Smart Software Project

Lab: Week 5
UART Comm.

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Today

- Lab announcement
- Review Lab assignments #3
- SmartCAR UART Communication
- Lab assignment #4
- Course announcement

Class Schedule

Week	Lecture Contents	Lab Contents
Week 1	Course introduction	Arduino introduction: platform & programming environment
Week 2	Embedded system overview & source management in collaborative repository (using GitHub)	Lab 1: Arduino Mega 2560 board & SmartCAR platform
Week 3	ATmega2560 Micro-controller (MCU): architecture & I/O ports, Analog vs. Digital, Pulse Width Modulation	Lab 2: SmartCAR LED control
Week 4	Analog vs. Digital & Pulse Width Modulation	Lab 3: SmartCAR motor control (Due: HW on creating project repository using GitHub)
Week 5	ATmega2560 MCU: memory, I/O ports, UART	Lab 4: SmartCAR control via Android Bluetooth
Week 6	ATmega2560 UART control & Bluetooth communication between Arduino platform and Android device	Lab 5: SmartCAR control through your own customized Android app (Due: Project proposal)
Week 7	Midterm exam	
Week 8	ATmega2560 Timer, Interrupts & Ultrasonic sensors	Lab 6: SmartCAR ultrasonic sensing
Week 9	Infrared sensors & Buzzer	Lab 7: SmartCAR infrared sensing
Week 10	Acquiring location information from Android device & line tracing	Lab 8: Implementation of line tracer
Week 11	Gyroscope, accelerometer, and compass sensors	Lab 9: Using gyroscope, accelerometer, and compass sensors
Week 12	Project	Team meeting (for progress check)
Week 13	Project	Team meeting (for progress check)
Week 14	Course wrap-up & next steps	
Week 15	Project presentation & demo I (Due: source code, presentation slides, & poster slide)	Project presentation & demo II
Week 16	Final week (no final exam)	

Lab Session

- Practice in-lab programming exercises based on the lecture materials
- Upload source codes for lab assignments in Ewha Cyber Campus after the lab session
  - Due: 11:59pm on the lab day
- Once you are done, you can leave the session after checking with me or TA
- Or, continue to work on programming for other homework assignments

Lab Policy

- 1) Please check out your SmartCAR (& Nexus 7 tablet) as soon as you arrive at the classroom
- 2) Please complete lab assignments
- 3) Upload required files to Ewha Cyber Campus
- 4) Check with me or TA
- **5) Please upload a null firmware to SmartCAR before you return it!!!**
  - **This will be a part of your lab score**
- 6) Please remove files that you created or downloaded in your computer after you are done
  - Remove your project completely
- 7) Please shut down your computer before you leave
- 8) Return the checked-out SmartCAR (& Nexus 7 tablet) to TA

Lab Announcement

- Please review C programming language
- I posted a brief document that includes C essentials in Ewha Cyber Campus
- Without this fundamental, it is very difficult for you to learn new embedded programming skillsets

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Lab Assignment #3

- 1) Move forward for 2 seconds
- 2) Stop for 0.5s
- 3) Turn right for 1.5s
- 4) Stop for 0.5s
- 5) Turn left for 1.5s
- 6) Stop for 0.5s
- 7) Move backward for 2 seconds
- 8) Stop forever!

- Upload your 1) lab3.h and 2) lab3.cpp file to Cyber Campus
- Show your result to TA or instructor

Lab Assignment #3

```
#define LEFT_MD_A       22
#define LEFT_MD_B       23
#define RIGHT_MD_A      24
#define RIGHT_MD_B      25

#define LEFT_MOTOR_EN 4
#define RIGHT_MOTOR_EN          5

int init_done = false;

//The setup function is called once at startup of the sketch
void setup()
{
    // Add your initialization code here
    pinMode(LEFT_MD_A, OUTPUT);
    pinMode(LEFT_MD_B, OUTPUT);
    pinMode(RIGHT_MD_A, OUTPUT);
    pinMode(RIGHT_MD_B, OUTPUT);
    pinMode(LEFT_MOTOR_EN, OUTPUT);
    pinMode(RIGHT_MOTOR_EN, OUTPUT);

    digitalWrite(LEFT_MD_A, LOW);
    digitalWrite(LEFT_MD_B, LOW);
    digitalWrite(RIGHT_MD_A, LOW);
    digitalWrite(RIGHT_MD_B, LOW);
    digitalWrite(LEFT_MOTOR_EN, LOW);
    digitalWrite(RIGHT_MOTOR_EN, LOW);
}
```

```
void move_forward()
{
    //Rotate counterclockwise for left motor
    digitalWrite(LEFT_MD_A, HIGH);
    digitalWrite(LEFT_MD_B, LOW);

    //Rotate clockwise for right motor
    digitalWrite(RIGHT_MD_A, LOW);
    digitalWrite(RIGHT_MD_B, HIGH);

    //Now turn left and right motors ON!
    analogWrite(LEFT_MOTOR_EN, 100);
    analogWrite(RIGHT_MOTOR_EN, 100);
}
void move_backward()
{
    //Rotate clockwise for left motor
    digitalWrite(LEFT_MD_A, LOW);
    digitalWrite(LEFT_MD_B, HIGH);

    //Rotate counterclockwise for right motor
    digitalWrite(RIGHT_MD_A, HIGH);
    digitalWrite(RIGHT_MD_B, LOW);

    //Now turn left and right motors ON!
    analogWrite(LEFT_MOTOR_EN, 100);
    analogWrite(RIGHT_MOTOR_EN, 100);
}
```

Lab Assignment #3

- Make sure to have a break for at least 500ms between different operations

```
void turn_left()
{
    //Rotate clockwise for right motor
    digitalWrite(RIGHT_MD_A, LOW);
    digitalWrite(RIGHT_MD_B, HIGH);

    analogWrite(LEFT_MOTOR_EN, 0);
    analogWrite(RIGHT_MOTOR_EN, 150);
}
void turn_right()
{
    //Rotate counterclockwise for left motor
    digitalWrite(LEFT_MD_A, HIGH);
    digitalWrite(LEFT_MD_B, LOW);

    analogWrite(LEFT_MOTOR_EN, 150);
    analogWrite(RIGHT_MOTOR_EN, 0);
}
void move_stop()
{
    analogWrite(LEFT_MOTOR_EN, 0);
    analogWrite(RIGHT_MOTOR_EN, 0);
}
```

```
void loop()
{
    if (init_done == false)
    {
        move_forward();
        delay(2000);

        move_stop();
        delay(500);

        turn_right();
        delay(1500);

        move_stop();
        delay(500);

        turn_left();
        delay(1500);

        move_stop();
        delay(500);

        move_backward();
        delay(2000);

        init_done = true;
    }
    else
        move_stop();
}
```

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SmartCAR UART Example

- UART_Echo.cpp

```
001: #include "UART_Echo.h"
002:
003: unsigned char text[] = "\r\n Welcome! Arduino Mega 2560 \r\n UART0 Test Program.\r\n";
004:
005: void setup()
006: {
007:     int i=0;
008:     Serial.begin(115200);
009:     while(text[i] !='\0')
010:       Serial.write(text[i++]);
011:     Serial.print("ECHO team 5 >>");
012: }
013:
014: void loop()
015: {
016:     if(Serial.available() > 0)
017:       Serial.write(Serial.read());
018: }
```

SmartCAR Example Code Analysis

- Global variable
  - text[]
    - Initial serial communication message

```
003: unsigned char text[] = "\r\n Welcome! Arduino Mega 2560 \r\n UART0 Test Program.\r\n";
```

- setup()
  - Serial.begin(speed): set the baud rate for serial port
    - 115200 bps
  - while(): use Serial.write(val) for text[] to write 1 byte ASCII value out of text[]
    - Execute until all bytes in text[] are sent

```
007:      int i=0;
008:      Serial.begin(115200);
009:      while(text[i] !='\0')
010:        Serial.write(text[i++]);
011:      Serial.print("ECHO >>");
```

SmartCAR Example Code Analysis

- loop()
  - Serial.available(): check the number of bytes
    - Serial.available() > 0
      - if there is any data that are received in the receive buffer,
      - Then, Serial.write(Serial.read())
    - Serial.read(): read 1 byte from the receive buffer
    - Serial.write(): write the received value back to the serial port (echo)

```
016:     if(Serial.available() > 0)
017:       Serial.write(Serial.read());
```

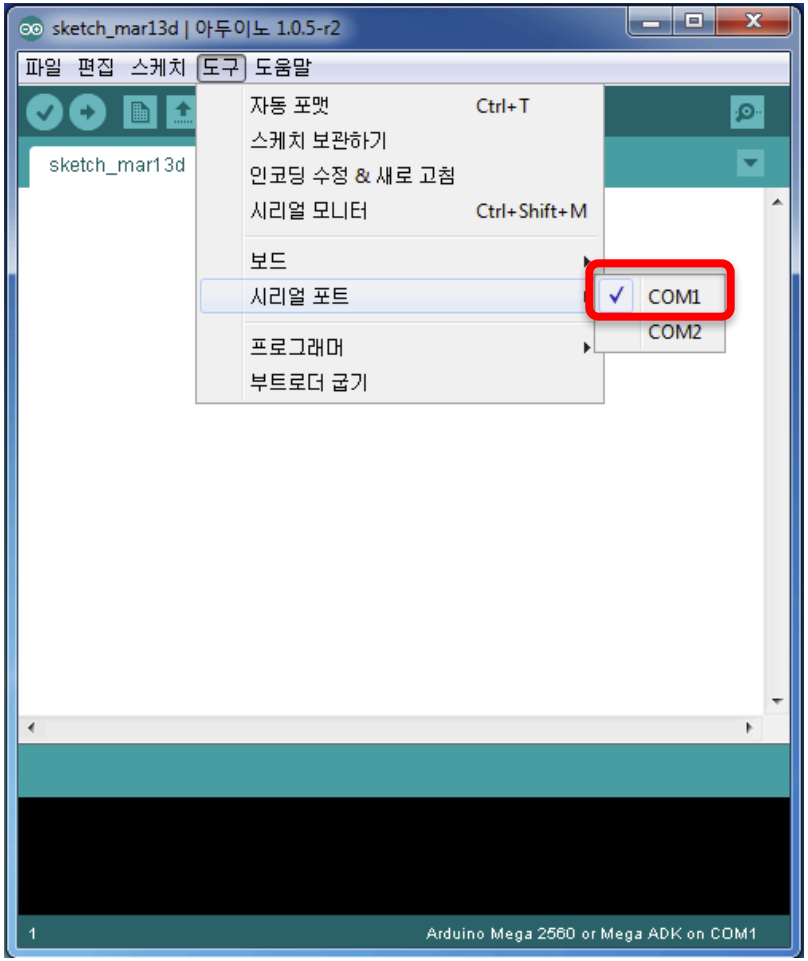
1. Exchange data with PC via Programming Serial Port

Run the Arduino IDE

- 1) Go to “Tool”
- 2) Run the “Serial Monitor” (Ctrl + Shift + M)

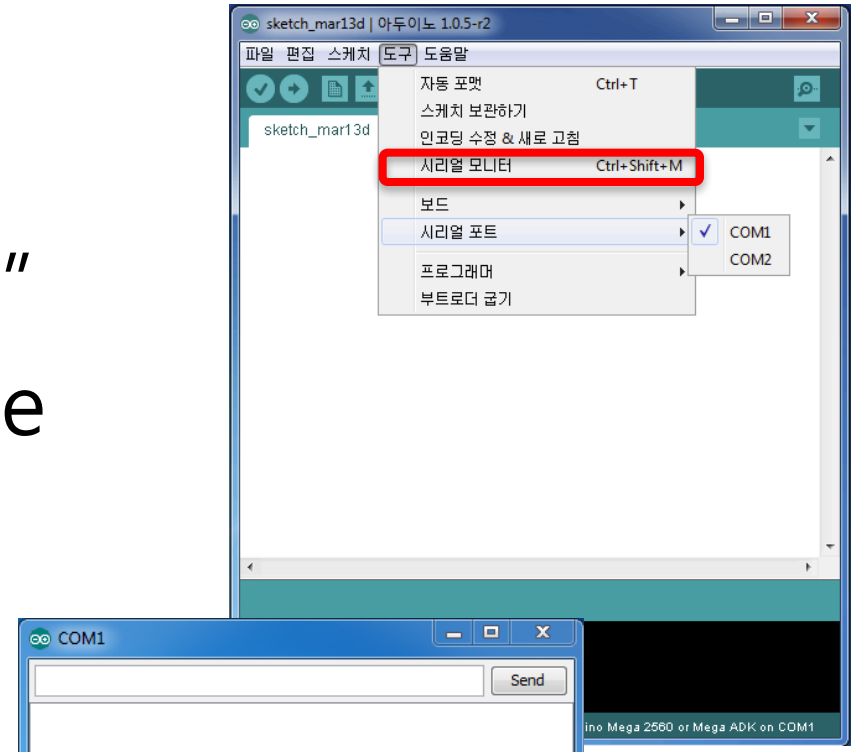
Run the Arduino IDE

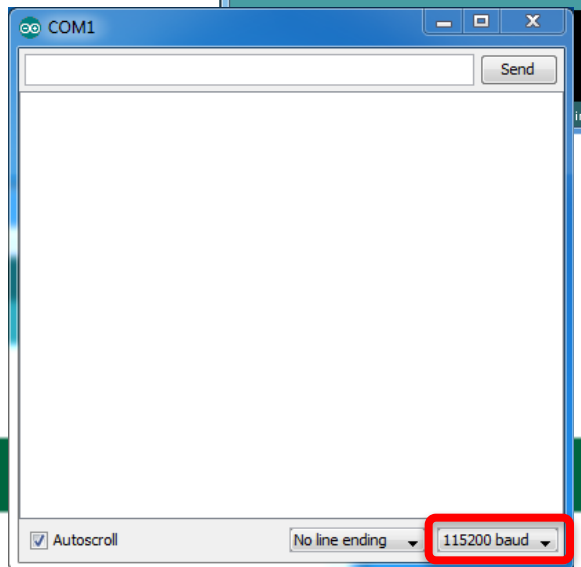
- Go to “Tools”
- For “Serial Port”
  - Select COMxx



Run the Arduino IDE

- Go to “Tools”
- Select “Serial Monitor”
- Then set the baud rate to “115200 baud”

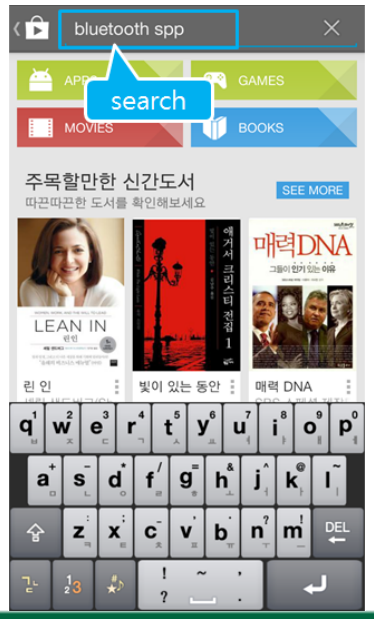


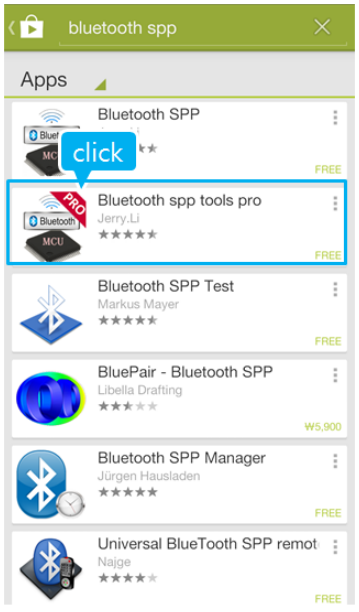


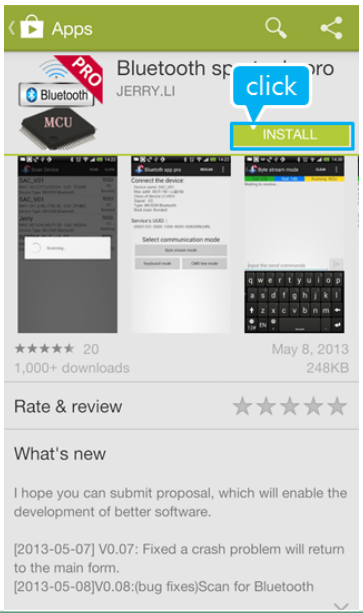
2. Exchange data with Android device via Bluetooth Wireless

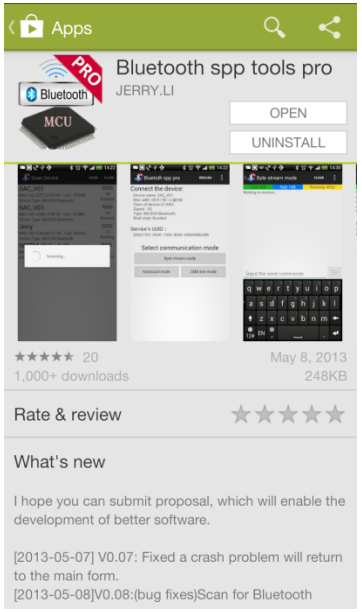
Bluetooth Serial App Installation

- To send and receive data via Bluetooth in Serial communication
  1) Go to “Play Store”
  2) Install “bluetooth spp tools pro” app



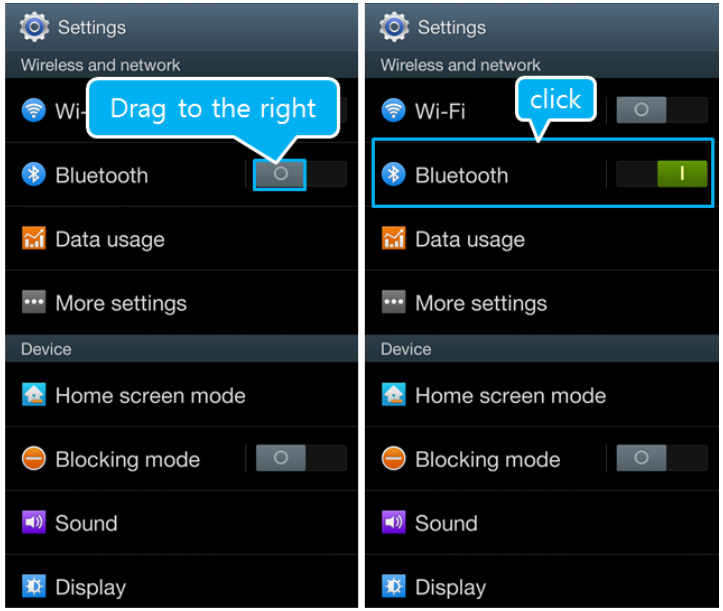


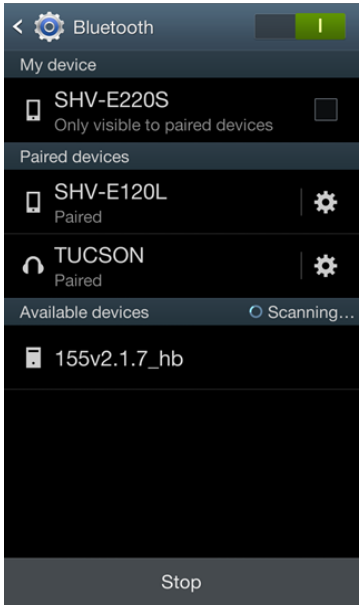




Bluetooth Paring with SmartCAR

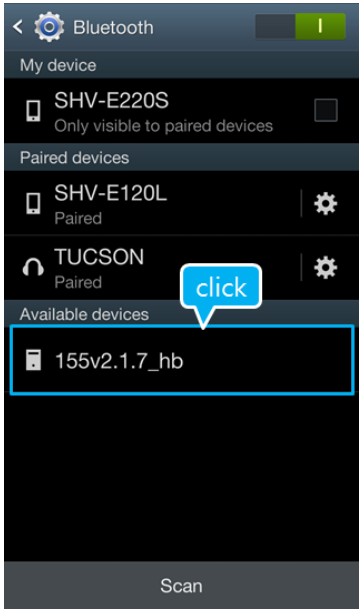
- How to pair your Android device with SmartCAR
  1) Power on SmartCAR
  2) Go to Settings in Android device
  3) Turn on Bluetooth and Click on it
  4) Scan Bluetooth device

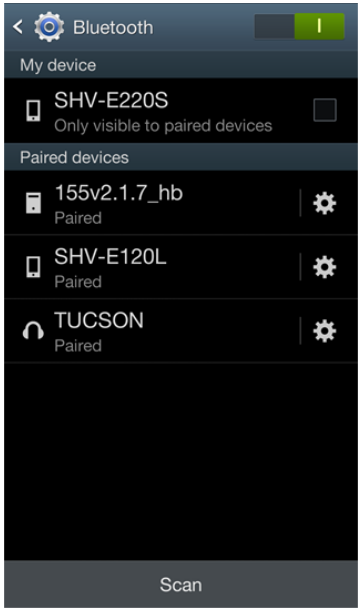




Bluetooth Paring with SmartCAR

- How to pair your Android device with SmartCAR
  5) Click on "155v2.1.7_hb"
  6) Check "PIN containing letters or symbols" and Enter "BTWIN", and then Click on "OK"
  7) Connection is completed if "Paired" is shown under 155v2.1.7_hb

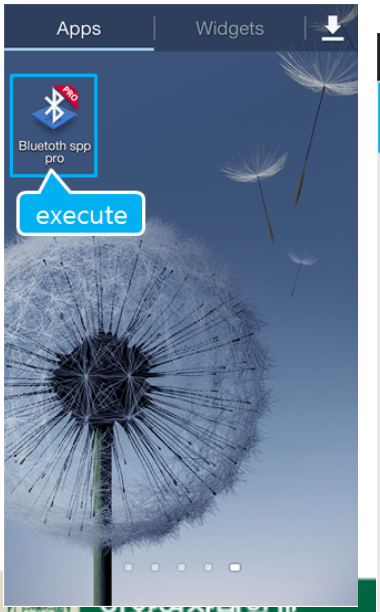


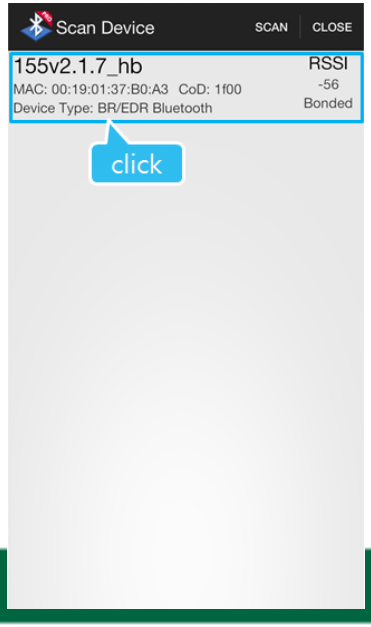


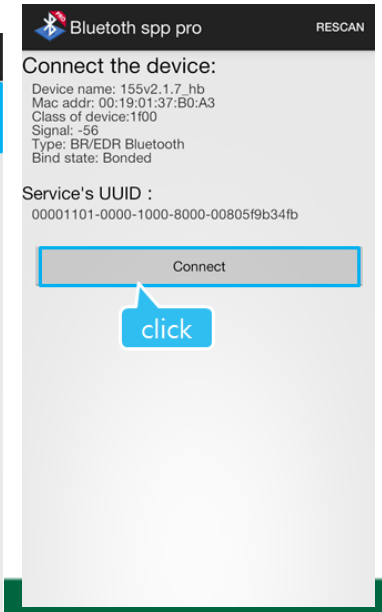
Wait..!!
SmartCAR's Bluetooth port uses USART0 port. This port is also used as programming. Thus, if programming port is connected to PC via USB cable. Bluetooth will be disabled
For Bluetooth communication, disconnect the USB cable to programming port!

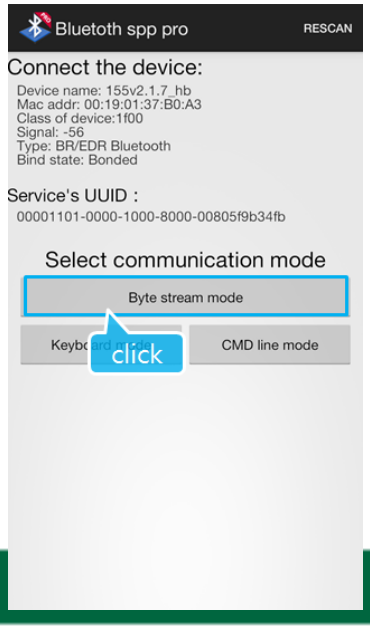
Run the Bluetooth Serial App

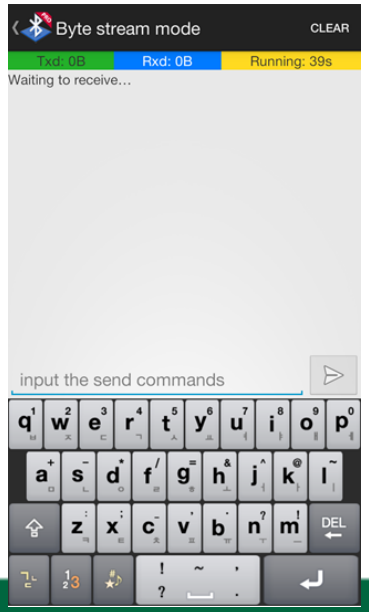
1) While SmartCAR is turned ON, run "Bluetooth app Pro" in Android device
2) Click on the already-paired device (155v2.1.7_hb)
3) Click on "Connect"
4) Click on "Byte stream mode"
5) Connection is completed
6) Push the Reset button on your SmartCAR











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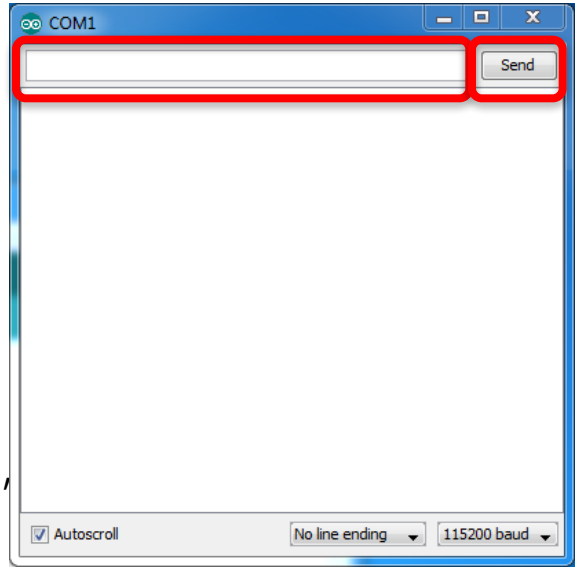
Lab Assignment #4

- 1) Serial communication to PC
  - Input your message
  - Then click on Send
  - If your message is shown under ECHO **team ID** >>, your SmartCAR is successfully connected to PC via serial port
- 2) Serial communication to Android device
  - Input your message
  - Then click on Send
  - If your message is shown under ECHO **team ID** >> , your SmartCAR is successfully connected to Android device via serial port (Bluetooth wireless)
- Submit 1) lab4_pc.png (screen capture)
  2) lab4_android.png (screen capture) files
- Show your result to TA or instructor



Course Announcement

- Next week, we will have midterm
  - 2pm - 4:30pm, Mon Apr 11
  - Closed book & closed classnote
  - Coverage: lecture & lab over week 1 ~ this week