Study Notes of Iteaduino Part IX

- Tracking car

In the last two notes, I introduced a track sensor and motor drive module MotoMama, and next I'll describe how to use track sensor, MotoMama motor drive module and DC motor to make a tracking car. The tracking car takes Iteaduino as control core, uses track sensor to detect the black track on the road and sends the road surface detection signal feedback to Iteaduino. Iteaduino will then analyze and judge the collected signals for timely control of the drive motor so as to adjust the car steering and speed, thus the car can move along the black track to achieve the purpose of automatic tracking.

To do this test, we will need:

- Iteaduino board x 1
- Makeblock car kit x 1
- Track sensor x 4
- MotoMama motor drive module x 1
- DC motor x 2
- White paper x 1
- Black tape x 1

Operational principle

'Tracking' in tracking car means the car moving along the black line on a white ground. To precisely determine the location of black line and moving direction of the car in the process of running along the track, it is necessary to install 4 track sensors in the chassis at one time to perform correction and control on direction of two sides and to improve the reliability of tracking.

When the black line is under the middle of the car, as shown in Figure 1, the four sensors cannot detect it, in this case, the car will move forward to the same direction.

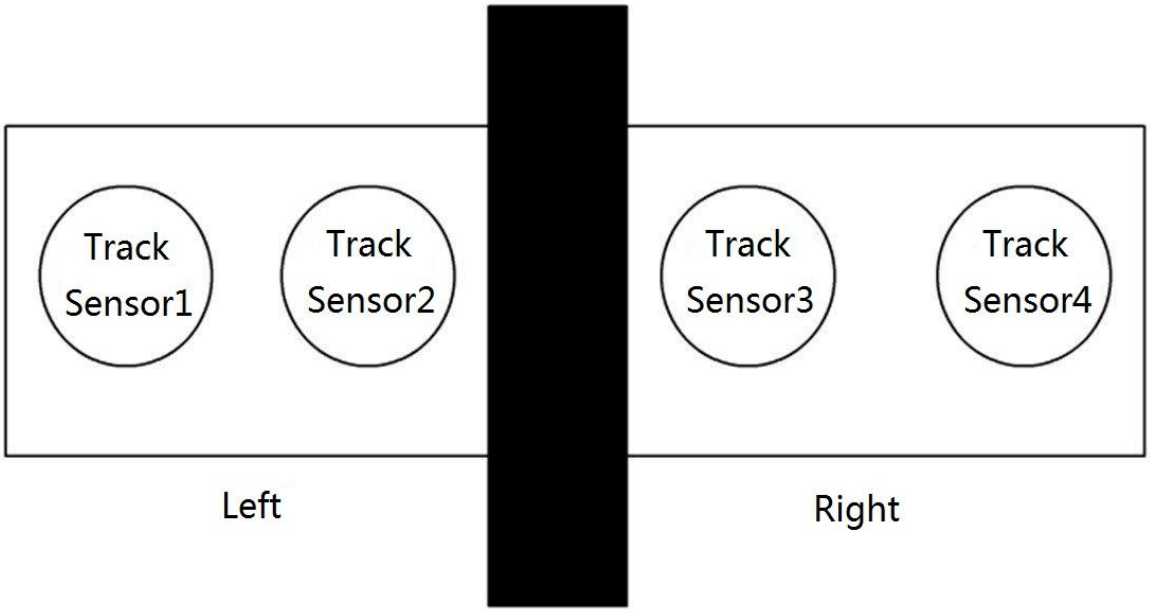

Figure 1

The car deviates from the black line, as shown in Figure 2 and Figure 3. When the black line shifts to left (Figure 2), track sensor 2 can detect the black line; when it shifts to right (Figure 3), track sensor 3 can detect it. After the track sensor detects black line, it will send signals to Iteaduino for processing, Iteaduino will send signal to correct the car tracking: when the black line shifts to left, car will decelerate and turn left; when the black line shifts to right, the car will decelerate and turn right. No matter how the car turns, ultimately the black line must be under the middle position of the car (Figure 1).

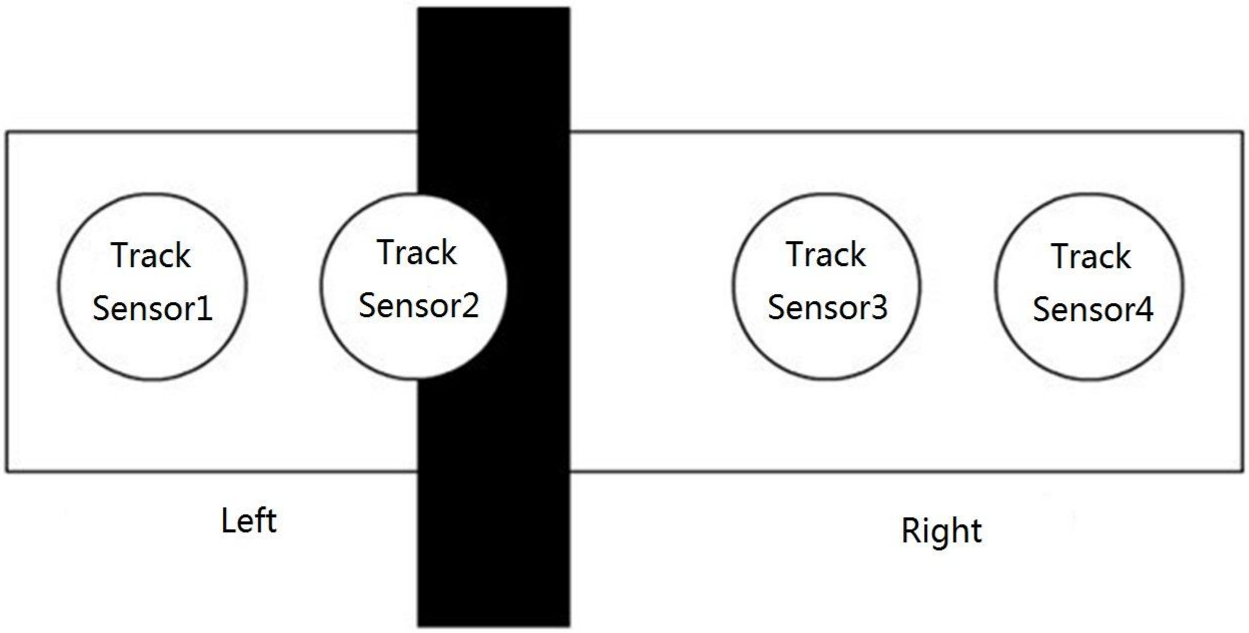

Figure 2

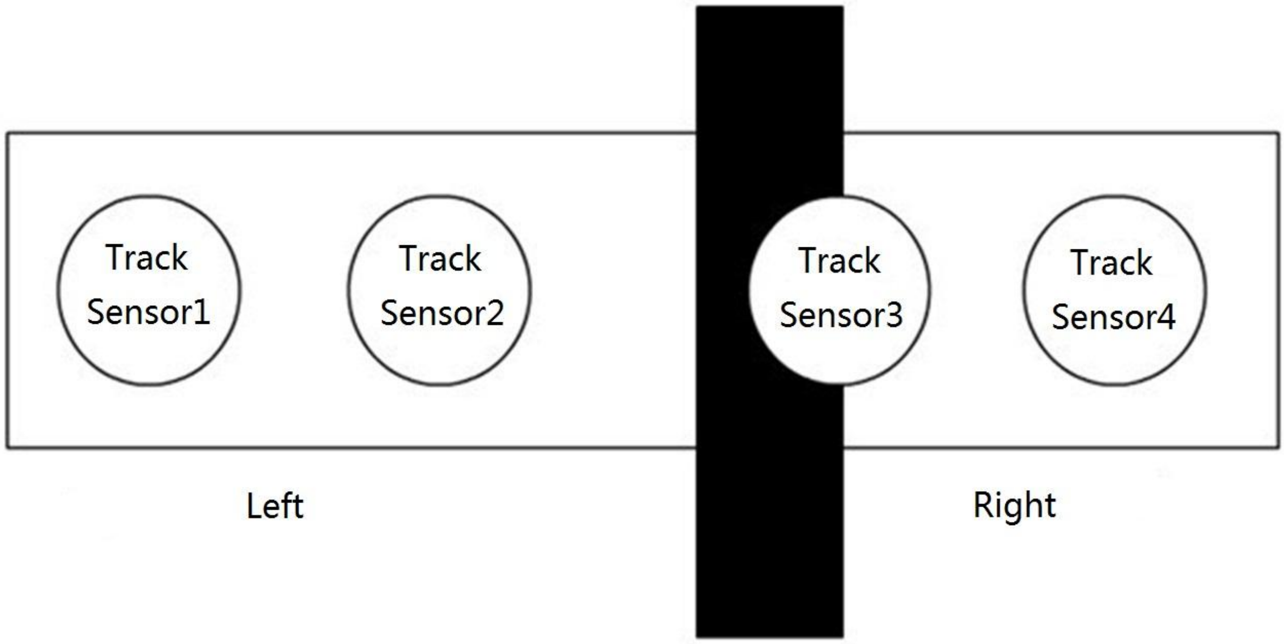

Figure 3

If there is too much inertia, and the car is still off the track and beyond the detection range of track sensor 2 and sensor 3, as shown in Figure 4 and Figure 5, track sensor 1 or sensor 4 can detect the black line and correct the movement of the car. If the black line shifts to left, the car will decelerate and turn left;

if the black line shifts to right, the car will decelerate and turn right . Eventually, the car will go back to the right track. As can be seen, track sensor 1 and sensor 4 are for back-up protections, thus improving the reliability of tracking.

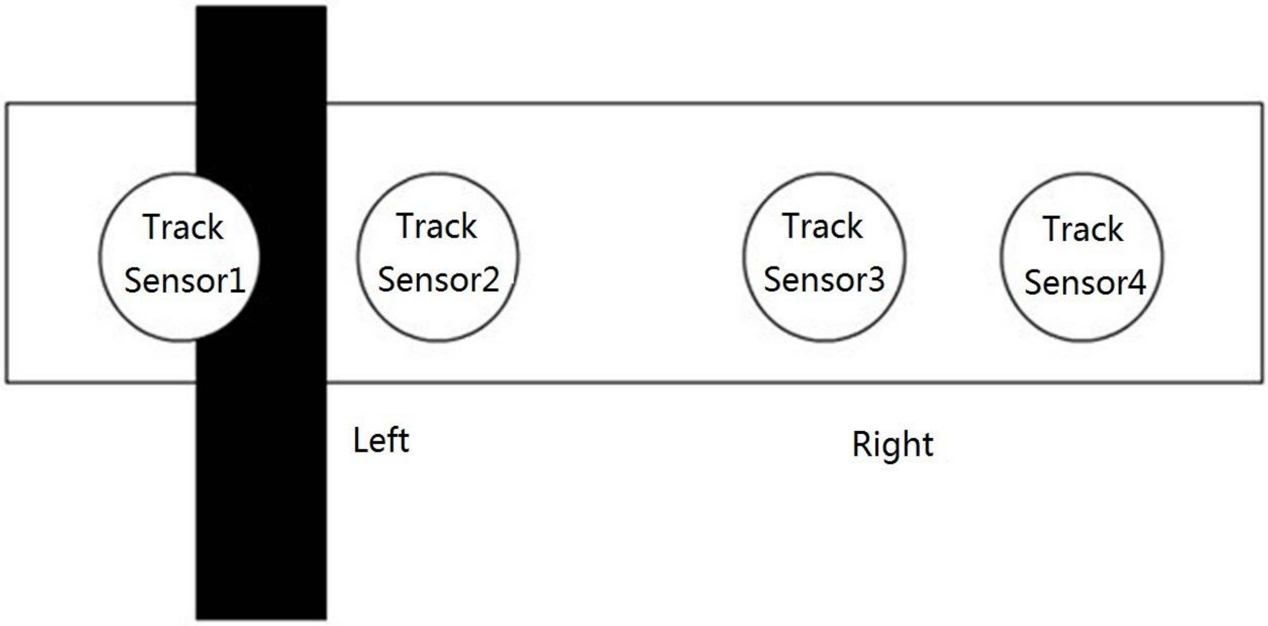

Figure 4

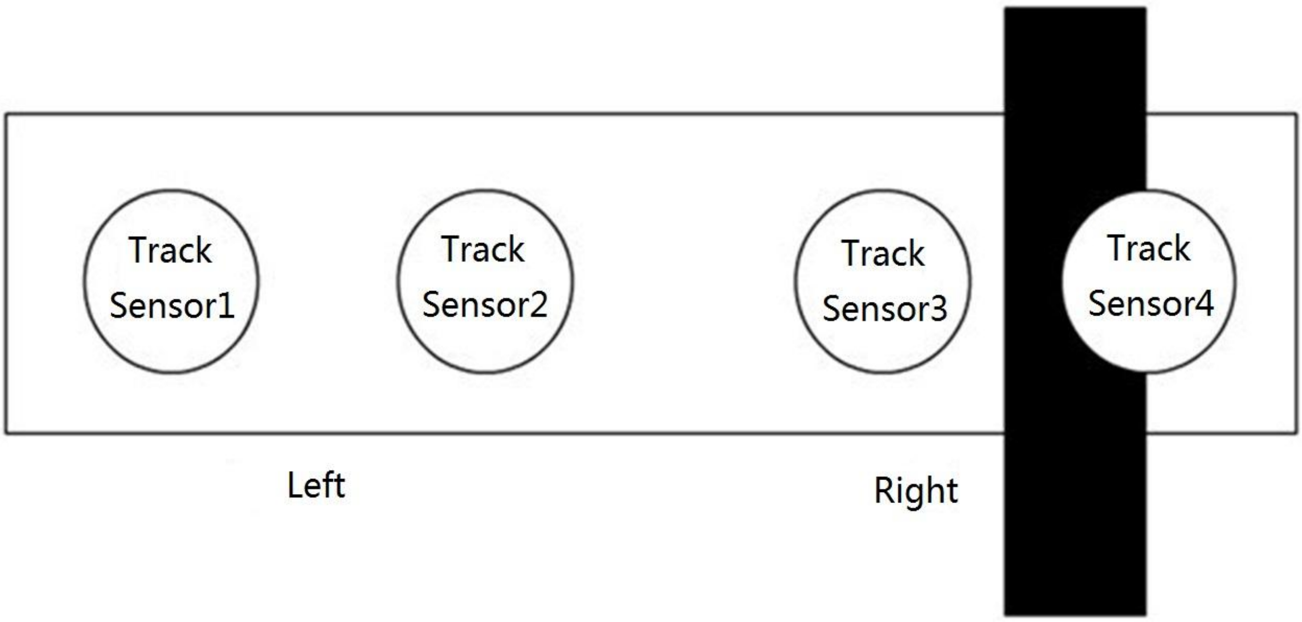

Figure 5

Construction of hardware circuit

First, insert MotoMama motor drive board directly into Iteaduino board, then connect the four track sensors to the analog input interfaces of MotoMama motor drive board with electronic brick connection cable: sensor 1 to AD0 interface, sensor 2 to AD1 interface, sensor 3 to AD2 interface and sensor 4 to AD3 interface. Finally connect the two DC motors respectively to the two motor interfaces on MotoMama drive board.In addition to connecting Iteaduino to the computer with a USB cable, the Iteaduino board should also be linked to a 9V external power supply.

The actual circuit schematic is shown in figure 6:

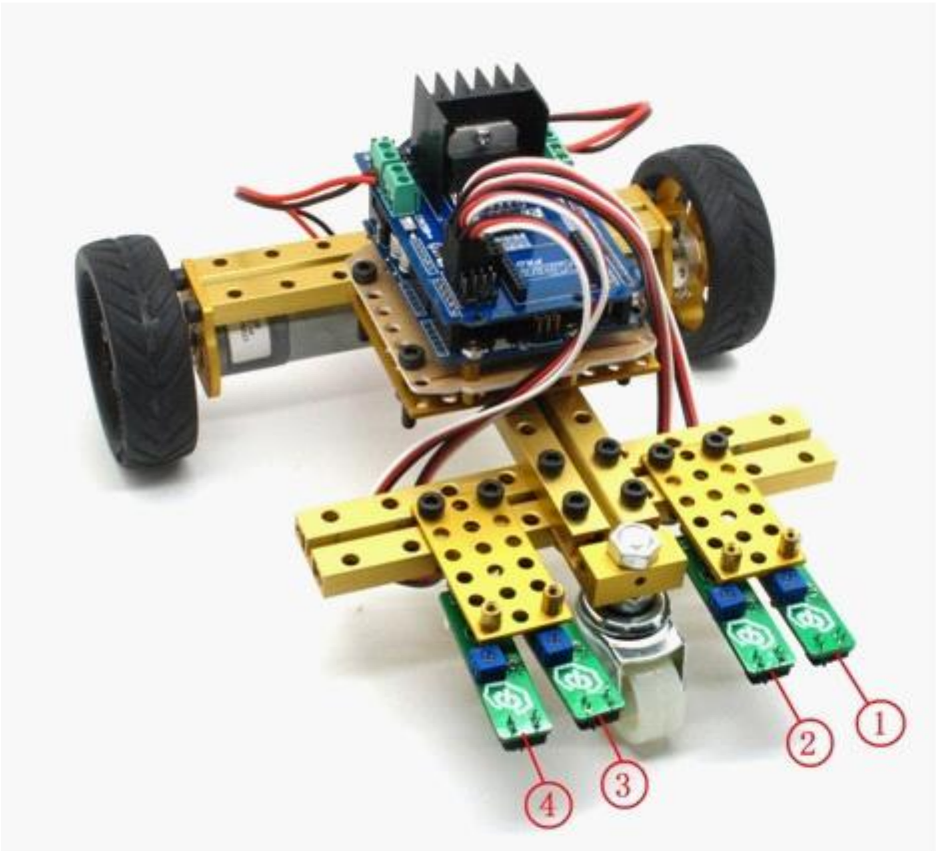

Figure 6

Writing of control program

The complete program used in the test is as below:

```
int IN1=8;
int IN2=9;
int ENA=10;
int ENB=11;
int IN3=12;
int IN4=13;
int red0=A0;
int red1=A1;
int red2=A2;
int red3=A3;

char PreviousStatus=0;       //to define a variation PreviousStatus to record the previous status of the
sensor
int ZeroValue=0;             //motor speed is 0
int SpeedValue1=50;          //low speed
int SpeedValue2=120;         // medium speed
int SpeedValue3=150;         // high speed
void setup()
{
    pinMode(IN1,OUTPUT);     //to set D8 as output interface
    pinMode(IN2,OUTPUT);     //to set D9 as output interface
    pinMode(IN3,OUTPUT);     //to set D12 as output interface
    pinMode(IN4,OUTPUT);     //to set D13 as output interface
    pinMode(red0,INPUT);     //to set A0 as input interface
    pinMode(red1,INPUT);     //to set A1 as input interface
    pinMode(red2,INPUT);     //to set A2 as input interface
```

```
    pinMode(red3,INPUT);        //to set A3 as input interface
}
int read()       //to read the status of four track sensors
{
    int ReadDirectionStatus = 0;
    ReadDirectionStatus = ReadDirectionStatus | digitalRead(red0);

  //to read value of A0 pin and put it at the fourth place of variation ReadDirectionStatus

    ReadDirectionStatus = ReadDirectionStatus << 1;
    ReadDirectionStatus = ReadDirectionStatus | digitalRead(red1);
    //to read value of A1 pin and put it at the third place of variation ReadDirectionStatus
    ReadDirectionStatus = ReadDirectionStatus << 1;
    ReadDirectionStatus = ReadDirectionStatus | digitalRead(red2);
    //to read value of A2 pin and put in at the second place of variation ReadDirectionStatus
    ReadDirectionStatus = ReadDirectionStatus << 1;
    ReadDirectionStatus = ReadDirectionStatus | digitalRead(red3);
    //to read value of A3 pin and put it at the first place of variation ReadDirectionStatus
    return (ReadDirectionStatus);
}
void forward(int value1,int value2)      //Car moves forward
{
  //When IN1 is at high level and IN2 at low level, motor at the left side of car rotates clockwise

    digitalWrite(IN1,HIGH);
    digitalWrite(IN2,LOW);
    //When IN3 is at high level and IN4 at low level, motor at the right side of car rotates clockwise
    digitalWrite(IN3,HIGH);
    digitalWrite(IN4,LOW);
    analogWrite(ENA,value1);       //to enable ENA，to drive left motor

    analogWrite(ENB,value2);       //to enable ENB，to drive right motor
  }
```

```
void turnleft(int value1,int value2)      //Car turns left
{
    //When IN1 is at low level and IN2 at high level, motor at the left side of car rotates counter-clockwise
    digitalWrite(IN1,LOW);
    digitalWrite(IN2,HIGH);
    //When IN3 is at high level and IN4 at low level, motor at the right side of car rotates clockwise
    digitalWrite(IN3,HIGH);
    digitalWrite(IN4,LOW);
    analogWrite(ENA,value1);        //to enable ENA，to drive left motor
    analogWrite(ENB,value2);        //to enable ENB，to drive right motor
    }
void turnright(int value1,int value2)      //Car turns right
{
    //When IN1 is at high level and IN2 at low level, motor at the left side of car rotates clockwise
    digitalWrite(IN1,HIGH);
    digitalWrite(IN2,LOW);
    //When IN3 is at low level and IN4 at high level, motor at the right side of car rotates
counter-clockwise
    digitalWrite(IN3,LOW);
    digitalWrite(IN4,HIGH);
    analogWrite(ENA,value1);        //to enable ENA，to drive left motor
    analogWrite(ENB,value2);        //to enable ENB，to drive right motor
    }
void backward(int value1,int value2)      //Car moves backward
{
    //When IN1 is at low level and IN2 at high level, motor at the left side of car rotates counter-clockwise
    digitalWrite(IN1,LOW);
    digitalWrite(IN2,HIGH);
    //When IN3 is at low level and IN4 at high level, motor at the right side of car rotates
```

counter-clockwise

```
    digitalWrite(IN3,LOW);
    digitalWrite(IN4,HIGH);
    analogWrite(ENA,value1);   //to enable ENA , to drive left motor
    analogWrite(ENB,value2);   //to enable ENB , to drive right motor
}
void stop()     //to stop car from running
{
    digitalWrite(IN1,LOW);
    digitalWrite(IN2,LOW);
    digitalWrite(IN3,LOW);
    digitalWrite(IN4,LOW);
        delay(10);
}
void DirectionRun(char DirectionStatus)   //to change the driving direction of car
{
    char left = 0;
    char right = 0;
    int ZeroSpeed = 0;
    //to read the status of the two sensors on the left
    left = (DirectionStatus >> 2) & 0x03;
    //to read the status of the two sensors on the right
    right = DirectionStatus & 0x03;
    //If the values of both left and right sensors are high levels, car will move forward at a medium speed.
    if((left == 0x03) && (right ==0x03))
    {
        forward(SpeedValue2,SpeedValue2);
    }
    //If value of neither of the two left sensors is high level, it indicates that the left sensor detected black line and car will turn left.
```

```
else if((left < 0x03)&& (right ==0x03))
{
      //Due to inertia, car may stop when turning, thus the car need to move backward a little bit to ensure it to run along the black line
            if(left == 0x01)
            {
                  backward(SpeedValue3,ZeroSpeed);
                  delay(100);
            }
            else
            {
                  turnleft(SpeedValue3,SpeedValue3);
            }
}
//If value of neither of the two right sensors is high level, it indicates that the right sensor detected black line and car will turn right.
else if((left == 0x03) &&(right < 0x03))
{
                  if(right == 0x02)
            {
                  backward(ZeroSpeed,SpeedValue3);
                  delay(100);
            }
            else
            {
        turnright(SpeedValue3,SpeedValue3);
            }
}
//If values of all the four sensors are low levels, the car will stop from running.
else
{
            stop();
}
   }
```

```
void loop()
{
    //to read the current status of sensor
    char NowStatus = char(read());
    delay(1);
    //If the previous status does not match the current status, the driving direction of car needs to be
changed according to the specific situation
    if(PreviousStatus != NowStatus)
    {
            stop();
        PreviousStatus = NowStatus;
        DirectionRun(PreviousStatus);
    }
}
```

Compiling and uploading of program

Next, compile and download the above program into Iteaduino，the operation of which is the same with that in last tests.

After downloading the program, put the car on the white paper with black tape (as the running track of car), the car will move along the black tape automatically, and it will automatically turn left or right according to the actual situation when running across curving tracks.

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