AI-Starter User Guide

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ShenZhen Yuejiang Technology Co., Ltd.

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Before using our product, please thoroughly read and understand the contents of this document and related technical documents that are published online, to ensure that the robotic arm is used on the premise of fully understanding the robotic arm and related knowledge. Please use this document with technical guidance from professionals. Even if follow this document or any other related instructions, Damages or losses will be happen in the using process, Dobot shall not be considered as a guarantee regarding to all security information contained in this document.

The user has the responsibility to make sure following the relevant practical laws and regulations of the country, in order that there is no significant danger in the use of the robotic arm.

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Preface

Purpose

This manual describes the functions of the AI-Starter, how to use the car and its API functions to help users quickly understand and use the car.

Intended Audience

This document is intended for:

- Customer Engineer
- Sales Engineer
- Installation and Commissioning Engineer
- Technical Support Engineer

Change History

Date	Change Description
2019/01/07	V1.1.0 Add demo and update API
2018/04/27	V1.0.0 The first release

Symbol Conventions

The symbols that may be founded in this document are defined as follows.

Symbol	Description
⚠DANGER	Indicates a hazard with a high level of risk which, if not avoided, could result in death or serious injury
⚠WARNING	Indicates a hazard with a medium level or low level of risk which, if not avoided, could result in minor or moderate injury, robotic arm damage
⚠NOTICE	Indicates a potentially hazardous situation which, if not avoided, can result in robotic arm damage, data loss, or unanticipated result
📖NOTE	Provides additional information to emphasize or supplement important points in the main text

Contents

1. **Safety Precautions**

1.1　**Service Security**

- Users need to assemble the AI-Starter by themselves. Please do not tighten screws hard when install to avoid the treads stripping.

- When put the batteries inside, please make sure that the polarity is not reversed. Only the Li-ion rechargeable battery of 18650 type is supported.

- Please keep an eye on the AI-Starter when AI-Starter works, to avoid motor stalling for a long time, which could damage the control board and motor of the AI-Starter.

1.2　**After-sales Service Terms**

1.2.1　**Warranty Regulation**

- The warranty period of machine body shall be 6 months.

- The battery is not included in warranty service. Only replacement of damage by default is provided.

- The battery does not enjoy the warranty service, only the factory damage replacement

- The vulnerable parts such as package, giveaway, USB, screws, wrench, structure parts, etc. shall be not covered by the warranty service. However, if there is any non-artificial performance failure at the first time using after purchase

- Please confirm the integrity of the package at the time of signing for acceptance of the goods. Within 7 days upon purchase of the goods (inclusive, calculated from the date of receipt of the goods), if the goods are found to be missing or damaged due to transportation, or a non-artificial performance failure occurs to the goods or accessories, please immediately contact the local after-sales service department for supplement or replacement; any application for supplement or replacement beyond this time limit shall be considered invalid.

- During the validity period of three guarantees (for repair, replacement or compensation of faulty products), where a product is in compliance with the replacement conditions but the seller has no product of the same time or specification, and the customer requires the return of goods as he or she is not willing to replace it with the product of a different type or specification, the customer may return the goods.

- The maintenance period of replacement parts within the warranty period is 2 months. The detective parts replaced shall be owned by DOBOT.

⚠NOTICE

> The freight for any replacement or return that meets the above conditions shall be borne by DOBOT officially, while the tariff at the destination which is required to be paid due to its policy shall be borne by the customer.

To provide the free maintenance service, the following conditions shall be met:

- The product is normal used within the specified warranty period and has any non-artificial performance failure.
- The valid purchase certificate, receipt and the number thereof are provided.
- If additional package, accessories or translation are needed, our company will charge a certain cost.

The free product maintenance service shall not be provided under any of the following circumstances:

- Damage caused by unauthorized maintenance, alteration and other acts.
- Damage caused by non-standard operating environment, such as overload, high voltage, high current, high temperature, etc
- Appearance and function abnormality caused by man-made collision and dropping.
- The abnormal function caused by wet environment, soak or burn.
- Damage caused by improper use, installation and operation that are not in accordance with the official instructions.
- Damage caused by circuit redesign, improper installation of the battery, overcharge, improper installation and connection, and improper use of the charger that are not in accordance with the official instructions.
- Damage caused by reliability and compatibility problems arising from simultaneous use of third-party parts that are not certified by our company.

Spacial instructions

- **The related after-sales service is proved by the local agent**
- **If you have questions about the related after-sale service, please contact the official after-sales service department. We will help you to solve your problem without delay**

2. **Introduction**

2.1 **Features**

AI-Starter is a smart car aimed to education and competition. It is designed with no-soldering assembly technique, using brass stubs to fix control board, and ribbon cables to connect each board, of which the layer is clear. The control board is designed based on Arduino Mega2560, compatible with Arduino, which is very easy to get started

Function features:

- Intelligent obstacle avoidance

- Automatic tracking

- Identify scenes based on color and perform different tasks

- Graphical programming, user can program by building blocks to control AI-Starter

2.2 **Parts List**

Table 2.1   Parts List

Part	Number
Chassis	1
Shell	1
Control Board	1
Ultrasonic Sensor	3
Infrared Sensor	1
Color Sensor	2
DC Gear Motor (with Encoder)	2
Universal Wheel	1
Coupling	2
Tire	2
18650 Li-ion Battery	2
18650 Battery Holder	1
Brass Stud M3*32+4	4
R2048 Nylon Rivet	10
M3*5 Cross Round Head Screw	30
M3*5 Cross Countersunk Screw	4
M3*6 Cross Round Head Screw	6

Part	Number
M4*6 Cross Round Head Screw	3
4PIN Ultrasonic Sensor Cable	3
6PIN Color Sensor Cable	2
8PIN Tracking Module Cable	1
6PIN Motor Cable	2
USB Cable	1
Acrylic Plate A	1
Acrylic Plate B	1
Cross Screwdriver	1
User Guide	1

2.3 Technical Parameters

Table 2.2 Technical Parameters

Parameters	Description
Operating Voltage	7.4V
Control Board	DuDuino Mega (compatible with Arduino Mega 2560)
MPU	ATmega2560
Battery	18650 Li-ion rechargeable battery
Ultrasonic Measurement Range	3mm~500mm
VTBOT Size	195mm*172mm*79mm
VRBOT Weight	810g
Maximum Load	500g
Tire Diameter	67mm
Operating Environment	0°C~40°C
Control Software	Arduino IDE or Mixly
Communication Interface	USB communication, Serial communication
Expansion Interface	4PIN general I/O interface *2
Sensor	• Ultrasonic sensor *3 • Color sensor*2 • Infrared tracking model*1

Parameters	Description
	• Geomagnetic sensor*1 • Light sensor *1
Motor Parameters	• Reduction ratio: 48 : 1 • Voltage: 7V • No-load current: 150mA • Stall current: 700mA • Maximum rotate speed: 100r/m • Encoder resolution ratio: 585pulse/r

3. **Feature Description**

3.1 **AI-Starter Controller**

3.1.1 **Overview**

AI-Starter control board is designed based on Arduino Mega2560, compatible with Arduino, not only integrate motor drive, geomagnetic sensor, light sensor, button module, LED module and so on, but also integrate infrared tracking interface, ultrasonic sensor interface, USB, Xbee, bluetooth, serial port and so on. The main control board of AI-Starter, which is shown in Figure 3.1 presets two servo signal interfaces for user expansion.
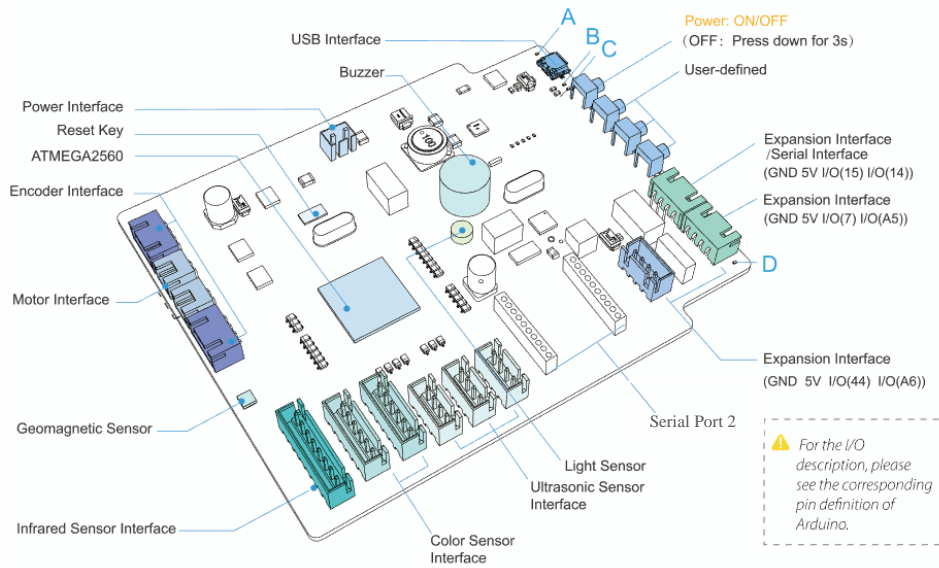
Figure 3.1   AI-Starter control board description

3.1.2 **AT Mega2560 Processor**

AI-Starter processor is atmega2560, which compatible with arduino2560, you can develop by arduinoIDE. Meanwhile we provide Mixly graphical programming environment.

3.1.3 **Button**

The end of AI-Starter controller integrates four independence buttons, as shown in Figure 3.1, the detail descriptions are shown in Table 3.1.

Table 3.1   Button description

No.	Description
1	AI-Starter Switch button, start or stop AI-Starter When you stop AI-Starter, you need to press and hold this button for about 3 seconds.
2	User-defined User can set function in Mixly or Arduino IDE environment

No.	Description
3	User-defined User can set function in Mixly or Arduino IDE environment
4	User-defined User can set function in Mixly or Arduino IDE environment

3.1.4   LED

The end of AI-Starter controller integrates four LED indicators, as shown in Figure 3.1, the detail descriptions are shown in Table 3.2.

Table 3.2   LED indicators description

No.	Color	description
A	Blue	User-defined User can set function in Mixly or Arduino IDE environment
B	Red	• Off: Indicate that the AI-Starter is uncharged. • Steady Red is always on: Indicates that the AI-Starter is charging.
C	Red	• Off: Indicates that the AI-Starter battery voltage is normal. • Steady Red: Indicates that the AI-Starter battery has a low voltage
D	Blue	User-defined User can set function in Mixly or Arduino IDE environment

3.1.5   USB

AI-Starter intergrates USB download function, you can download program to AI-Starter by USB, and make AI-Starter run by program. Meanwhile, USB charging function are supported by AI-Starter, you can charge AI-Starter by connecting AI-Starter to computer with USB cable when AI-Starter battery has a low voltage.

Operating systems are supported by USB driver:

• Win7

• Win8

• Win10

⚠NOTICE

When you install Mixly or Arduino IDE, the Arduino USB drive will be installed automatically. After connecting AI-Starter to computer by USB cable and starting computer, you can find the corresponding COM port on device manager, as shown in Figure 3.2. If the corresponding COM port is not found, you need to install Arduino

USB drive again in *Arduino-X/drivers* path, X is the Arduino version, please replace it according to the actual situation.
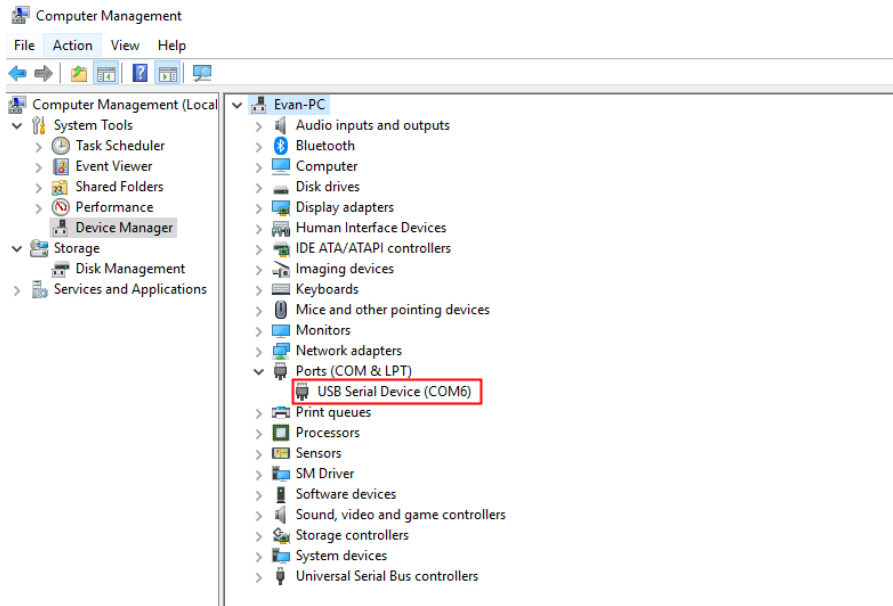

Figure 3.2　USB drive

3.1.6　Interface Description
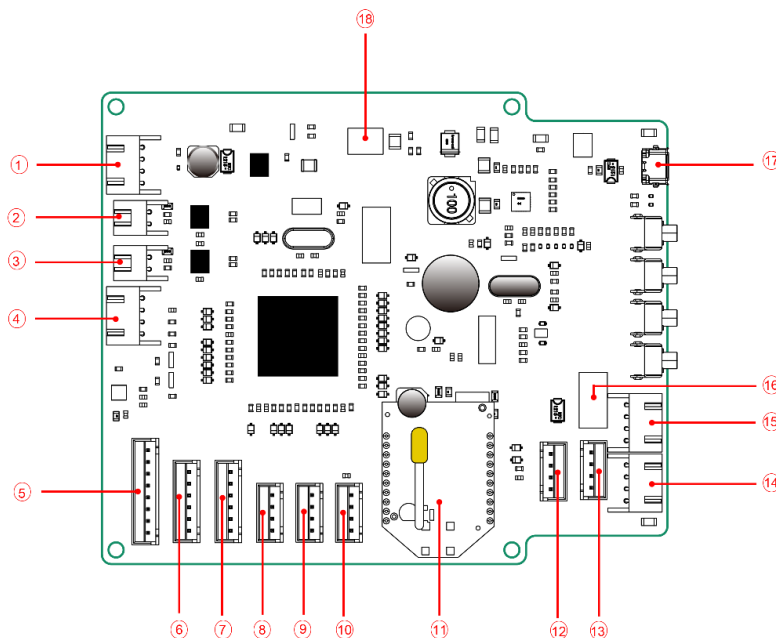
Figure 3.3　AI-Starter main control board interface description

Table 3.3　Interface description

No.	Description
1	Encoder interface, connect to the right motor on the AI-Starter chassis
2	Motor interface, connect to the right motor on the AI-Starter chassis
3	Motor interface, connect to the left motor on the AI-Starter chassis
4	Encoder interface, connect to the left motor on the AI-Starter chassis
5	infrared sensor interface, connect to AI-Starter infrared tracking sensor
6	Color sensor interface, connect to the right color sensor on the AI-Starter chassis
7	The left color sensor interface, connect to the left color sensor on the AI-Starter chassis
8	Ultrasonic sensor interface, connect to the ultrasonic sensor on the right side of AI-Starter
9	Ultrasonic sensor interface, connect to the ultrasonic sensor on the front　of AI-Starter
10	Ultrasonic sensor interface, connect to the ultrasonic sensor on the left side of AI-Starter
11	Xbee interface,
12	Reserved servo interface
13	Bluetooth interface, which is UART interface.
14	Reserved servo interface
15	Reserved serial interface, which is UART interface
16	Wifi interface, which is UART interface
17	USB interface, which is standard Micro-USB interface
18	Power interface, connected to battery on the AI-Starter chassis

3.2　**Infrared Sensor**

An infrared sensor is built into the bottom of AI-Starter, which can recognize black line by judging ground color for automatic patrol. 6-channel high-precision infrared pair tubes and 6 adjustable potentiometers are built into infrared sensor, which are used to adjust the distance detected by infrared pair tube. Infrared sensor can detect track black line accurately, the detection range is 3cm, and the accuracy is 0.1cm.

3.3　**Ultrasonic Sensor**

Three ultrasonic sensors are built into the head of AI-Starter, which can detect obstacle distance in the range of 3mm to 500mm in front of AI-Starter.

3.4　**Color Sensor**

Two color sensors are built into the bottom of AI-Starter, which can recognize the color on the ground to execute different task according to different color.

4. **Installation**

4.1   **Mixly Installation**

Mixly is an open Arduino graphical programming software based on Google Blockly graphical programming frame. AI-Starter adds wrapper function on Mixly, user can call wrapper function by building blocks and upload it to AI-Starter to control AI-Starter.

You can use Mixly directly after download without complicated installation. The download path is http://mixly.org/explore/software/mixly-arduino

📖NOTE

At present, AI-Starter only support Mixly 0.995, the other versions are not supported.

4.2   **Arduino IDE**

AI-Starter supports Arduino C programming language. Arduino is a convenient and flexible open source electronic platform, which includes Arduino develop tools Arduino IDE and core library.

The Arduino IDE package is nested in the Mixly package and can be used directly after extracting the Mixly installation package. The Arduino IDE software path is ***Installation path*/Dobot_Mixly/arduino-*XXX*.** *XXX* is Arduino version, please replace it according to the actual situation.

5. **User Operation**

5.1 **Mixly Introduction**

Mixly page is shown in Figure 5.1. When you use Mixly, you need to select **Arduino\Genuino Mega or Mega 2560[atmega2560]** Development board and choose the corresponding serial port, as shown in Figure 5.1.

User can drag the programming blocks on the left of Mixly page, and upload program to AI-Starter after compiling, AI-Starter will work according to the program. For the API function details, please see API Function.
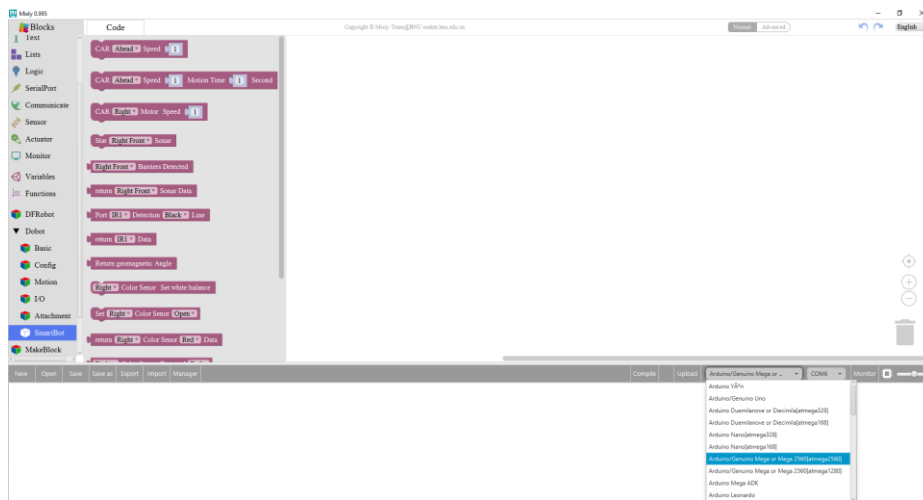
Figure 5.1   The page of Mixly

⚠NOTICE
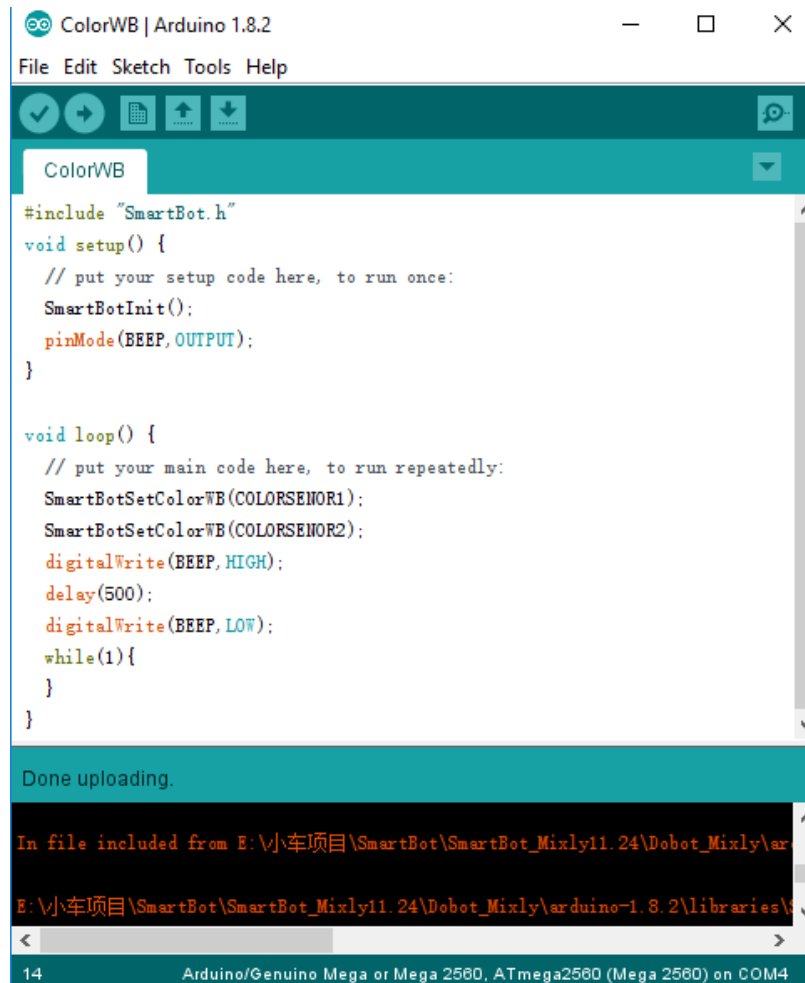
If you can not get the corresponding serial port of AI-Starter when you open Mixly, please ensure the Arduino USB drive has been installed. If you still can not get serial port information after installing, please open Mixly as an administrator.

Mixly instructions are not described in detail in this manual. For the detail about Mixly, please see the related manual on Mixly official website.

5.2 **Arduino IDE Introduction**

The page of Arduino IDE is shown in Figure 5.2.

Figure 5.2   The page of Arduino IDE

After opening Arduino IDE, select **Arduino/Genuino Mega or Mega 2560** on the **Tools > Borad** page, select **ATmega2560 (Mega 2560)** in **Tools > Processor** path, select the corresponding serial port in **Tools > Port** path.

User can select example on the **File > Examples > AiStarter** page, click [➡] to upload example to AI-Starter, which will make AI-Starter work according to the example. You can also refer to API Function to upload program to AI-Starter by calling API function, which will make AI-Starter work according to the program.

6. **AI-Starter Demo**

6.1 **Line Tracking Demo**

6.1.1 **Description**

This demo shows that AI-Starter tracks line automatically on testing map.

6.1.2 **Procedure**

Step 1　Turn on AI-Starter.

Step 2　Press down the key **start|stop**, AI-Starter starts tracking line after buzzer beeps one time.

Step 3　Press down the key **start|stop** once agian, AI-Starter stops tracking line after the buzzer beeps one time.

6.1.3 **Code Description**

1）　Get the current infrared sensor value.

Program 6.1　Get infrared sensor value

```
void getCurrentIRState(int *irstate)
{
    *irstate = 0;
    for (int i = 0; i < IR_NUM; i++) {
        *irstate |= AIStarter_SmartBotGetIRModuleValue(i) << i;
    }
}
```

2）　Get AI-Starter pose.

Program 6.2　Get AI-Starter pose

```
float getCurrentPos(const int irstate)
{
    const float coeff = 0.7;
    const int irPos[] = {-30, -18, -6, 6, 18, 30};
    static float lastPos;
    float curPos;
    float readPos;
    int total = 0;
    int irOffCnt = 0;
```

```
//calculate the car position offset
for (int i = 0; i < IR_NUM; i++) {
    if (irstate & (1 << i)) {
        total += irPos[i];
        irOffCnt++;
    }
}
if (irOffCnt) {
    readPos = total / irOffCnt;
}
else {
    readPos = lastPos;
}
//calculate the current position
curPos = (1 - coeff) * lastPos + coeff * readPos;
lastPos = curPos;
return curPos;
}
```

3) Set AI-Starter speed.

Program 6.3 Set AI-Starter speed

```
void setCarSpeed(const float curPos)
{
    const int baseSpeed = 50; //rpm
    const float kp = 1;
    const float ki = 0.06;
    const float kd = 0.0;
    const float errorsumLimit = 50;

    float error = curPos;
    static float lastError;
    static float errorsum;
    float errorChange;
    int speedLeftWheel;
    int speedRightWheel;
```

```
    int speedOffset;


    //pid
    errorsum += error;
    if (errorsum > errorsumLimit) {
        errorsum = errorsumLimit;
    }
    else if (errorsum < -errorsumLimit){
        errorsum = -errorsumLimit;
    }
    errorChange = error - lastError;
    speedOffset = kp * error + ki * errorsum + kd * errorChange;
    lastError = error;


    //calculate the wheel speed
    speedLeftWheel    = baseSpeed + speedOffset;
    speedRightWheel = baseSpeed - speedOffset;


    AIStarter_SmartBotSetMotor(MOTORL, speedLeftWheel);
    AIStarter_SmartBotSetMotor(MOTORR, speedRightWheel);
    Serial.println("go ahead");
}
```

6.2 **Obstacle Avoiding Demo**

6.2.1 **Description**

This demo shows that AI_Starter avoids obstacle automatically.

6.2.2 **Procedure**

Step 1   The motors stop running after turning on AI-Starter.

Step 2   Press down the key **start|stop**, AI-Starter starts avoiding obstacle.

Step 3   AI-Starter moves back for a certain distance after detecting obstacle, and turn left or right according to the ultrasonic sensors.

Step 4   Press down the key **start|stop** once agian, AI-Starter stops tracking line after the buzzer beeps one time.

6.2.3 **Code Description**

1） Initialize AI-Starter.

Program 6.4　Initialize AI-Starter

```
AIStarter_SmartBotInit();
```

2)　Put the ultrasonic sensor values into the array **dis**.

Program 6.5　Save ultrasonic sensor values

```
dis[0] = AIStarter_SmartBotGetSonar(SONAR1);

dis[1] = AIStarter_SmartBotGetSonar(SONAR2);

dis[2] = AIStarter_SmartBotGetSonar(SONAR3);
```

3)　Set turning mode according to the distance between obstacle and AI-Starter.

Program 6.6　Set turning mode

```
    if(dis[0] > 2*DIS ){

        motorStatus = AHEAD;

    }else if(dis[0] > DIS    && dis[0] < 2*DIS ){

        motorStatus = motorStatus;

    }else if(dis[0] > 0    && dis[0] < DIS ){

        motorStatus = BACKRIGHT;

        break;

    }

    if(dis[1] > 2*DIS ){

        motorStatus = AHEAD;

    }else if(dis[1] > DIS    && dis[1] < 2*DIS ){

        motorStatus = motorStatus;

    }else if(dis[1] > 0    && dis[1] < DIS ){

        motorStatus = BACKRIGHT;

        break;

}

if(dis[2] > 2*DIS ){

        motorStatus = AHEAD;

    }else if(dis[2] > DIS    && dis[2] < 2*DIS ){

        motorStatus = motorStatus;

    }else if(dis[2] > 0    && dis[2] < DIS ){

        motorStatus = BACKLEFT;

        break;

    }
```

4)   AI-Starter turns around according to obstacle position.

- BACKRIGHT: turn right

- BACKLEFT: turn left

- AHEAD: go straight.

Program 6.7   Turns around according to obstacle position

```
switch(motorStatus){
    case BACKRIGHT:
        AIStarter_SmartBotSetMotor(MOTORR,BACKSPEED);
        AIStarter_SmartBotSetMotor(MOTORL,BACKSPEED);
        delay(BACKTIME);
        AIStarter_SmartBotSetMotor(MOTORR,DIFSPEED);
        AIStarter_SmartBotSetMotor(MOTORL,FRONTSPEED);
        delay(SWERVETIME);
    break;
    case BACKLEFT:
        AIStarter_SmartBotSetMotor(MOTORR,BACKSPEED);
        AIStarter_SmartBotSetMotor(MOTORL,BACKSPEED);
        delay(BACKTIME);
        AIStarter_SmartBotSetMotor(MOTORR,FRONTSPEED);
        AIStarter_SmartBotSetMotor(MOTORL,DIFSPEED);
        delay(SWERVETIME);
    break;
    case AHEAD:
        AIStarter_SmartBotSetMotor(MOTORR,FRONTSPEED);
        AIStarter_SmartBotSetMotor(MOTORL,FRONTSPEED);


    break;
    default:
    break;
}
```

6.3 **White Balance Calibration Demo**

6.3.1 Description

This demo shows white balance calibration.

6.3.2 Procedure

Step 1 Put AI-Starter on a piece of A4 paper.

Step 2 Put down the key **start|stop** to calibrate white balance.

6.3.3 Code Description

1) Initialize AI-Starter.

Program 6.8 Initialize AI-Starter

```
AIStarter_SmartBotInit();
```

2) Calibrate white balance.

Program 6.9 Calibrate white balance

```
AIStarter_SmartBotSetColorWB(COLORSENOR1);
AIStarter_SmartBotSetColorWB(COLORSENOR2);
```

6.4 Color Recogition and Line Tracking Demo

6.4.1 Description

This demo shows how combine color recognition with line tracking.

6.4.2 Procedure

Step 1 Press down the key **start|stop**, AI-Starter starts tracking line after buzzer beeps one time.

Step 2 In tracking line process, when detecting black line, AI-Starter stops moving, and begins to detect color.

Step 3 When the recognized color is red, AI-Starter stops moving for 3s, and the buzzer beeps three times.

Step 4 When the recognized color is red, AI-Starter stops moving for 3s, and the buzzer makes a long call for 3s.

Step 5 AI-Starter goes ahead after finishing the above steps

Step 6 Press down the key **start|stop** once agian, AI-Starter stops tracking line after the buzzer beeps one time.

6.4.3 Code Description

1) Initialize AI-Starter.

Program 6.10 Initialize AI-Starter

```
AIStarter_SmartBotInit();
```

2) Detect color.

Program 6.11 Detect color

```
if(AIStarter_SmartBotGetColorSenor(COLORSENOR1,RCOLOR)
-AIStarter_SmartBotGetColorSenor(COLORSENOR1,GCOLOR) > 30 &&
   AIStarter_SmartBotGetColorSenor(COLORSENOR1,RCOLOR)
-AIStarter_SmartBotGetColorSenor(COLORSENOR1,BCOLOR) > 30) {
        colorState = RLINE;
}
```

3) AI-Starter executes different action according to different color status.

Program 6.12 Execute action

```
    switch(colorState) {
        case OTHERLINE:
            //colorRec = false;
            lineState = LINEPATROL;
        break;
        case RLINE:
            delay(3000);
            //colorRec = false;
            lineState = LINEPATROL;
        break;
        case GLINE:
            delay(3000);
            //colorRec = false;
            lineState = LINEPATROL;
        break;
        default:
        break;
    }
```

6.5 **Cooperation Demo**

6.5.1 Description

This demo shows the coorperation of AI-Starter and Magician.

1) AI-Starter moves to the green line and then stops moving for one minute.

2)   Magician Detects AI-Starter moves to the carring position by Pixy.

3)   Magician starts to grab cubes to AI-Starter.

4)   After one minute, AI-Starter finishes carrying, and then starts line tracking function.

6.5.2   Procedure

AI-Starter

Step 1   Press down the key **start|stop**, AI-Starter starts tracking line after the buzzer beeps one time.

Step 2   In tracking line process, when detects black stoping line, AI-Starter stops moving, and begins to detect color.

Step 3   When the recognized color is red, AI-Starter stops moving for 3s, and the buzzer beeps three times.

Step 4   When the recognized color is green, AI-Starter stops moving for 1 minute, and the buzzer beeps one time.

Step 5   AI-Starter keeps tracking line.

Step 6   Press down the key **start|stop** once agian, AI-Starter stops tracking line after the buzzer beeps one time.

Magician

Step 1   Open Magician file in the Magician Coorperation file folder to upload Magician firmware to Arduino expansion board.

Step 2   When detecting that AI-Starter moves to the carrying position, Magician begins to grab cubes to AI-Starter.

Step 3   AI-Starter keeps tracking line.

6.5.3   Code Description

AI-Starter

1)   Initialize AI-Starter.

Program 6.13   Initialize AI-Starter

```
AIStarter_SmartBotInit();
```

2)   Detect color.

Program 6.14   Detect color

```
if(AIStarter_SmartBotGetColorSenor(COLORSENOR1,RCOLOR)
-AIStarter_SmartBotGetColorSenor(COLORSENOR1,GCOLOR) > 30 &&
```

```
AIStarter_SmartBotGetColorSenor(COLORSENOR1,RCOLOR)

-AIStarter_SmartBotGetColorSenor(COLORSENOR1,BCOLOR) > 30)

{

   colorState = RLINE;

}
```

3）AI-Starter executes different action according to different color status.

Program 6.15　Execute action

```
    switch(colorState) {

        case OTHERLINE:

            //colorRec = false;

            lineState = LINEPATROL;

        break;

        case RLINE:

            delay(3000);

            //colorRec = false;

            lineState = LINEPATROL;

        break;

        case GLINE:

            delay(3000);

            //colorRec = false;

            lineState = LINEPATROL;

        break;

        default:

        break;

    }
```

Magician

1）Set cube position.

Program 6.16　Set cube position

```
float AreaPoint[4][3] = {

   {137.05, -206.94, -39},

   {137.05, -244.31, -39},

   {100.50, -206.94, -39},

   {100.50, -244.31, -39}
```

```
};
```

2） Set AI-Starter carrying position.

Program 6.17   Set carring position

```
float trayPoint[4][3] = {

    {308.12,   25.92,   28},

    {308.12, -15.92,   28},

    {258.12,   25.92,   28},

    {258.12, -15.92,   28}

};
```

3） Magician grabs cubes to AI-Starter.

Program 6.18   Grab cude

```
void AreaToAIStarter()

{

    for(uint8_t i=0; i<4; i++){

        Dobot_SetPTPCmdEx(JUMP_XYZ, AreaPoint[i][0], AreaPoint[i][1], AreaPoint[i][2], 0);

        Dobot_SetEndEffectorSuctionCupEx(true);

        Dobot_SetPTPCmdEx(MOVL_XYZ, AreaPoint[i][0], AreaPoint[i][1], AreaPoint[i][2]+70, 0);

        Dobot_SetPTPCmdEx(JUMP_XYZ, trayPoint[i][0], trayPoint[i][1], trayPoint[i][2], 0);

        Dobot_SetEndEffectorSuctionCupEx(false);

        Dobot_SetPTPCmdEx(MOVL_XYZ, trayPoint[i][0], trayPoint[i][1], trayPoint[i][2]+30, 0);

    }

    Dobot_SetPTPCmdEx(MOVJ_XYZ, InitPositionX, InitPositionY, InitPositionZ, InitPositionR);

}
```

4） Initialize Pixy and Magician.

Program 6.19   Initialize Pixy and Magician

```
pixy.init();

Dobot_Init();
```

5） Detect cube number.

Program 6.20   Detect cube number

```
pixy.ccc.getBlocks();
```

6.6 **Servo Drive Demo**

6.6.1 Introduction

This demo shows how AI-Starter drives servo rotate from 0° to 180°.

6.6.2 Procedure

Step 1 Connect servo to digital I/O 7. For I/O 7 description details please refer to Chapter 3.1.1 Overview.

Step 2 Press down the button **start|stop**. Servo rotates from 0° to 180° repeatedly.

6.6.3 Code Description

1) Initialize AI-Starter.

Program 6.21　Initialize AI-Starter

```
AIStarter_SmartBotInit();

AIStarter_SmartBotServoAttach(SERVO1);
```

2) Servo rotates from 0° to 180° repeatedly.

Program 6.22　Servo rotates 180°

```
for (pmwServo = 0; pmwServo <= 180; pmwServo += 1) {

    AIStarter_Servo.write(pmwServo);

    delay(15);

}
for (pmwServo = 180; pmwServo >= 0; pmwServo -= 1) {

    AIStarter_Servo.write(pmwServo);

    delay(15);

}
```

6.7 Xbee Communication Demo

6.7.1 Introduction

This demo shows show AI-Starter communicates with PC by Xbee.

6.7.2 Procedure

Step 1 Download XCTU software on XCTU official website:

https://www.digi.com/support/productdetail?pid=3352&type=utilities.

Step 2 Load XbeeMatch.xpro firmware by XCTU.

Step 3 After finishing loading the firmware, please connect Xbee to serial port 2 on AI-Starter. For serial port 2 details, please refer to Chapter 3.1.1 Overview.

Step 4 Press down the button **start|stop**, and send a control command to AI-Starter.

Step 5 AI-Starter would execute the corresponding actions according to the command sent by PC.

6.7.3 Code Description

1)   Initialize AI-Starter.

Program 6.23   Initialize AI-Starter

```
AIStarter_SmartBotInit();
```

2)   Read Xbee data.

Program 6.24   Read Xbee data

```
strCommand = AIStarter_SmartBotXbeeRead();
```

3)   Execute the corresponding actions according to Xbee data.

Program 6.25   Execute corresponding action

```
if(!AIStarter_SmartBotXbeeCompare(strCommand, "Ahead")) {

    rOffSet = 1;

    lOffSet = 1;

} else if(!AIStarter_SmartBotXbeeCompare(strCommand, "Back")) {

    rOffSet = -1;

    lOffSet = -1;

} else if(!AIStarter_SmartBotXbeeCompare(strCommand, "TurnLeft")) {

    rOffSet = 1;

    lOffSet = 0.5;

} else if(!AIStarter_SmartBotXbeeCompare(strCommand, "TurnRight")) {

    rOffSet = 0.5;

    lOffSet = 1;

} else if(!AIStarter_SmartBotXbeeCompare(strCommand, "Stop")) {

    rOffSet = 0;

    lOffSet = 0;

}
```

4)   Clear Xbee data.

Program 6.26   Clear Xbee data

```
AIStarter_SmartBotXbeeClear();
```

7. **API Function**

7.1 **Initializing AI-Starter**

Table 7.1   Initialize AI-Starter

Function	int AIStarter_SmartBotInit ();
Description	Initialization
Paramater	None
Return	None

7.2 **Setting Direction and Speed**

Table 7.2   Set direction and speed

Function	int AIStarter_SmartBotSetMovment (int dir, int speed)
Description	Set direction and speed

Paramater	dir: Set direction
	
	enum{
	
	    FRONT,
	
	    BACK,
	
	    RIGHT,
	
	    LEFT
	
	    };
	
	speed: Set Duty Ratio, Value range: 0 – 255

Return	None

7.3 **Setting Direction\Speed\Time**

Table 7.3   Set direction\speed\time

Function	int AIStarter_SmartBotSetMovmentTime (int dir, int speed, float time)
Description	Set direction, speed and time

Paramater	dir: Set direction
	
	enum{
	
	    FRONT,
	
	    BACK,
	
	    RIGHT,

	LEFT };
	speed: Set Duty Ratio. Value range: 0 – 255
	time: Set running time (unit: s)
Return	None

7.4 **Setting Motor Speed**

Table 7.4   Set motor speed

Function	int AIStarter_SmartBotSetMotor (int port,int speed)
Description	Set motor speed

Paramater	port: Select motor
	enum{
	    MOTORR,
	    MOTORL
	    };
	speed: Set speed. Value range: 0 – 200rpm

Return	None

7.5 **Setting Motor Parameter**

Table 7.5   Set motor parameter

Function	int AIStarter_SmartBotSetMotorPI (float KP, float KI)
Description	Set motor parameter
Paramater	KP: Proportion factor. Value range: 0.5~2.5 KI: Integral factor. Value range: 0.05~0.5
Return	None

7.6 **Getting Motor Pose**

Table 7.6   Get motor pose

Function	float AIStarter_SmartBotGetMotorPose (int port)
Description	Get motor pose
Paramater	port: Select motor enum{

	MOTORR, MOTORL };
Return	Return motor value

7.7 Initializing Ultrasonic Sensor

Table 7.7   Initialize ultrasonic sensor

Function	int AIStarter_SmartBotSetSonar (int port)
Description	Initialize ultrasonic sensor

Paramater	port: Select ultrasonic sensor
	
	enum {
	
	SONAR1,
	
	SONAR2,
	
	SONAR3
	
	};

Return	None

7.8 Getting the Detection Distance of Ultrasonic Sensor

Table 7.8   Get the detection distance of ultrasonic sensor

Function	float AIStarter_SmartBotGetSonar (int port)
Description	Get the detection distance of ultrasonic sensor

Paramater	port: Select ultrasonic sensor
	
	enum {
	
	SONAR1,
	
	SONAR2,
	
	SONAR3
	
	};

Return	Return detection distance (Unit: cm)

7.9 Detecting obstacle

Table 7.9   Detect obstacle

Function	bool AIStarter_SmartBotGetBarrier (int port)

Description	Detect obstacle

Paramater	port: Select ultrasonic sensor
	
	enum {
	    SONAR1,
	    SONAR2,
	    SONAR3
	    };

Return	1: Obstacle detected 0: No obstacles detected

7.10 **Getting Infrared Sensor Data**

Table 7.10   Get infrared sensor data

Function	int AIStarter_SmartBotGetIRModuleValue (int port)
Description	Get infrared sensor data

Paramater	port: Select infrared sensor ports
	
	enum {
	    IR1,
	    IR2,
	    IR3,
	    IR4,
	    IR5,
	    IR6
	    };

Return	Return 1: Black line detected Return 0: No black line detected

7.11 **Getting Geomagnetic Angle**

Table 7.11   Get geomagnetic angle

Function	float AIStarter_SmartBotGetCompass ()
Description	Get geomagnetic angle
Paramater	None
Return	Return geomagnetic angle

7.12 **Geomagnetic Calibration**

Table 7.12 Geomagnetic calibration

Function	void AIStarter_SmartBotSetCompassCalibration()
Description	Calibration method: Press down the left-most key after starting up, make AI-Starter rotate 360° around space axes X, Y, Z respectively, press down the left-most key once again to finish calibration
Paramater	None
Return	None

7.13 **Setting White Balance**

Table 7.13 Set white balance

Function	int AIStarter_SmartBotSetColorWB(int port)
Description	Set white balance

Paramater	port: Color sensor
	
	enum{
	
	COLORSENOR1,
	
	COLORSENOR2
	
	};

Return	None

7.14 **Setting Color Sensor Status**

Table 7.14 Set color sensor status

Function	int AIStarter_SmartBotSetColorSenor (int port,bool ison)
Description	Set color sensor status

Paramater	port: Color sensor
	
	enum{
	
	COLORSENOR1,
	
	COLORSENOR2
	
	};
	
	Ison: True: open, False: close

Return	None

7.15 **Detecting Color**

Table 7.15   Detect color

Function	bool AIStarter_SmartBotDetColorSenor (int port, int color)
Description	Detect color

Paramater	port:Color sensor
	
	enum{
	
	COLORSENOR1,
	
	COLORSENOR2
	
	};
	
	color: Detect color
	
	enum{
	
	RCOLOR,
	
	GCOLOR,
	
	BCOLOR,
	
	};

Return	Return 1: Color detected Return 0: No color detected

7.16 **Getting RGB Value**

Table 7.16   Get RGB value

Function	int AIStarter_SmartBotGetColorSenor (int port,int color)
Description	Get RGB value

Paramater	port: Color sensor
	
	enum{
	
	COLORSENOR1,
	
	COLORSENOR2
	
	};
	
	color: Get color
	
	enum{
	
	RCOLOR,
	
	GCOLOR,
	
	BCOLOR,
	
	};

Return	Return color value

7.17 **Initializing Switch**

Table 7.17   Initialize switch

Function	int MobilePlatform_SmartBotSetKeyInit ()
Description	Initiallize switch
Paramater	None
Return	None

7.18 **Getting Switch Status**

Table 7.18   Get switch status

Function	int AIStarter_SmartBotGetKeyValue (int key)
Description	Get switch status

Paramater	key: Select switch
	
	enum{
	
	    SW1,
	
	    SW2,
	
	    SW3
	
	    };

Return	Return 1: Press down Return 0: Release

7.19 **Setting LED Status**

Table 7.19   Get switch status

Function	int AIStarter _SmartBotSetLED(int port,int state)
Description	Set LED

Paramater	port: Select LED
	
	enum{
	
	    LED1
	
	    LED2
	
	    }
	
	state: Set status
	
	enum{

	ON, OFF, BLINK };
Return	None

7.20 **Getting Photosensitive Value**

Table 7.20   Get photosensitive value

Function	int AIStarter_SmartBotGetLightAnalog ()
Description	Get photosensitive value
Paramater	None
Return	Return photosensitive value

7.21 **Setting Ultrasonic Threshold**

Table 7.21   Set ultrasonic threshold

Function	int AIStarter_SmartBotSetSonarThreshold (int dis)
Description	Set ultrasonic threshold
Paramater	dis: Set threshold(Unit: cm)
Return	None

7.22 **Connecting Servo**

Table 7.22   Connect servo

Function	int AIStarter_SmartBotServoAttach(int servo)
Description	Connect servo

Paramater	servo: select servo
	
	enum{
	
	SERVO1,
	
	SERVO2
	
	};

Return	None

7.23 **Setting Servo Angle**

Table 7.23　Set servo angle

Function	int AIStarter_SmartBotServoWrite(int servo, int value)
Description	Set servo angle

Paramater	servo: Select servo
	
	enum{
	
	　　SERVO1,
	
	　　SERVO2
	
	　　};
	
	value: Set servo angle. Value range: 0°~180°

Return	None

7.24 **Disconnecting Servo**

Table 7.24　Disconnect servo

Function	int AIStarter_SmartBotServoDetach(int servo)
Description	Disconnect servo

Paramater	servo: Select servo
	
	enum{
	
	　　SERVO1,
	
	　　SERVO2
	
	　　};

Return	None

7.25 **Turning on Timer Task**

Table 7.25　Turn on timer task

Function	int AIStarter_SmartBotTimerTaskAttach()
Description	Turn on timer task
Paramater	None
Return	None

7.26 **Turning off Timer Task**

Table 7.26   Turn off timer task

Function	int AIStarter_SmartBotTimerTaskDetach()
Description	Turn off timer task
Paramater	None
Return	None

7.27 **Reading Xbee Data**

Table 7.27   Read Xbee data

Function	String& AIStarter_SmartBotXbeeRead()
Description	Read Xbee data
Paramater	None
Return	None

7.28 **Writing Xbee Data**

Table 7.28   Write Xbee data

Function	String& AIStarter_SmartBotXbeeWrite()
Description	Write Xbee data
Parameter	None
Return	None

7.29 **Comparing Xbee Data**

Table 7.29   Compare Xbee data

Function	int AIStarter_SmartBotXbeeCompare(const String &str1, const String &str2)
Description	Compare two strings
Parameter	None
Return	Return zero: Strings are same Return nonzero: Strings are different

7.30 **Clearing Xbee data**

Table 7.30   Clear Xbee data

Function	int AIStarter_SmartBotXbeeClear()
Description	Clear Xbee data
Paramater	None
Return	None