Smart Software Project

Lab: Week 8

Bluetooth Comm.
with Android Dev.

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이화여자대학교
EWHA WOMANS UNIVERSITY

Today

- Lab announcement
- Review Lab assignment #4
- SmartCAR with Android device
- Lab assignment #5
- 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 <u>after checking with me or TA</u>

- 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

NOTE: How to run SmartCAR in Lab

- Power OFF
  - Compile your code
  - Lift up your SmartCAR with your hand
  - Upload your code
- Disconnect the USB cable
- Go to find a spacious area
- Put it down there
- Power ON
- It will run your firmware
- After test, turn power OFF

Lab Announcement

- Bluetooth pairing “headache”
  - Because there are so many Bluetooth devices in the classroom with the same name
    - “**155v2.1.7_hb**” <- SmartCAR
  - So please go outside with your SmartCAR and your Android device, and then pair them
  - Please do not pair with other students’ devices

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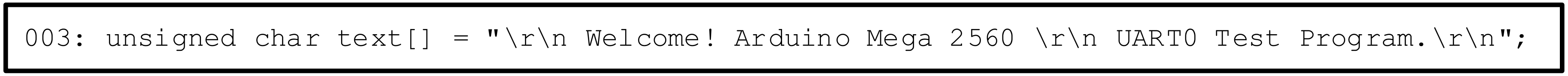
SmartCAR UART Example

- UART_Echo.cpp

```
#include "UART_Echo.h"

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

void setup()
{
    int i=0;
    Serial.begin(115200);
    while(text[i] !='\0')
      Serial.write(text[i++]);
    Serial.print("ECHO team 5 >>");
}

void loop()
{
    if(Serial.available() > 0)
      Serial.write(Serial.read());
}
```

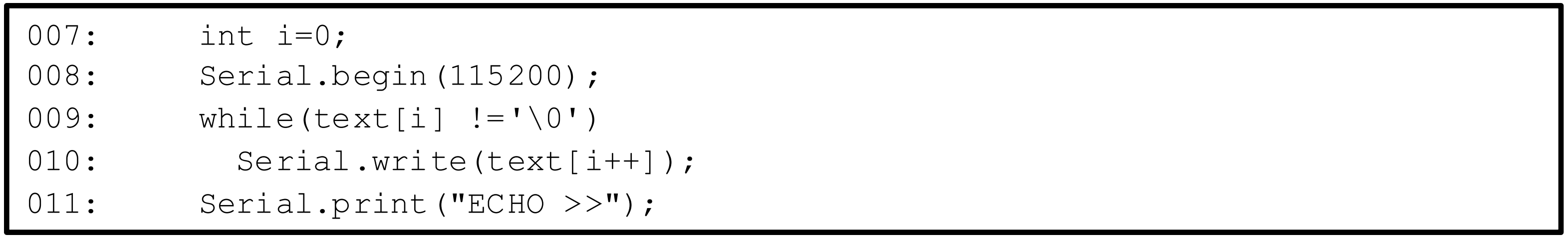
SmartCAR Example Code Analysis

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



```
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



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

SmartCAR Example Code Analysis

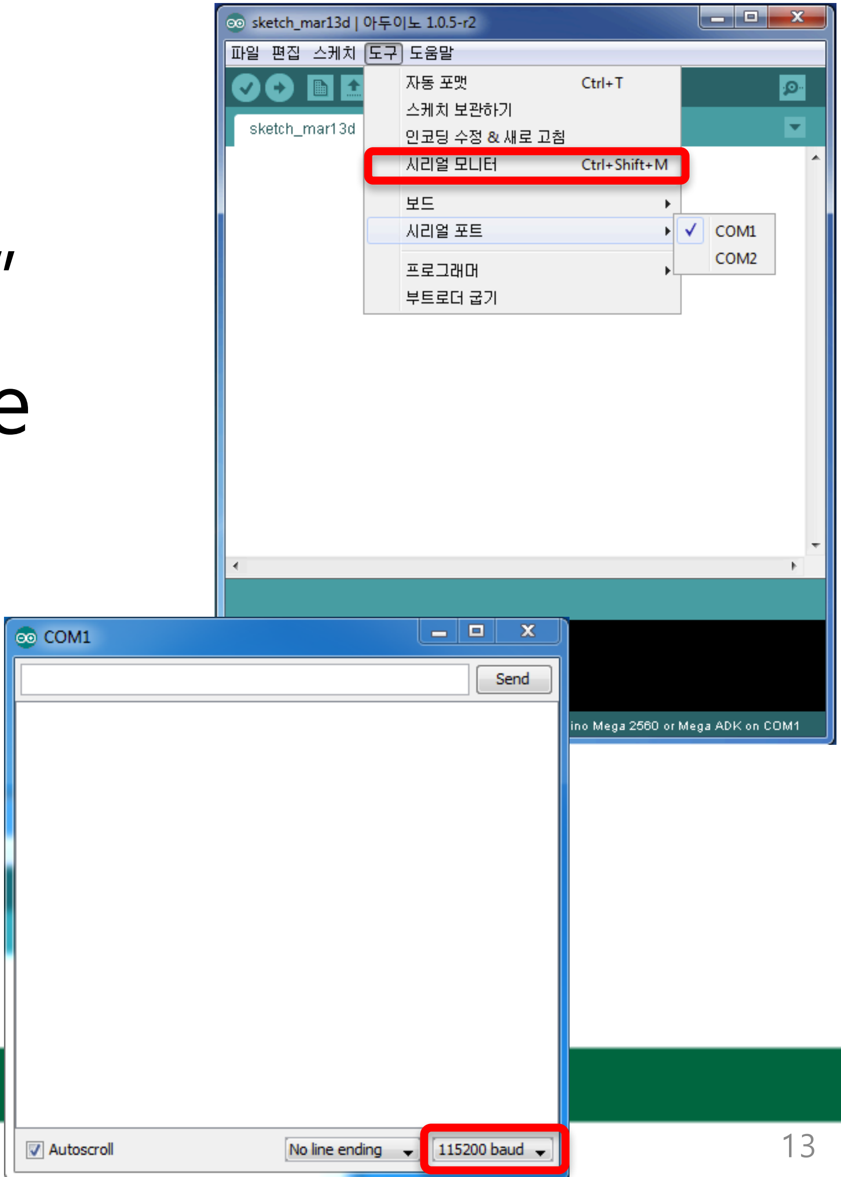
- loop()
  - Serial.available(): check the number of bytes
    - Serial.available() > 0
      - if there is any data that are received in the receive buffer,
      - Then, Serial.write(Serial.read())
    - Serial.read(): read 1 byte from the receive buffer
    - Serial.write(): write the received value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

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

1. Exchange data with PC via Programming Serial Port

Run the Arduino IDE

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



ino Mega 2560 or Mega ADK on COM1

☑ Autoscroll

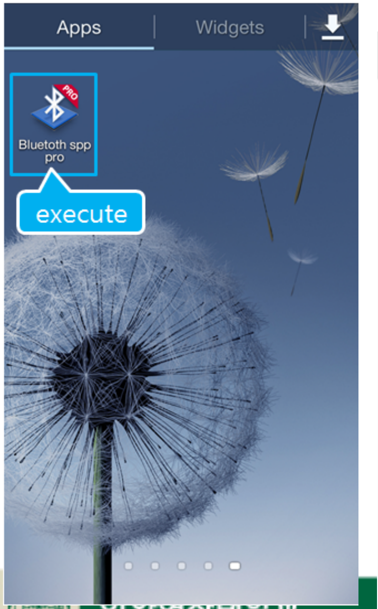
No line ending

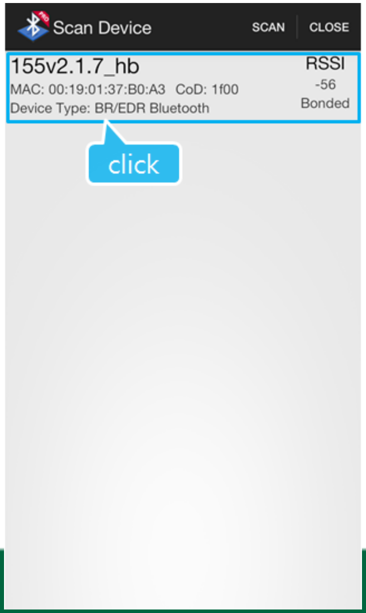
115200 baud

2. Exchange data with Android device via Bluetooth Wireless

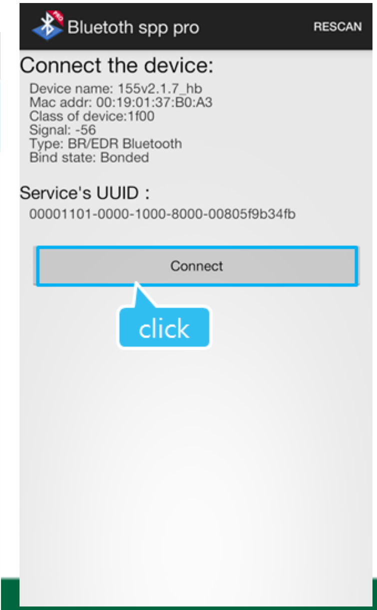
Run the Bluetooth Serial App

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



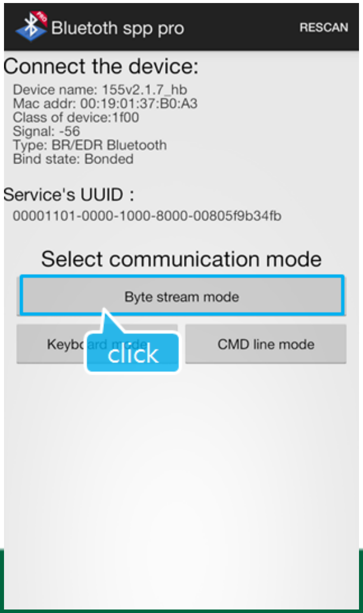


155v2.1.7_hb RSSI
MAC: 00:19:01:37:B0:A3 CoD: 1f00 -56
Device Type: BR/EDR Bluetooth Bonded



Connect the device:
Device name: 155v2.1.7_hb
Mac addr: 00:19:01:37:B0:A3
Class of device:1f00
Signal: -56
Type: BR/EDR Bluetooth
Bind state: Bonded

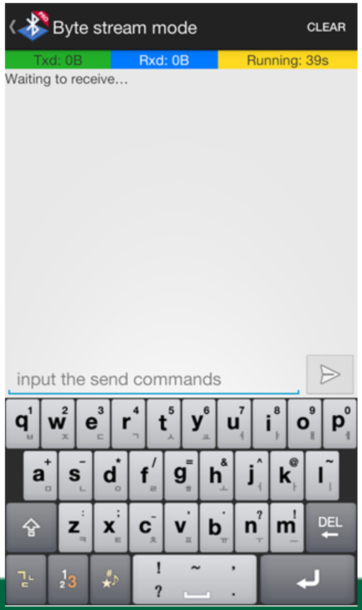
Service's UUID :
00001101-0000-1000-8000-00805f9b34fb



Connect the device:
Device name: 155v2.1.7_hb
Mac addr: 00:19:01:37:B0:A3
Class of device:1f00
Signal: -56
Type: BR/EDR Bluetooth
Bind state: Bonded

Service's UUID :
00001101-0000-1000-8000-00805f9b34fb

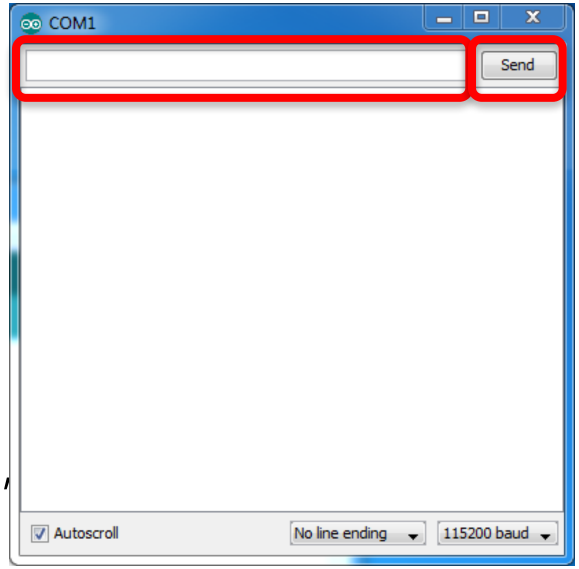
Select communication mode

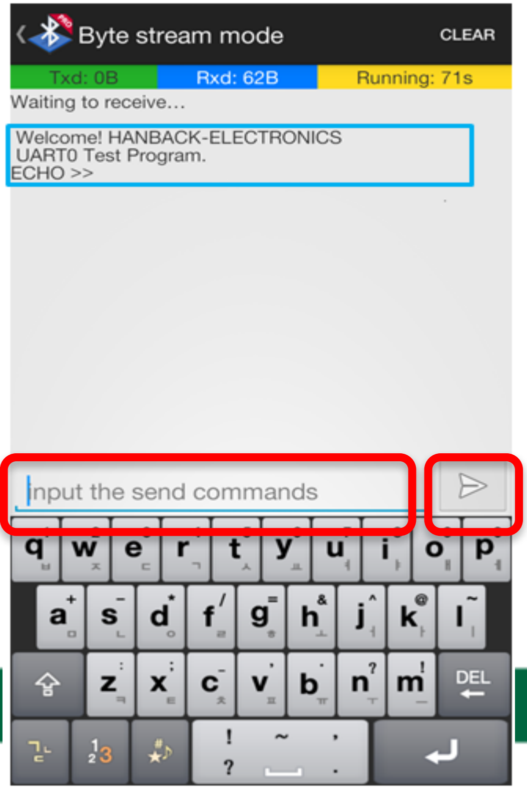


Txd: 0B Rxd: 0B Running: 39s
Waiting to receive...

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





```
Waiting to receive...
Welcome! HANBACK-ELECTRONICS
UART0 Test Program.
ECHO >>
```

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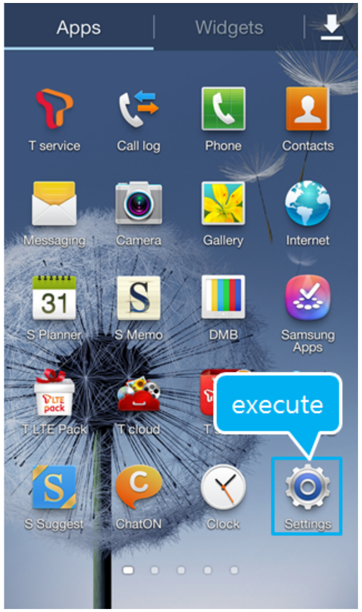
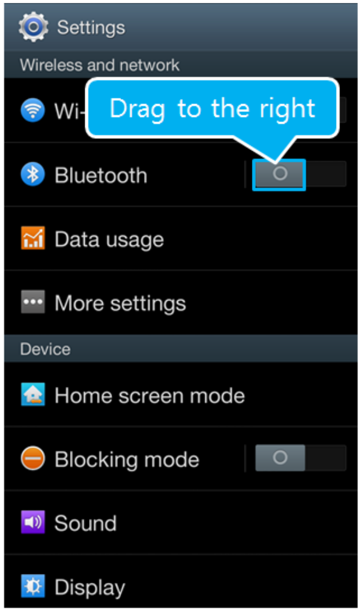
Bluetooth Pairing with SmartCAR

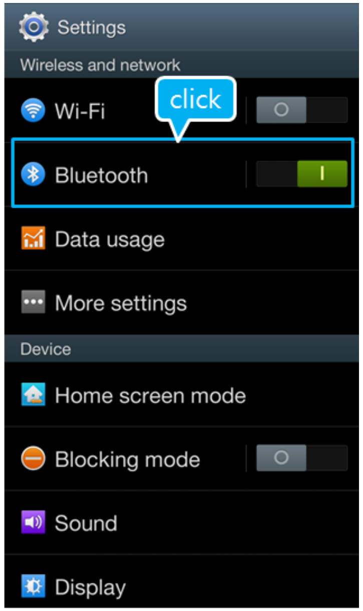
- How to pair your Android device with SmartCAR
  1) Power on SmarCAR
  2) Go to Settings in Android device
  3) Turn on Bluetooth and Click on it
  4) Scan Bluetooth device



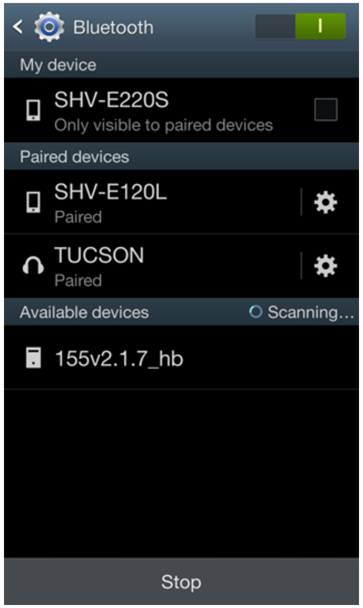
execute



Drag to the right

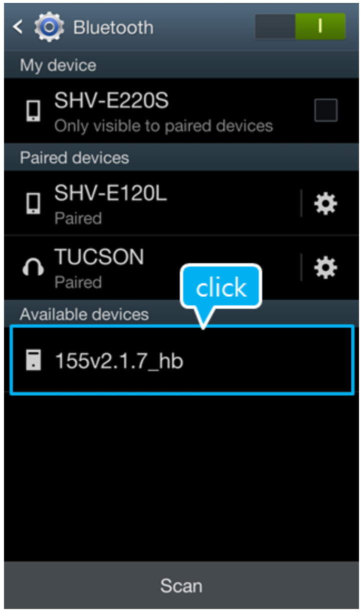


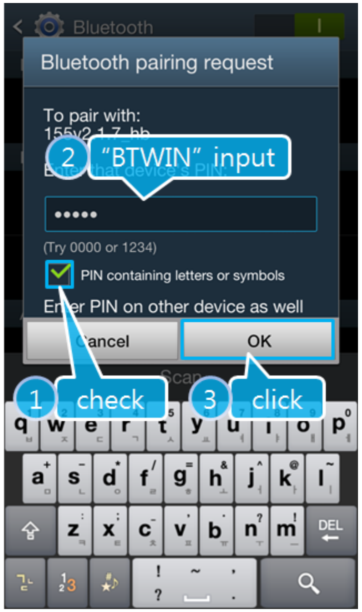
click

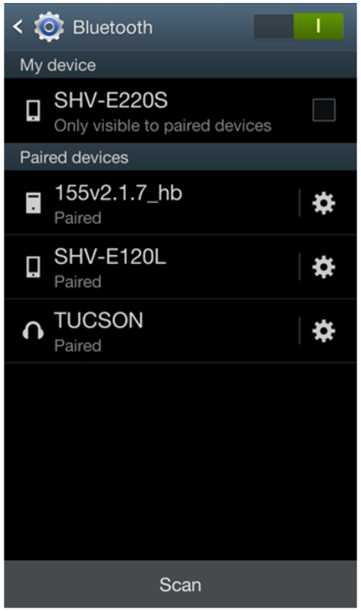


Bluetooth Pairing with SmartCAR

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



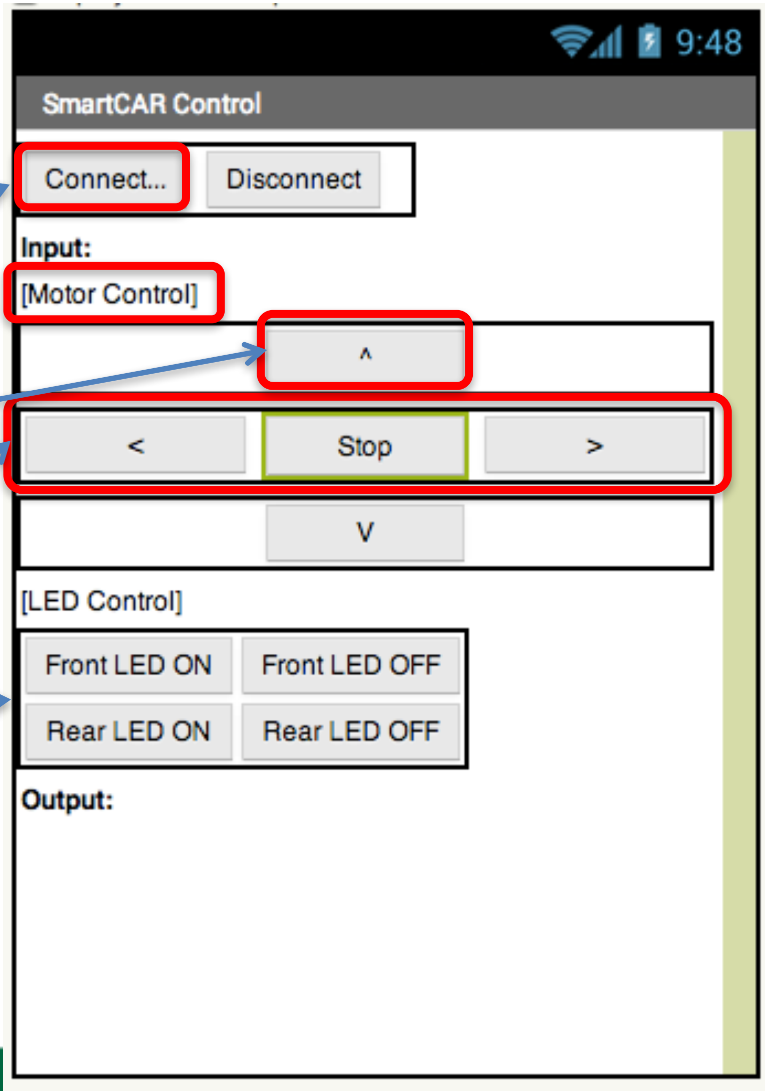




Wait..!!
SmartCAR’s Bluetooth port uses USART0 port. This port is also used as programming. Thus, if programming port is connected to PC via USB cable. Bluetooth will be disabled
For Bluetooth communication, disconnect the USB cable to programming port!

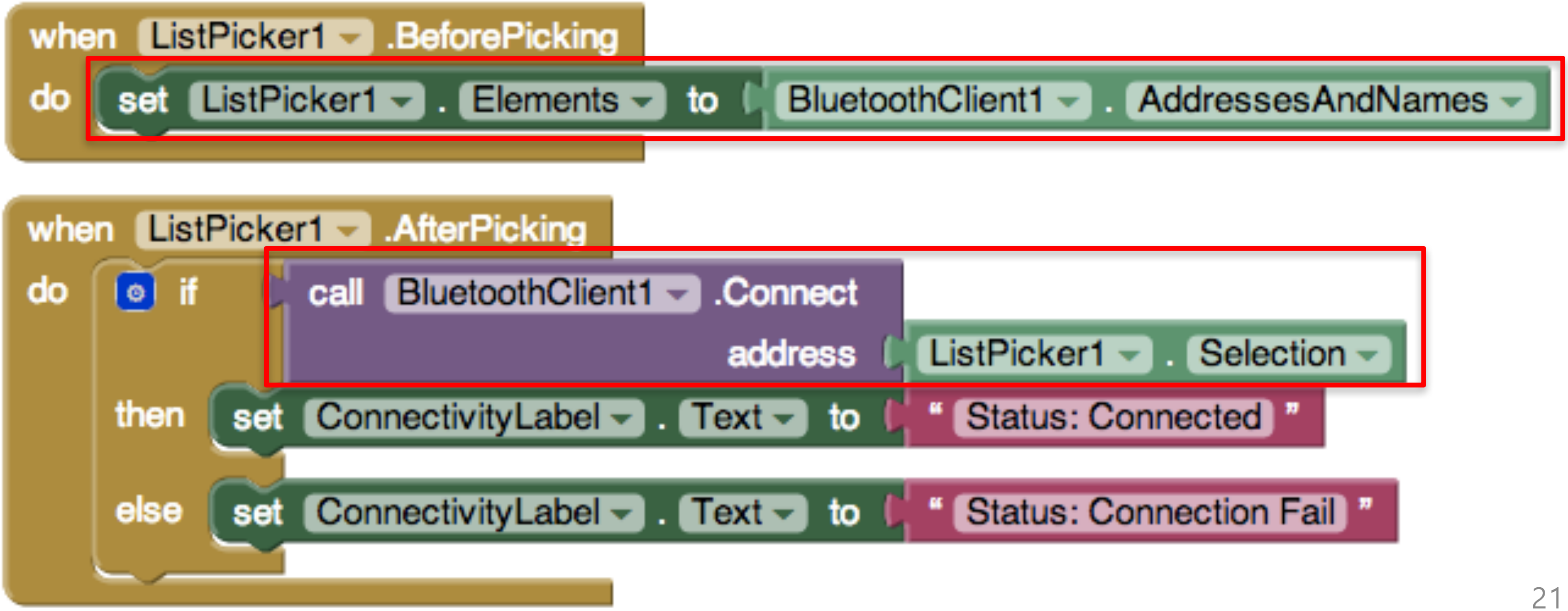
SmartCAR Control App

- http://ai2.appinventor.mit.edu
- Click on "New Project"
- Enter "SmartCAR" in Project Name (One word, no space)
- Under "User Interface"
  - Drag-and-drop "ListPicker" component
    - To select a Bluetooth device
  - Drag-and-drop "Button" component
  - Drag-and-drop "Label" component
- Under "Layout"
  - Drag-and-drop "TableArrangement"
  - Drag-and-drop "TableArrangement"
- Under "Connectivity"
  - Drag-and-drop "BluetoothClient"
    - **Uncheck "Secure"**
- Under "Sensors"
  - Drag-and-drop "AccelerometerSensor"



Bluetooth Connection

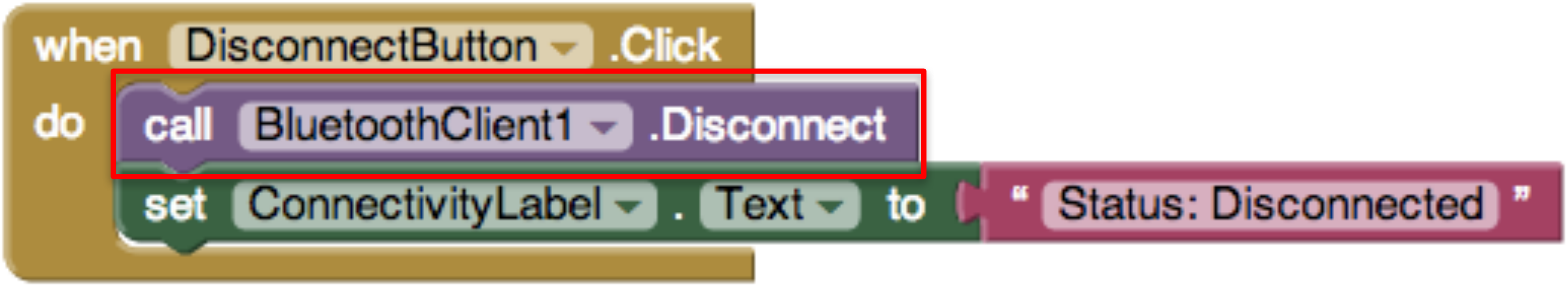
- Before picking a Bluetooth device in ListPicker
  - Show all connectable Bluetooth devices' Addresses and Names in Element
- After picking a Bluetooth device in ListPicker
  - Connect to the device selected in ListPicker.Selection
    - If success, print "Status: Connected" in label
    - If fail, print "Status: Connection Fail" in label



```
when ListPicker1 .BeforePicking
do  set ListPicker1 . Elements to BluetoothClient1 . AddressesAndNames

when ListPicker1 .AfterPicking
do  if   call BluetoothClient1 .Connect
                          address ListPicker1 . Selection
    then set ConnectivityLabel . Text to " Status: Connected "
    else set ConnectivityLabel . Text to " Status: Connection Fail "
```

Bluetooth Disconnection

- When “Disconnect” button is clicked
  - Execute BluetoothClient1.Disconnect
  - Print “Status: Disconnected” in label

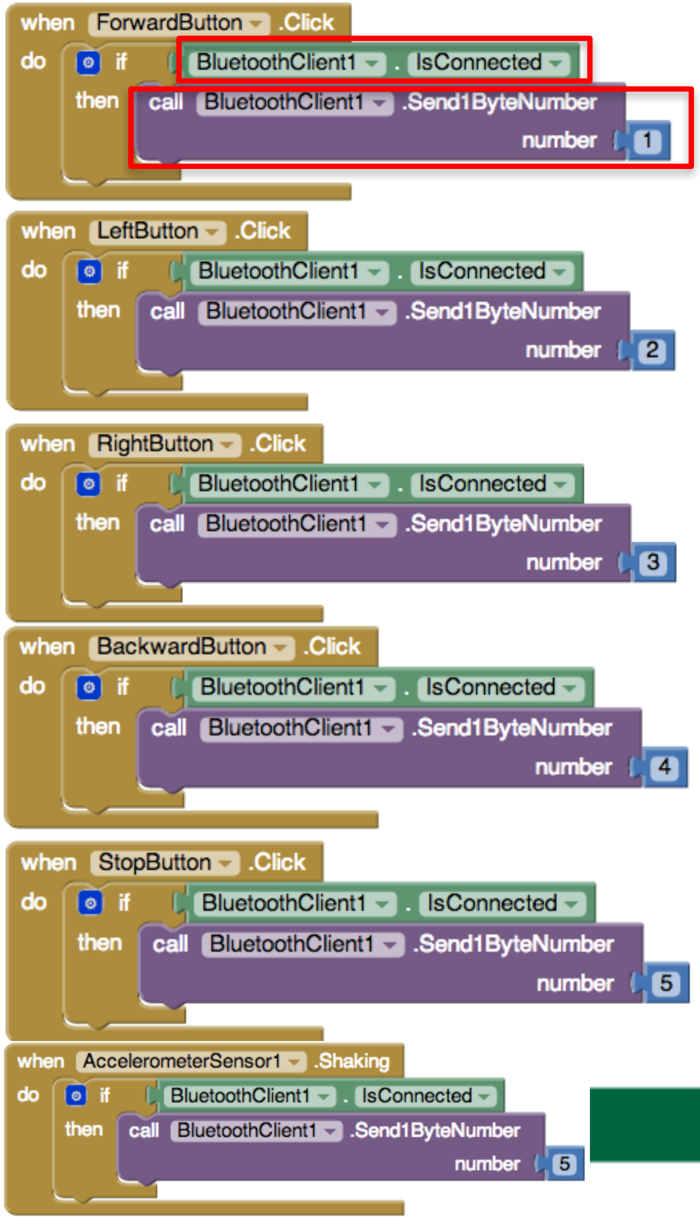


```
when DisconnectButton .Click
do  call BluetoothClient1 .Disconnect
    set ConnectivityLabel . Text to " Status: Disconnected "
```

SmartCAR Motor Control

- Move forward (command byte: 1)
  - Send "1" in number using "BluetoothClient.Send1ByteNumber"
- Turn left (command byte: 2)
  - Send "2" in number using "BluetoothClient.Send1ByteNumber"
- Turn right (command byte: 3)
  - Send "3" in number using "BluetoothClient.Send1ByteNumber"
- Move backward (command byte: 4)
  - Send "4" in number using "BluetoothClient.Send1ByteNumber"

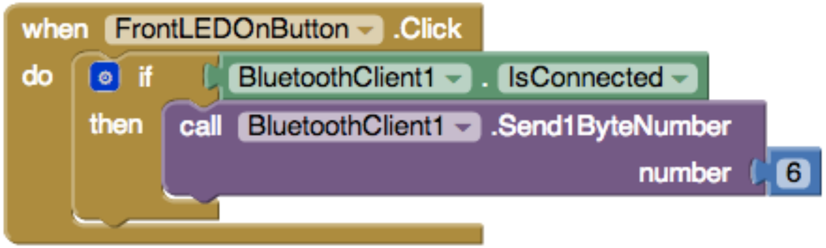
- Stop (command byte: 5)
  - Send "5" in number using "BluetoothClient.Send1ByteNumber"



```
when ForwardButton .Click
do  if   BluetoothClient1 . IsConnected
    then call BluetoothClient1 .Send1ByteNumber
                               number 1

when LeftButton .Click
do  if   BluetoothClient1 . IsConnected
    then call BluetoothClient1 .Send1ByteNumber
                               number 2

when RightButton .Click
do  if   BluetoothClient1 . IsConnected
    then call BluetoothClient1 .Send1ByteNumber
                               number 3

when BackwardButton .Click
do  if   BluetoothClient1 . IsConnected
    then call BluetoothClient1 .Send1ByteNumber
                               number 4

when StopButton .Click
do  if   BluetoothClient1 . IsConnected
    then call BluetoothClient1 .Send1ByteNumber
                               number 5

when AccelerometerSensor1 .Shaking
do  if   BluetoothClient1 . IsConnected
    then call BluetoothClient1 .Send1ByteNumber
                               number 5
```

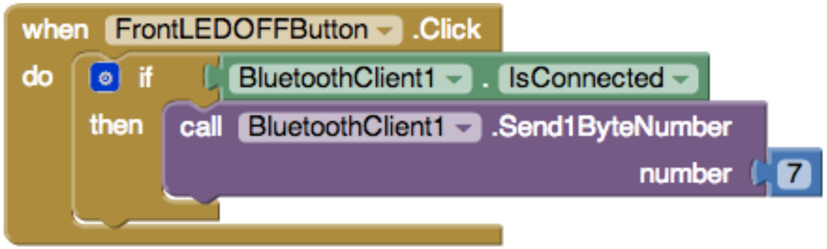
SmartCAR LED Control

- Turn Front LED ON (command byte: 6)
  - Send "6" in number using "BluetoothClient.Send1ByteNumber"



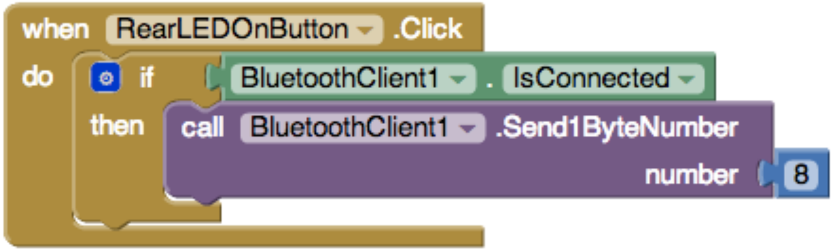
```
when FrontLEDOnButton .Click
do  if   BluetoothClient1 . IsConnected
    then call BluetoothClient1 .Send1ByteNumber
                                      number 6
```

- Turn Front LED OFF (command byte: 7)
  - Send "7" in number using "BluetoothClient.Send1ByteNumber"



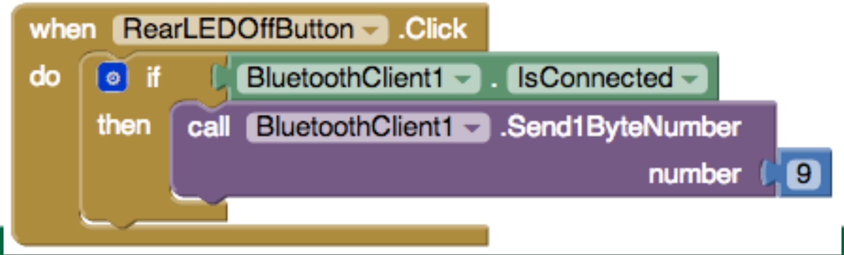
```
when FrontLEDOFFButton .Click
do  if   BluetoothClient1 . IsConnected
    then call BluetoothClient1 .Send1ByteNumber
                                      number 7
```

- Turn Rear LED ON (command byte: 8)
  - Send "8" in number using "BluetoothClient.Send1ByteNumber"



```
when RearLEDOnButton .Click
do  if   BluetoothClient1 . IsConnected
    then call BluetoothClient1 .Send1ByteNumber
                                      number 8
```

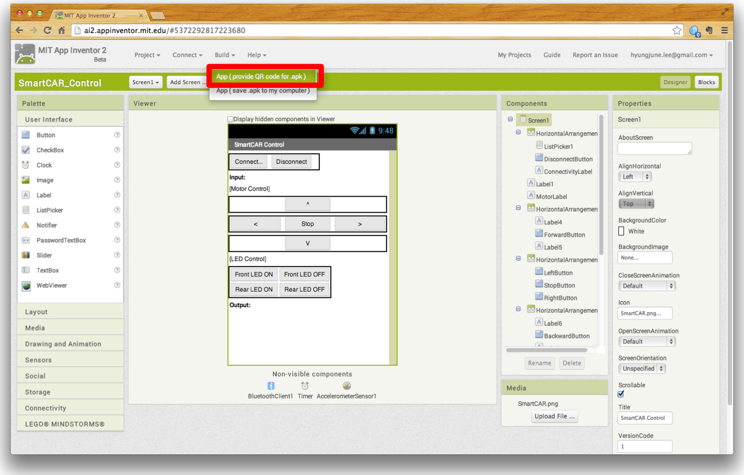
- Turn Rear LED OFF (command byte: 9)
  - Send "9" in number using "BluetoothClient.Send1ByteNumber"

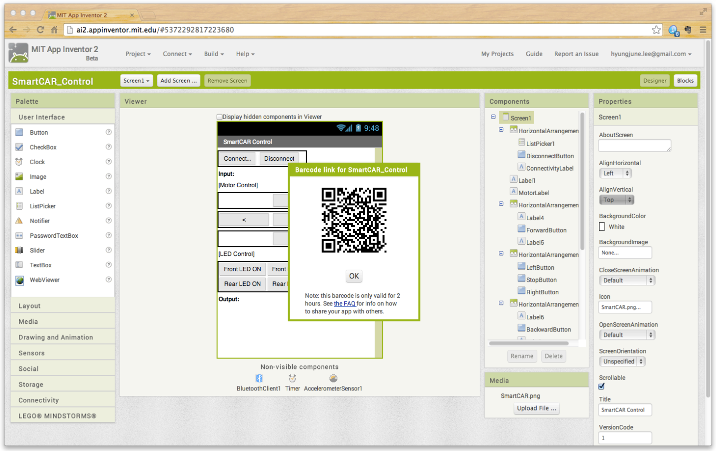


```
when RearLEDOffButton .Click
do  if   BluetoothClient1 . IsConnected
    then call BluetoothClient1 .Send1ByteNumber
                                      number 9
```

How to Run your Android app

- 1. Install “QR Barcode Scanner” in Play Store (Android device)
- 2. Click on “Build” (PC)
  - Click on “App (provide QR code for .apk)”
- 3. Run “QR Barcode Scanner” (Android device)
- 4. Touch the URL link (Android device)
- 5. Select “OK” to install .apk file (Android device)





Note: this barcode is only valid for 2 hours. See the FAQ for info on how to share your app with others.

SmartCAR Firmware

```
unsigned char text[] = "₩r₩n Welcome! Arduino Mega₩r₩n UART Test Program.₩r₩n";

void setup()
{
// Add your initialization code here
    int i = 0;
    Serial.begin(115200);

    while (text[i] != '₩0')
        Serial.write(text[i++]);

    Serial.write("Received cmds: ");

    //initialize ports
    pinMode(....);
    ....
    digitalWrite(...);
}
```

SmartCAR Firmware

```
void  loop()
{
    if (Serial.available() > 0)
    {
        int command = Serial.read();
       Serial.print(command, DEC);
        Serial.print(" ");
        switch (command)
        {
            case 1:
                move_stop();
                delay(500);

                move_forward();
                break;
            case 2:
                move_stop();
                delay(500);

                turn_left();
                break;
            case 3:
                move_stop();
                delay(500);

                turn_right();
                break;
            case 4:
                move_stop();
                delay(500);

                move_backward();
                break;
```

```
            case 5:
                move_stop();
                break;
            case 6:
                front_led_control(true);
                break;
            case 7:
                front_led_control(false);
                break;
            case 8:
                rear_led_control(true);
                break;
            case 9:
                rear_led_control(false);
                break;
            default:
                move_stop();
                front_led_control(false);
                rear_led_control(false);
        }
    }
}
```

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Lab Assignment #5

- Submit three following files to Cyber Campus
  - 1) lab5.cpp (Arduino firmware code)
  - 2) lab5.h (Arduino firmware code)
  - 3) SmartCAR.apk (Android app package)
    - You should set the app icon image to "SmartCAR.png"
    - In App Inventor, "Build" ➔ "App (save .apk to my computer)"

- Show your result to TA or instructor

Course Announcement

- Next lecture, we will continue to study
  - Ultrasonic sensors
  - Infrared sensors

- Next lab session, we will cover
  - Using timers in SmartCAR
  - Using ultrasonic sensors in SmartCAR