)	
Program-Interface	Micro-USB Type (DFU)	
User-Interface	Character LCD 16x2	
	Buzzer 1EA	
	Function Button 5EA	
Communication	Status LED 2EA, Power LED 1EA	
	Bluetooth 2.0+EDR (FB155BC) (*Factory Option)	
	CAN 2.0 Part A & CAN 2.0 Part B	
Motor	LIN 1.3 & 2.0	
	RG35GM 11Type DC12V 1/50 with Encoder DC-Motor	
	MRS-D2009 Servo Motor	
Motor Driver	SST42D1100 Step-Motor	
	L298P Dual Full-Bridge Driver	
	SLA7024M High-Current PWM, Unipolar Stepper Motor Driver	
Sensor	MPU-6050 3Axis Accelerometer	
	TMP36GT9 Low Voltage Temperature Sensor	
	Encoder With DC-Motor	
Size	MI-23HT Photo Interrupter	
	215MM X 175MM X 90MM	



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### RoboEX-ARM (Robot ARM Module)

Item	Specifications	
Core Module	Controller	32bit ARM Cortex-M3 ATSAM3X8EA-AU MCU up to 84MHz
	Flash Memory	512KB
	SRAM	64 + 32 KB
	DFU Controller	Low Power AVR 8bit Microcontroller ATmega16U2-AU (DFU)
	EXT-Interface	0.8MM 2Raw 40Pin Connector 2EA (Plug)
Size	35MM x 35MM	
Core-Module Interface	0.8MM 2Raw 40Pin Connector 2EA (Receptacle)	
Program-Interface	Micro-USB Type (DFU)	
EXT-Interface	USB-HOST	
User-Interface	Character LCD 16x2	
	Buzzer 1EA	
	Function Button 5EA	
Communication	Status LED 2EA, Power LED 1EA	
	Bluetooth 2.0+EDR (FB155BC) ( *Factory option )	
	CAN 2.0 Part A & CAN 2.0 Part B	
	LIN 1.3 & 2.0	
Motor	AX-12A Dynamic-cell Servo-Motor 7EA	
Sensor	MPU-6050 3Axis Accelerometer + 3Axis Gyro	
	IESP-12 Pressure Sensor	
	TMP36GT9 Low Voltage Temperature Sensor	
Size	275MM X 275MM X 460MM	

### RoboEX-Brain ( Robot Intelligence Module ) Embedded Part

Item	Specifications
Processor	Samsung Exynos5 Octa 1.8GHz(Cortex-A15 Quad + Cortex-A7 Quad)
Memory	2Gbyte LPDDR3 RAM PoP (800MHz, 1600Mbps, 2x32bit Bus)
GPU	PowerVR SGX544MP3 GPU (OpenGL ES2.0, OpenGL ES1.1 and OpenCL 1.1EP)
Storage	eMMC 16GByte(eMMC 4.5 Support), *Option 8/16/32GByte MicroSD Card
Network	802.11b/g/n Wireless LAN
Bluetooth	4.0+EDR, 1.1/1.2/2.0/2.1+EDR compatible (*Max data speed 3Mbps)
PMIC	1EA Power Management IC
Digital Video	HDMI 1.4 Video Out (1080p)
Audio	Audio Codec, Build-In Speaker, Headphone-Jack (Mic + Speaker)
USB	USB 3.0 Host (Super Speed Standard A Type Connector x 1 Port)
	USB 3.0 OTG (Super Speed USB Micro A-B Type Connector x 1 Port)
	USB 2.0 Host (High Speed Standard A Type Connector x 2 Port)
UART	1 Port Serial to USB (Micro Type, Default : Debugging UART)
Camera	USB Camera [UVC Support] (*Option )

### RoboEX-Brain ( Robot Intelligence Module ) Sub-system Part

Item	Specifications	
Core Module	Controller	32bit ARM Cortex-M3 ATSAM3X8EA-AU MCU up to 84MHz
	Flash Memory	512KB
	SRAM	64 + 32 KB
	DFU Controller	Low Power AVR 8bit Microcontroller ATmega16U2-AU (DFU)
	EXT-Interface	0.8MM 2Raw 40Pin Connector 2EA (Plug)
Size	35MM x 35MM	
Core-Module Interface	0.8MM 2Raw 40Pin Connector 2EA (Receptacle)	
Program-Interface	Micro-USB Type (DFU)	
EXT-Interface	USB-HOST	
User-Interface	Character LCD 16x2	
	Speaker 2EA	
	Function Button 5EA	
	Status LED 2EA, Power LED 1EA	

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Communication	CAN 2.0 Part A & CAN 2.0 Part B LIN 1.3 & 2.0
Motor	AX-12A Dynamic-cell Servo-Motor 7EA
Size	275MM X 275MM

### RoboEX-3WD (Robot Actuator Module)

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Item	Specifications	HBE-RoboEX Series
Core Module	Controller	32bit ARM Cortex-M3 ATSAM3X8EA-AU MCU up to 84MHz
	Flash Memory	512KB
	SRAM	64 + 32 KB
	DFU Controller	Low Power AVR 8bit Microcontroller ATmega16U2-AU (DFU)
	EXT-Interface	0.8MM 2Raw 40Pin Connector 2EA (Plug)
Size	35MM x 35MM	
Core-Module Interface	0.8MM 2Raw 40Pin Connector 2EA (Receptacle)	
Program-Interface	Micro-USB Type (DFU)	
EXT-Interface	USB-HOST	
User-Interface	Character LCD 16x2	
	Buzzer 1EA	
	Function Button 5EA	
Communication	Status LED 2EA, Power LED 1EA	
	Bluetooth 2.0+EDR (FB155BC)	
	CAN 2.0 Part A & CAN 2.0 Part B LIN 1.3 & 2.0	
Motor	RG35GM 13Type DC12V 1/30 with Encoder DC-Motor	
Motor Driver	L298P Dual Full-Bridge Driver	
Sensor	MPU-6050 3Axis Accelerometer	
	TMP36GT9 Low Voltage Temperature Sensor	
	Encoder With DC-Motor	
	MA40S4R / MA40S4S Ultrasonic Sensor	
Wheel	GP2Y0A21YK Distance Measuring Sensor	
Battery	Omni Wheel 60MM Active Type / 6MM Motor Shaft Hole	
Size	11.1V @ 5200mA 3EA	
	205MM X 192MM X 190MM	

### RoboEX-Pendulum (Pendulum Control Module)

Item	Specifications	
Core Module	Controller	32bit ARM Cortex-M3 ATSAM3X8EA-AU MCU up to 84MHz
	Flash Memory	512KB
	SRAM	64 + 32 KB
	DFU Controller	Low Power AVR 8bit Microcontroller ATmega16U2-AU (DFU)
	EXT-Interface	0.8MM 2Raw 40Pin Connector 2EA (Plug)
Size	35MM x 35MM	
Core-Module Interface	0.8MM 2Raw 40Pin Connector 2EA (Receptacle)	
Program-Interface	Micro-USB Type (DFU)	
EXT-Interface	USB-HOST	
User-Interface	Buzzer 1EA	
	Status LED 2EA, Power LED 1EA	
	Bluetooth 2.0+EDR (FB155BC)	
Communication	CAN 2.0 Part A & CAN 2.0 Part B LIN 1.3 & 2.0	
	Motor	RA35GM 07Type DC12V 1/6
	Motor Driver	LMD18200T H-Bridge DC and Stepper Motor Driver
Encoder	E40S6-1024 1024 Pulse Rotary Encoder 2EA	
Sensor	TMP36GT9 Low Voltage Temperature Sensor	
Size	516MM X 157MM X 340MM	

# Intelligent Robot

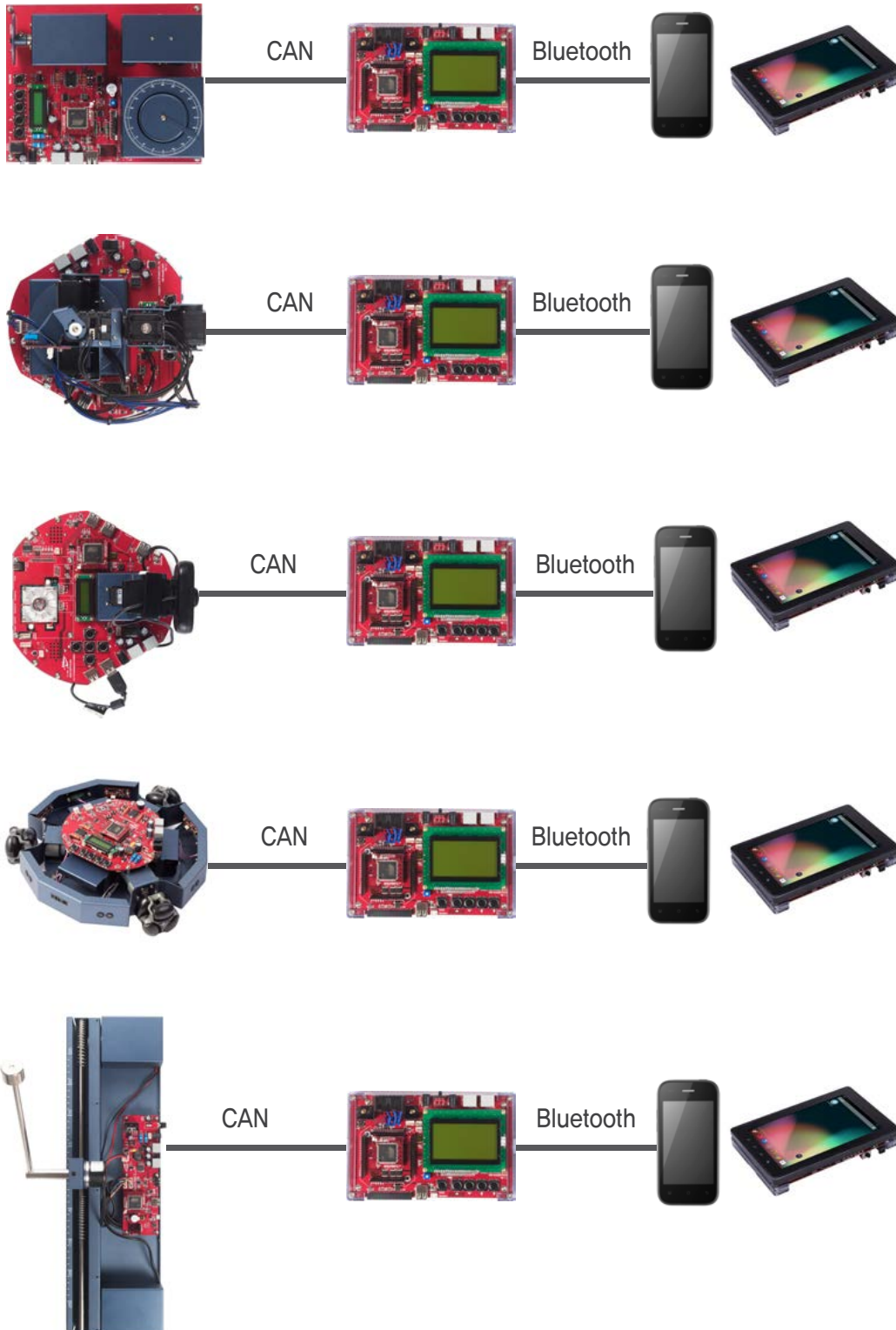
## >>HBE-RoboEX Series

### Software Specifications

Item	Specifications											
Arduino Integrated Development Environment	AndroX Studio™											
HBE-RoboEx-Main Firmware (Common)	Bluetooth based Remote control between Smart Device and Motor Study Module CAN communication based Remote control of Motor Study Module Control System Integrated Firmware, Remote Control Program for Smart Phone											
HBE-RoboEx Series Module Firmware(Common)	DC-Motor operation control by Infrared sensor DC-motor operation control by Encoder Servo Motor Control by Accelerometer Step Motor control Input Voltage and Temperature measurement Buzzer Control Motor Study Integrated Firmware Digital I/O control (LED, CLCD, PUSH & DIP SWITCH) Data Transmit/Receiving with Main Control Module using CAN Remote Control Program for SmartPhone											
HBE-RoboEx-ARM Firmware	Dynamic Cell Servo Motor Control Servo Motor Control by Pressure sensor Servo Motor Control by Accelerometer and Gyro sensor Buzzer Control Input Voltage and Temperature measurement											
HBE-RoboEx-Brain Firmware & Application	Dynamic Cell Servo Motor Control Data transformation with Embedded System by UART communication Intelligent Application Program based image processing(OpenCV) <table border="1" data-bbox="527 1202 1383 1360"> <tr> <td rowspan="5">Embedded Module</td> <td>Bootloader</td> <td>U-boot 1.3.4</td> </tr> <tr> <td>OS</td> <td>Linux Kernel 3.4.5</td> </tr> <tr> <td>Platform</td> <td>Android Jelly Bean 4.2.2</td> </tr> <tr> <td>Audio</td> <td>Audio driver, ALSA</td> </tr> <tr> <td>USB</td> <td>USB gadget driver</td> </tr> </table>	Embedded Module	Bootloader	U-boot 1.3.4	OS	Linux Kernel 3.4.5	Platform	Android Jelly Bean 4.2.2	Audio	Audio driver, ALSA	USB	USB gadget driver
Embedded Module	Bootloader		U-boot 1.3.4									
	OS		Linux Kernel 3.4.5									
	Platform		Android Jelly Bean 4.2.2									
	Audio		Audio driver, ALSA									
	USB	USB gadget driver										
HBE-RoboEx-3WD Firmware	DC-Motor operation control DC-Motor operation control by Encoder DC Motor Control by Accelerometer and Gyro sensor Distance Measurement Using Ultrasonic Sensors Distance Measurement Using PSD Sensor Buzzer control Input Voltage and Temperature measurement Robot Actuator Integrated Firmware											
HBE-RoboEx-Pendulum Firmware	PID DC-motor control DC-motor operation control by Encoder Inverted Pendulum module angle measurement by Encoder Buzzer Control Input Voltage and Temperature measurement											
Smart Device Application Program	Sensor value Receive and Remote control of RoboEX OpenCV Image Processing (HBE-RoboEx-Brain) Voice Recognition Processing (HBE-RoboEx-Brain) Pendulum monitoring Emulation program (HBE-RoboEx-Pendulum)											

## Expandability

Inter-connectable with HBE-SM7-S4412 and SmartPhone



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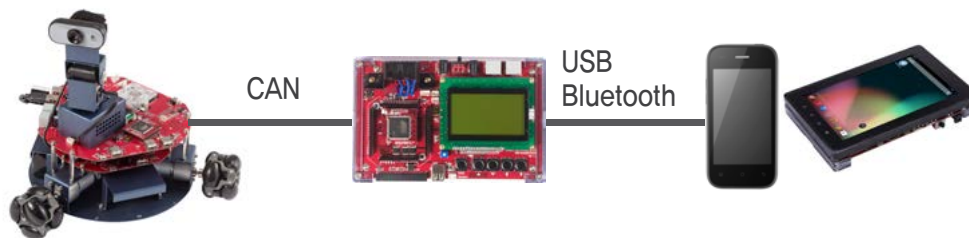


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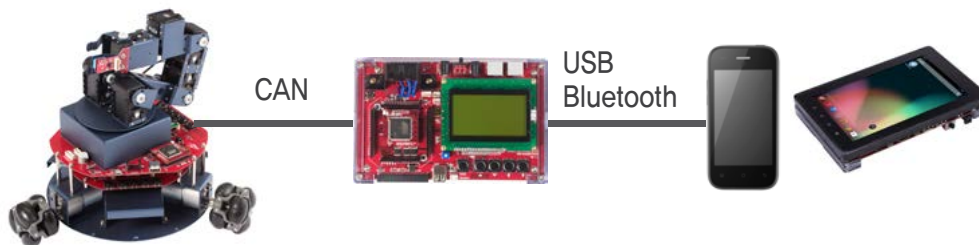
## >>HBE-RoboEX Series

Inter-connectable with other products of HBE-RoboEX series

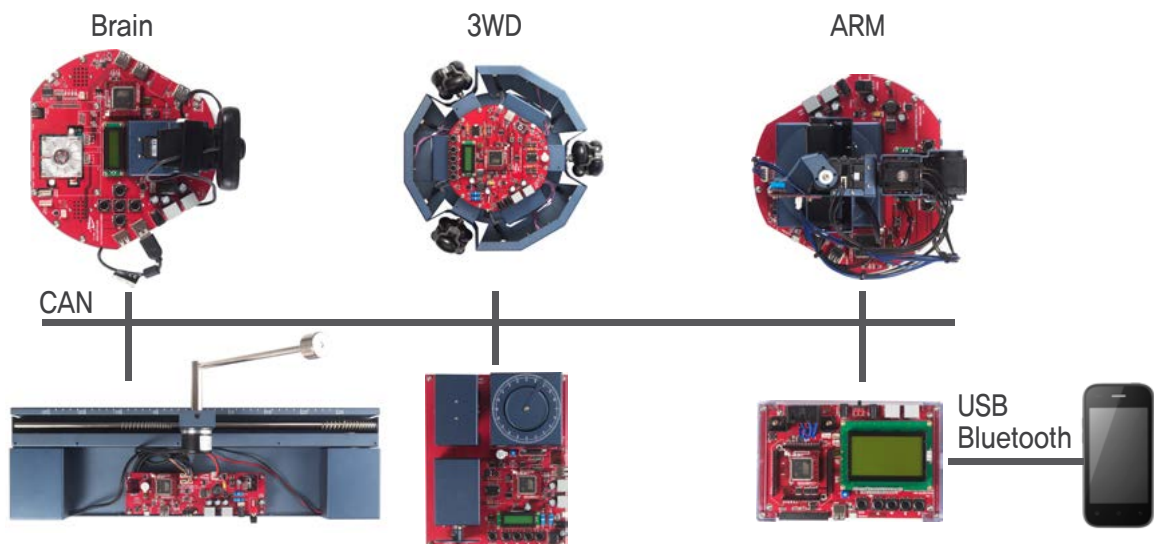
- Expendable to Image Processing Robot Solution executing project by inter-connection with HBE-RoboEX 3WD



- Expendable to Manipulator Robot Solution executing project by inter-connection with HBE-RoboEX 3WD



- Inter-connectable with other products of HBE-RoboEX series and controlled by Smart phone



## Components

Common package	Control System Module 1EA, UTP cable 1EA, Power Adapter 1EA, Platform CD 1EA, AndroX Studio DVD 1EA, User Manual 1EA, Micro USB cable 1EA
HBE-RoboEX-Motor	Motor Study Module 1EA, Experiment Manual 1EA
HBE-RoboEX-ARM	Robot ARM Module 1EA, Experiment Manual 1EA
HBE-RoboEX-Brain	Robot Intelligence Module 1EA, Experiment Manual 1EA
HBE-RoboEX-Pendulum	Pendulum Module 1EA, Experiment Manual 1EA

## Education Content

HBE-RoboEX-Brain	<ul style="list-style-type: none"> <li>Chapter 1 HBE-RoboEX-Brain</li> <li>Chapter 2 Configuration of Development Environment</li> <li>Chapter 3 AndroX Studio</li> <li>Chapter 4 Embedded System</li> <li>Chapter 5 Device Control</li> <li>Chapter 6 Controlling Motor for Image Tracking</li> <li>Chapter 7 Voice Processing and Recognition</li> <li>Chapter 8 Android Image Processing</li> <li>Chapter 9 Ubuntu</li> <li>Chapter 10 Appendix</li> </ul>
HBE-RoboEX-Theory	<ul style="list-style-type: none"> <li>Chapter 1 Microcontroller</li> <li>Chapter 2 Arduino</li> <li>Chapter 3 Digital I/O</li> <li>Chapter 4 Interrupt</li> <li>Chapter 5 Motor</li> <li>Chapter 6 A/D Converter</li> <li>Chapter 7 Communication</li> <li>Chapter 8 Sensor</li> <li>Chapter 9 PID</li> <li>Chapter 10 Inverse Pendulum System</li> </ul>
HBE-RoboEX-Experiment	<ul style="list-style-type: none"> <li>Chapter 1 Development environment setting of RoboEX</li> <li>Chapter 2 Digital Input/output</li> <li>Chapter 3 Interrupt</li> <li>Chapter 4 DC Motor</li> <li>Chapter 5 STEP Motor</li> <li>Chapter 6 SERVO Motor</li> <li>Chapter 7 Communication</li> <li>Chapter 8 A/D Converter</li> <li>Chapter 9 Movement Direction Control of Omniwheel Module</li> <li>Chapter 10 PID Control Method</li> <li>Chapter 11 Ultrasonic Sensor</li> <li>Chapter 12 Application</li> </ul>

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