Modbus RTU for Arm Conversation

By: Qirong

Table of contents

01

Introduction of Modbus

02

Introduction of RS-485

03

Brief of my work

04

Circuit and hardware

05

Code explanation

06

Experiment process and result

01

Introduction of Modbus

What is Modbus

Software-level communication protocol widely used in the field of industrial automation

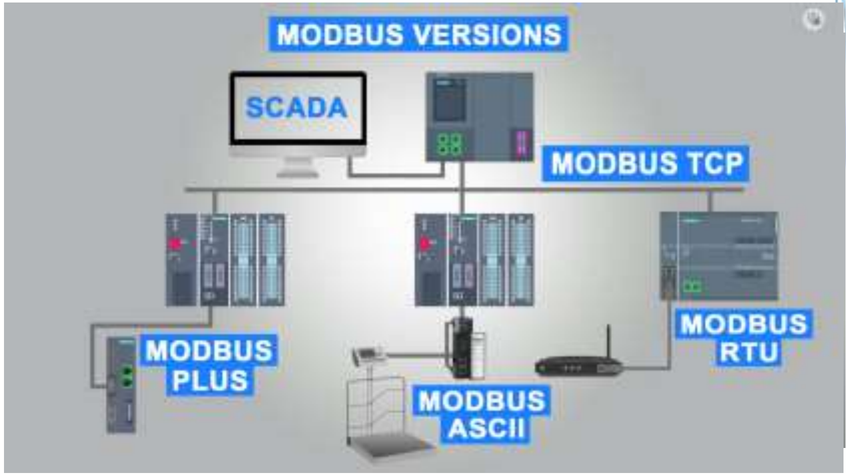
Features

Master-Slave Architecture:

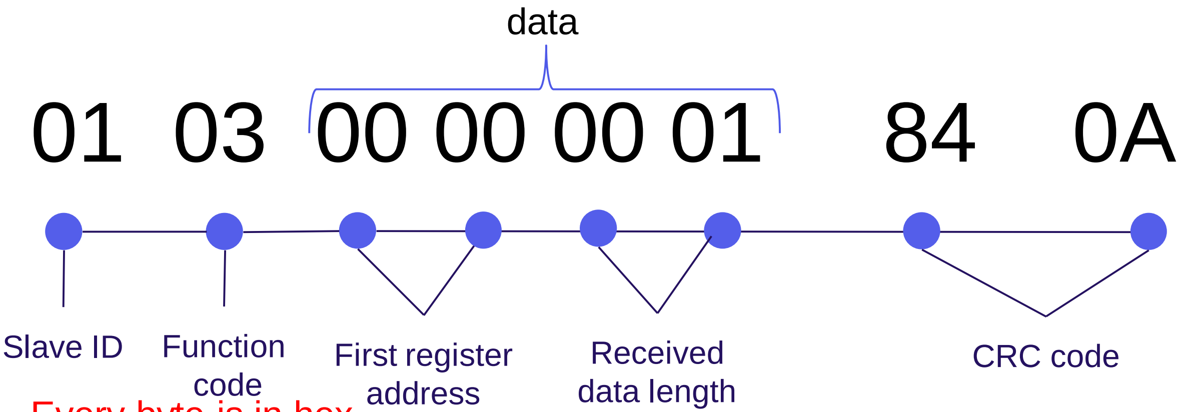
- The master station sends requests and receives responses from slave stations.
- Up to 247 slaves

Data Formats ：

- Modbus RTU (binary)
- Modbus ASCII (text)
- Modbus TCP/IP for Ethernet communication



Data format of Modbus RTU



data

01 03 00 00 00 01 84 0A

Slave ID

Function code

First register address

Received data length

CRC code

Every byte is in hex

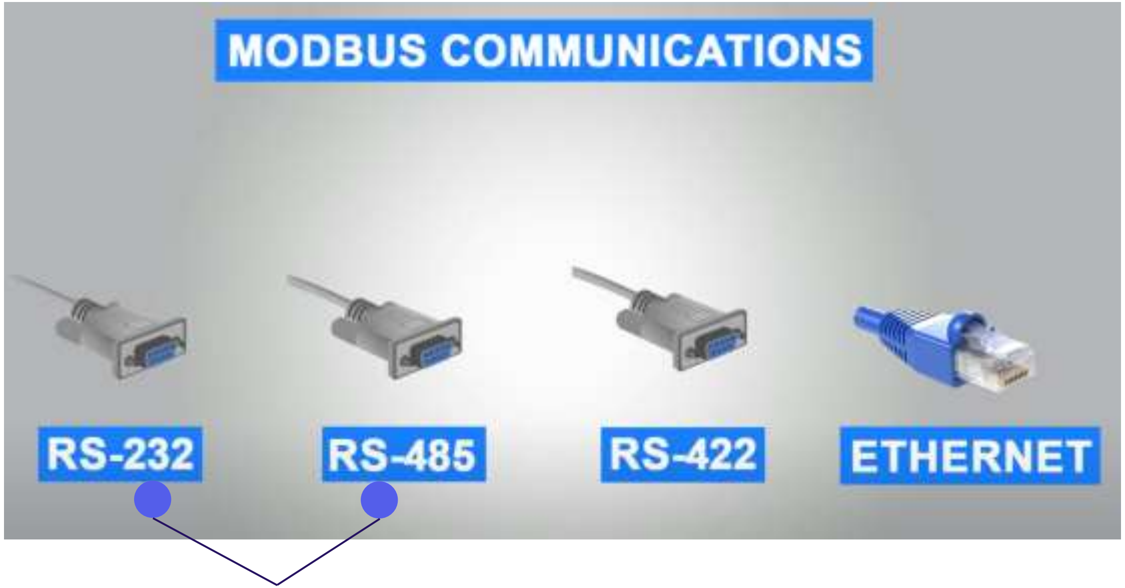
Slave ID: 0 is master and slaves usually use 1-127, 128-247 for unusual condition

Function code: There are many different functions in RTU and 03 is for reading holding registers

Data: Recognize the start address and end address of register, for this example means read 40001 address of holding register only.

CRC code: To check if the received data is same with the sent data. CRC code is based on some function to compute and RTU has its own function

Physical interfaces of Modbus

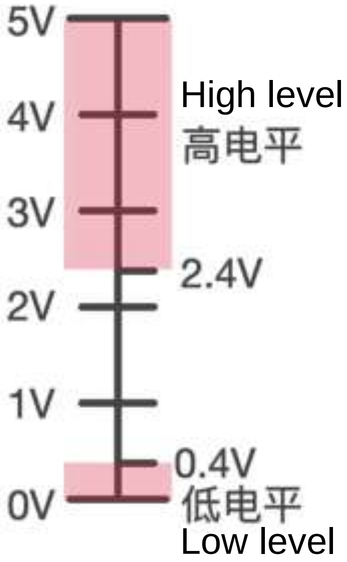


Modbus RTU

02

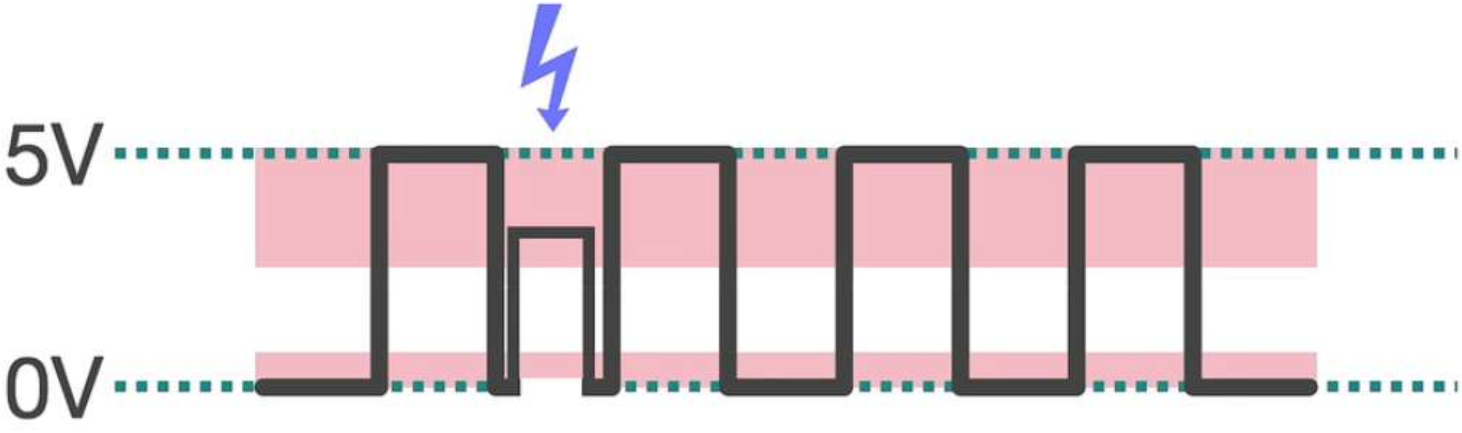
Introduction of RS-485

Why we don’t use TTL



Very poor anti-interference ability

Why we don’t use TTL



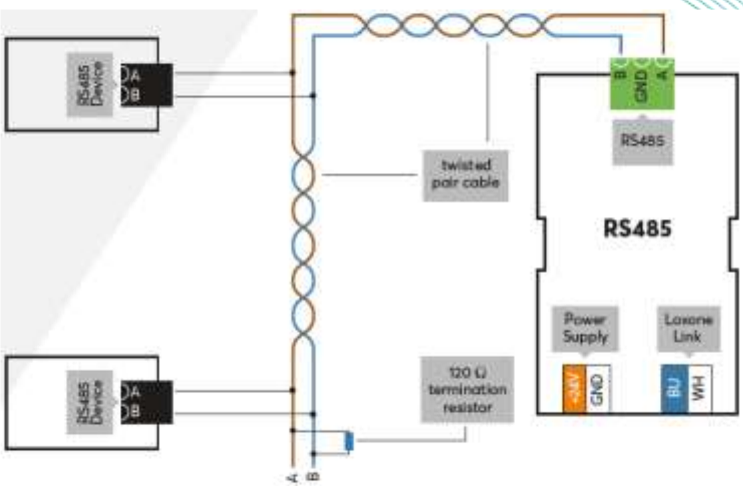
0->1

Very poor anti-interference ability

Transfer distance: less than 1 meter

What is RS-485

Recommended Standard by EIA
And Physical layer communication standard



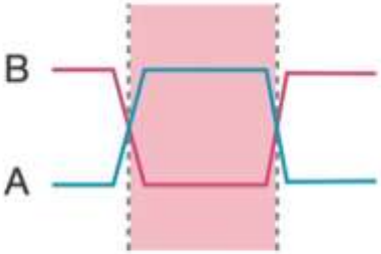
Features

Two wire twisted pair

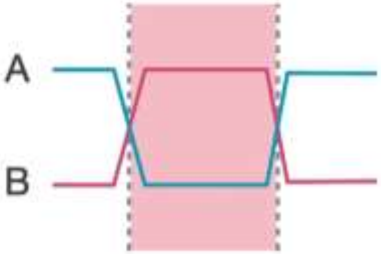
Half-duplex(only can receive or send data in one time)

Multi-point communication

Why we use RS-485



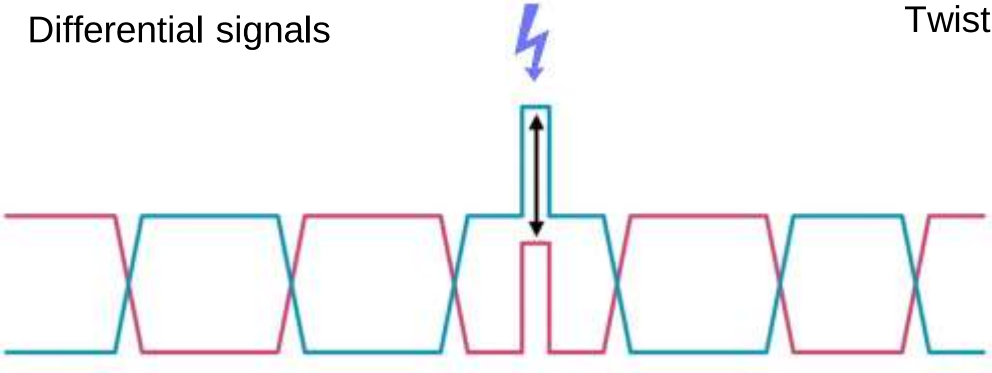
Logic 0



Logic 1

Differential signals

Twisted pair



Difference remain the same

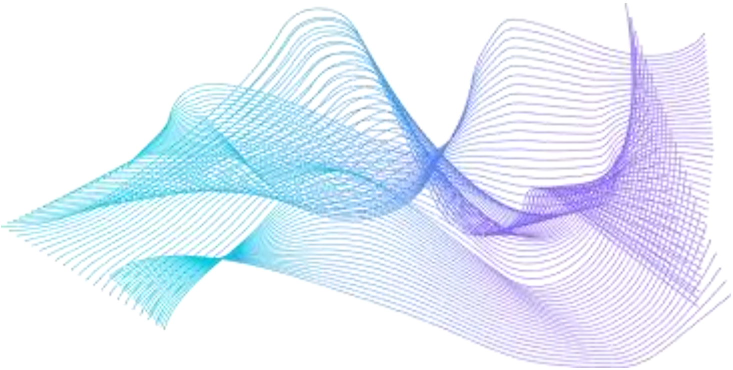
Transfer distance form 1m to 1200m!

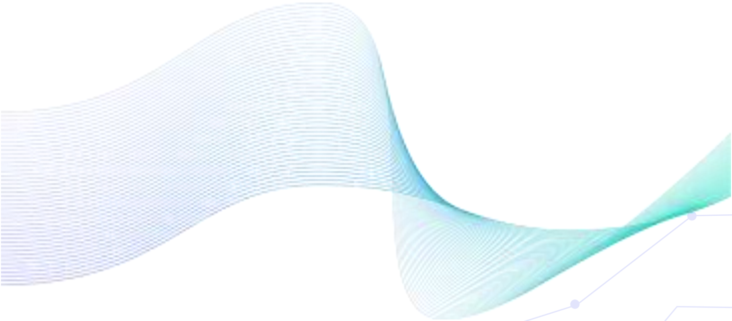
For our project

- Modbus and rs-485 allow us implement 1 to many communication

- Modbus RTU allow us double check the data by using CRC code

- RS-485 provides more stable data which is meaningful for the satety and longer tranfer distance as well

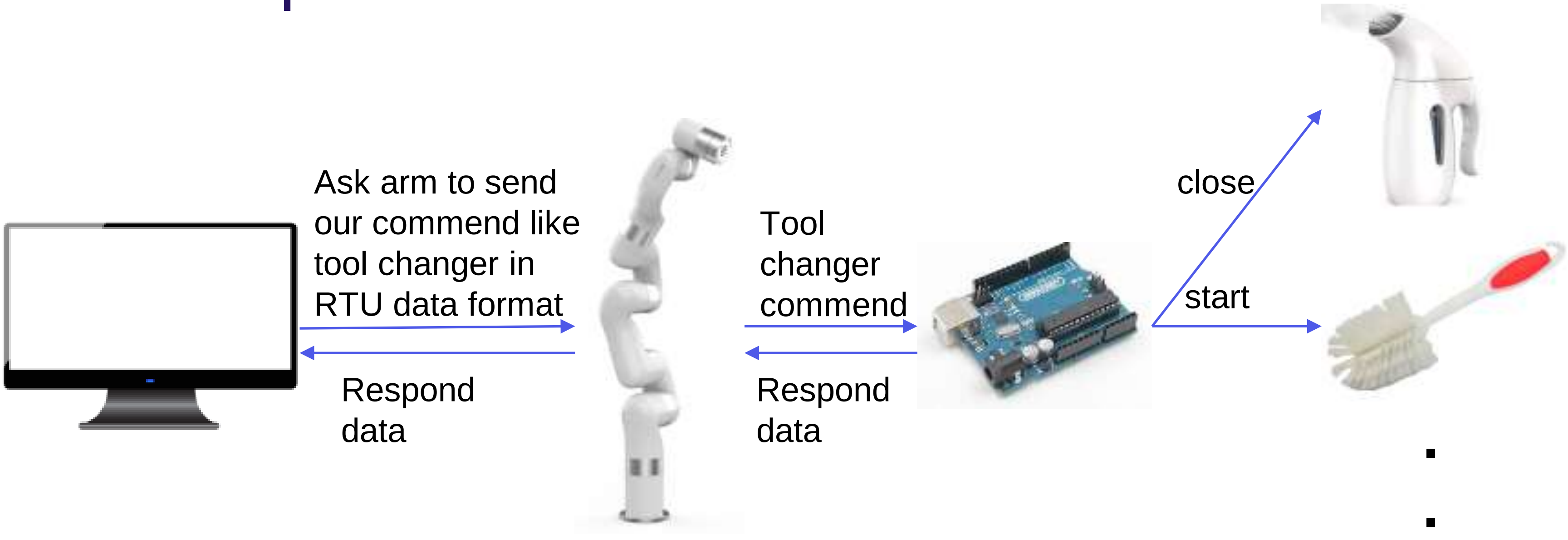




03

Brief of my work

Work process



Ask arm to send our commend like tool changer in RTU data format

Respond data

Tool changer commend

Respond data

close

start

Computer of robot

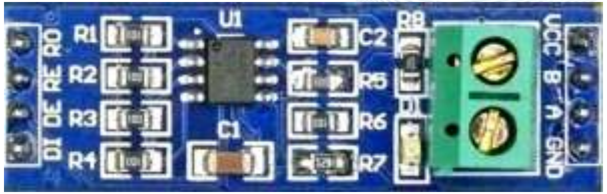
Modbus Master-arm

RS-485

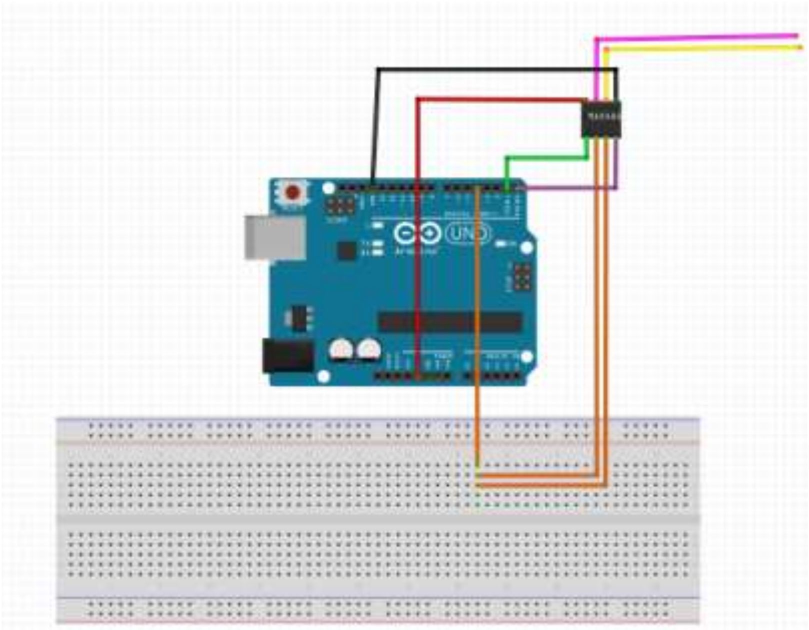
Modbus Slave-Arduino

Tools

Circuit and hardware



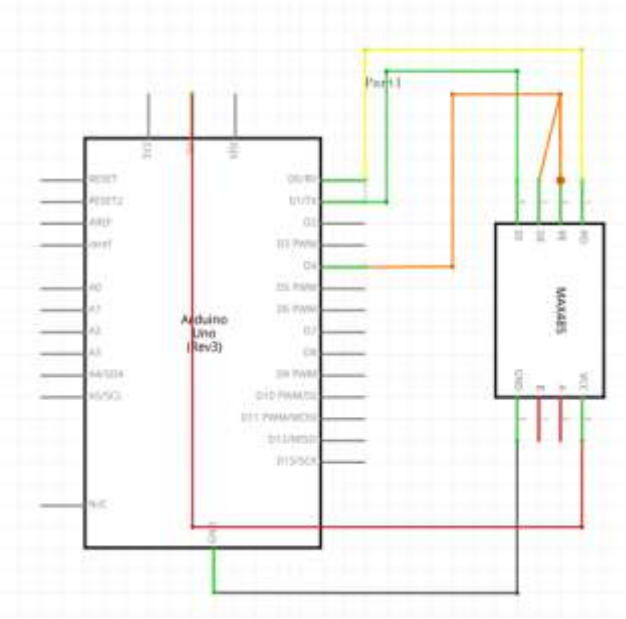
MAX485: 485-TTL

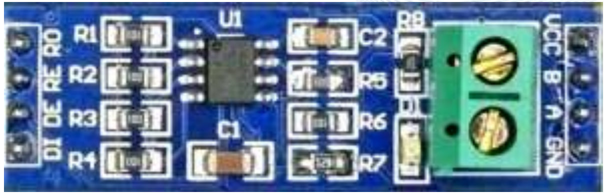


Pin Name	Pin Description
VCC	5V
A	Non-inverting Receiver Input Non-Inverting Driver Output
B	Inverting Receiver Input Inverting Driver Output
GND	GND (0V)
RO	Receiver Out (TX pin)
RE	Receiver Output (LOW-Enable)
DE	Driver Output (HIGH-Enable)
DI	Driver Input (RX pin)

RS485 is half-duplex

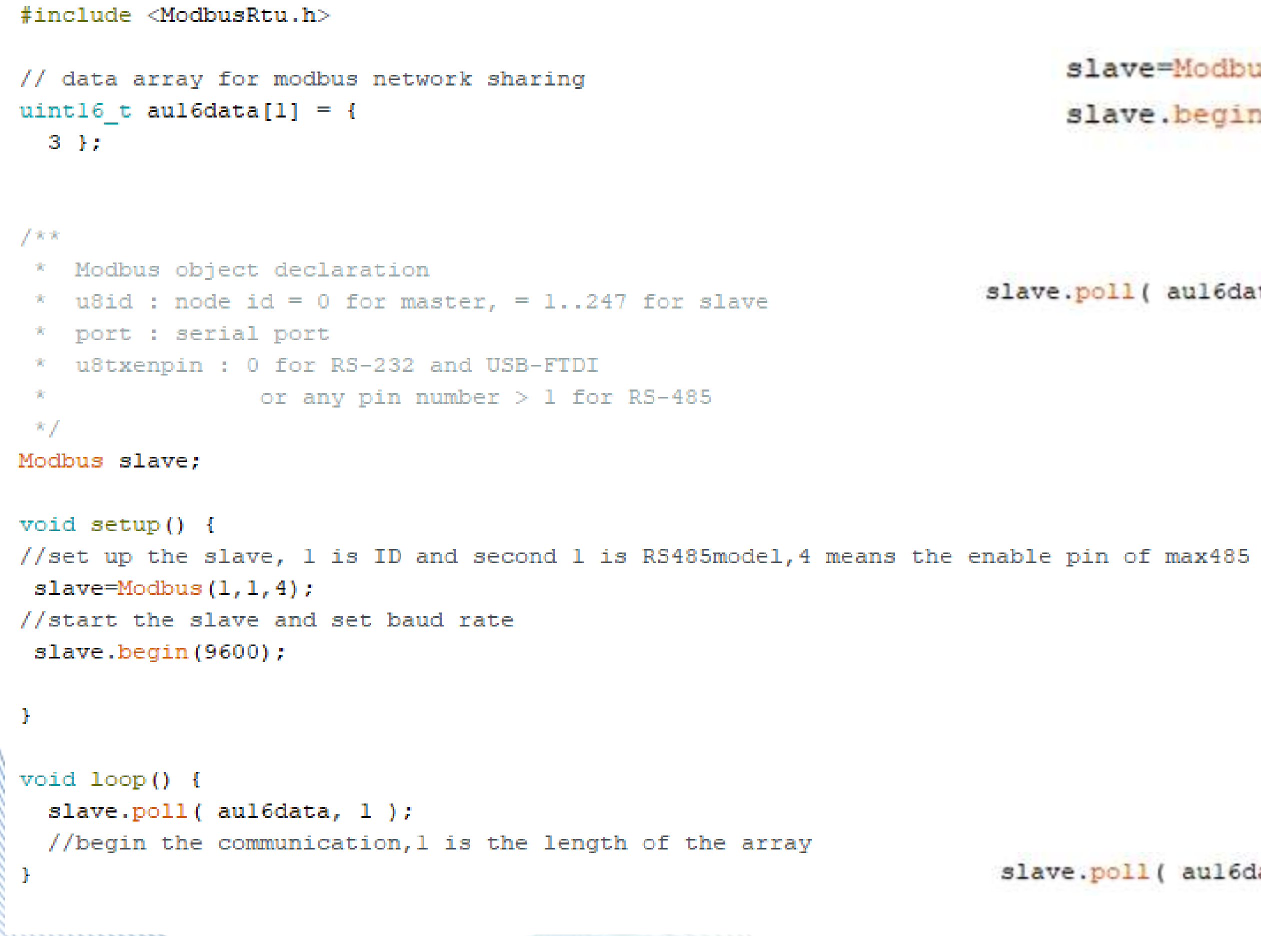
Circuit and hardware





Pin Name	Pin connected
VCC	5V
A	A wire of end-effector
B	B wire of end-effector
GND	GND of Arduino
RO	RX pin of Arduino
RE	Pin 4
DE	Pin 4
DI	TX pin of Arduino

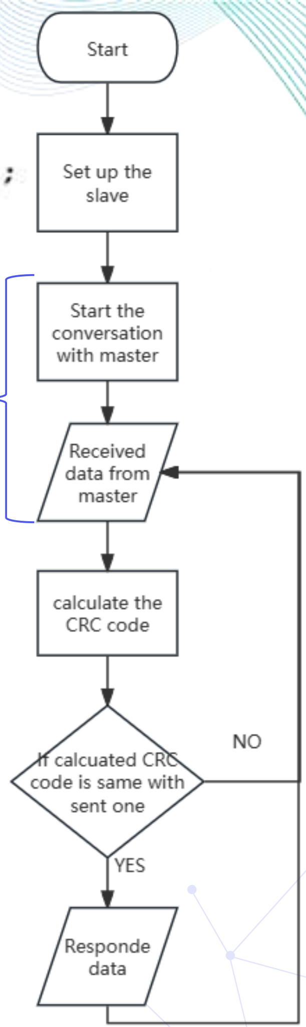
Code explaination



```
#include <ModbusRtu.h>

// data array for modbus network sharing
uint16_t au16data[1] = {
  3 };


/**
 *  Modbus object declaration
 *  u8id : node id = 0 for master, = 1..247 for slave
 *  port : serial port
 *  u8txenpin : 0 for RS-232 and USB-FTDI
 *               or any pin number > 1 for RS-485
 */
Modbus slave;

void setup() {
//set up the slave, 1 is ID and second 1 is RS485model,4 means the enable pin of max485
 slave=Modbus(1,1,4);
//start the slave and set baud rate
 slave.begin(9600);

}

void loop() {
  slave.poll( au16data, 1 );
  //begin the communication,1 is the length of the array
}
```

```
slave=Modbus(1,1,4);
slave.begin(9600);
```

```
slave.poll( au16data, 1 );
```


Start
Set up the slave
Start the conversation with master
Received data from master
calculate the CRC code
If calcuated CRC code is same with sent one
NO
YES
Responde data

```
slave.poll( au16data, 1 );
```

Experiment process in terminal

```
roslaunch xarm_bringup xarm7_server.launch robot_ip:=192.168.1.128 report_type:=normal
```

//Start all xarm server, change the control box ip in real condition

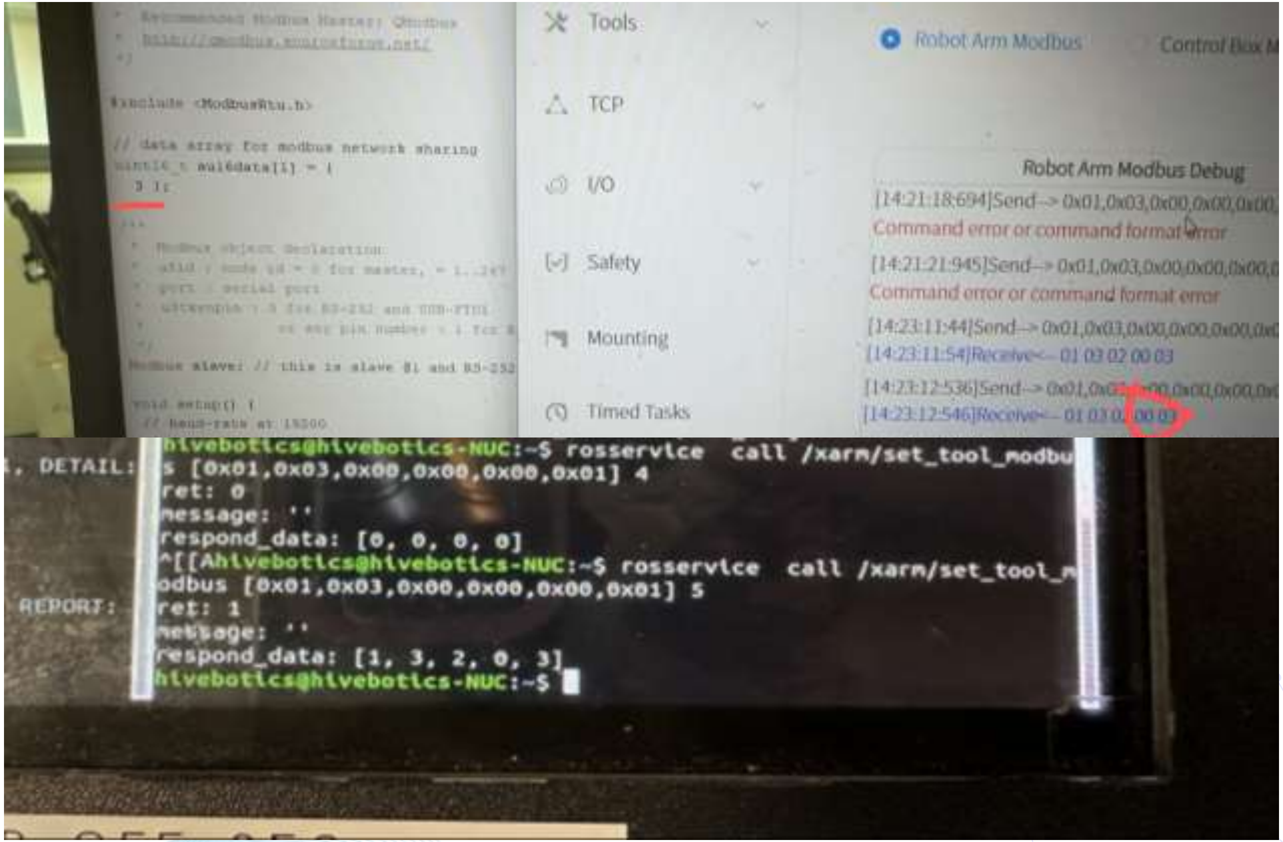
```
rosservice call /xarm/config_tool_modbus 9600 20
```

//Set proper baud rate and timeout(ms） parameters

```
rosservice call /xarm/set_tool_modbus [0x01,0x03,0x00,0x00,0x00,0x01] 5
```

//Set data array to be sent to the modbus tool device, and second is the number of characters to be received as a response from the device. No need to set CRC code

Result



```
 * Recommended Modbus Master: QModbus
 * http://qmodbus.sourceforge.net/
 */

#include <ModbusRtu.h>

// data array for modbus network sharing
uint16_t au16data[1] = {
  3 };

/**
 *  Modbus object declaration
 *  u8id : node id = 0 for master, = 1..247
 *  port : serial port
 *  u8txenpin : 0 for RS-232 and USB-FTDI
 *               or any pin number > 1 for R
 */
Modbus slave; // this is slave @1 and RS-232

void setup() {
  // baud-rate at 19200
```

Robot Arm Modbus Debug

```
[14:21:18:694]Send--> 0x01,0x03,0x00,0x00,0x00,
Command error or command format error
[14:21:21:945]Send--> 0x01,0x03,0x00,0x00,0x00,0
Command error or command format error
[14:23:11:44]Send--> 0x01,0x03,0x00,0x00,0x00,0x0
[14:23:11:54]Receive<-- 01 03 02 00 03
[14:23:12:536]Send--> 0x01,0x0[illegible]0,0x00,0x00,0x0
[14:23:12:546]Receive<-- 01 03 0[illegible] 00 03
```

```
, DETAIL: hivebotics@hivebotics-NUC:~$ rosservice  call /xarm/set_tool_modbu
          s [0x01,0x03,0x00,0x00,0x00,0x01] 4
          ret: 0
          message: ''
          respond_data: [0, 0, 0, 0]
          ^[[Ahivebotics@hivebotics-NUC:~$ rosservice  call /xarm/set_tool_m
          odbus [0x01,0x03,0x00,0x00,0x00,0x01] 5
REPORT:   ret: 1
          message: ''
          respond_data: [1, 3, 2, 0, 3]
          hivebotics@hivebotics-NUC:~$
```

What parts are included in data format of RTU

Slave id, function code, data and CRC code

What’s the difference between Modbus and RS-485

Modbus is communication protocal which defines the data dormat and RS-485 is a phsical communication standard to denote logic

What’s the difference between Serial and RS-485

Serial use ttl logic and is full duplex, RS-485 use differencial signal and is half duplex

Thanks!

Do you have any questions?

Qirong.shen@hivebotics.tech
+65 888 550 49

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First-year revenue of the project