CEE-445 Embedded System Design

Embedded System Design

Last Update:
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FPGA 2 Part 2:
UART and Bluetooth Communications
MIT App Creator 2

Lab Goal

The goal of this lab is to introduce you how to control our FPGA robot cart via Bluetooth with an Android app created with MIT App Creator 2. MIT Creator is an intuitive and visual programing environment to build fully functional Android apps for smartphones and tablets without any background on java or java scripts.

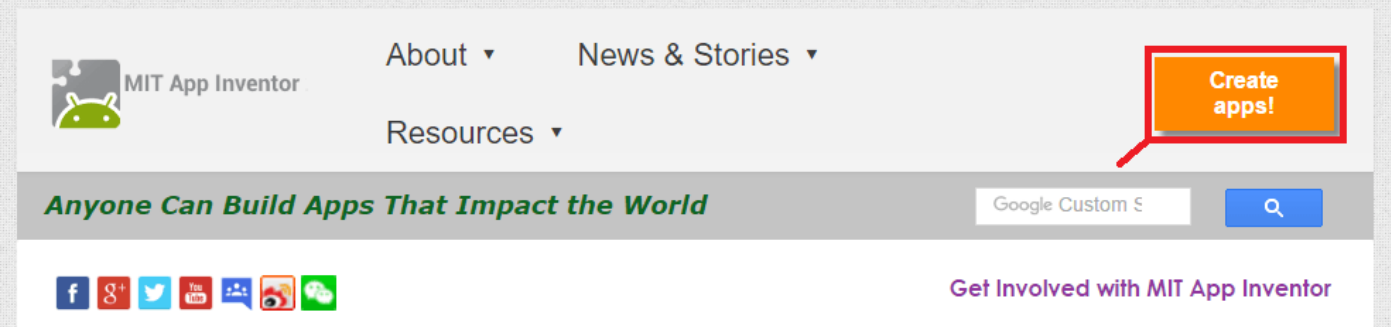
Introduction

This part of the lab exercise is to walk you through a creation of Android app that will be used to control our FPGA robot cart via Bluetooth modules – HC-06 or BlueSMiRF. MIT App Inventor 2 is a free service for creating Android applications, so you build apps directly in your Chrome browser with an internet connection and your Google's Gmail account.

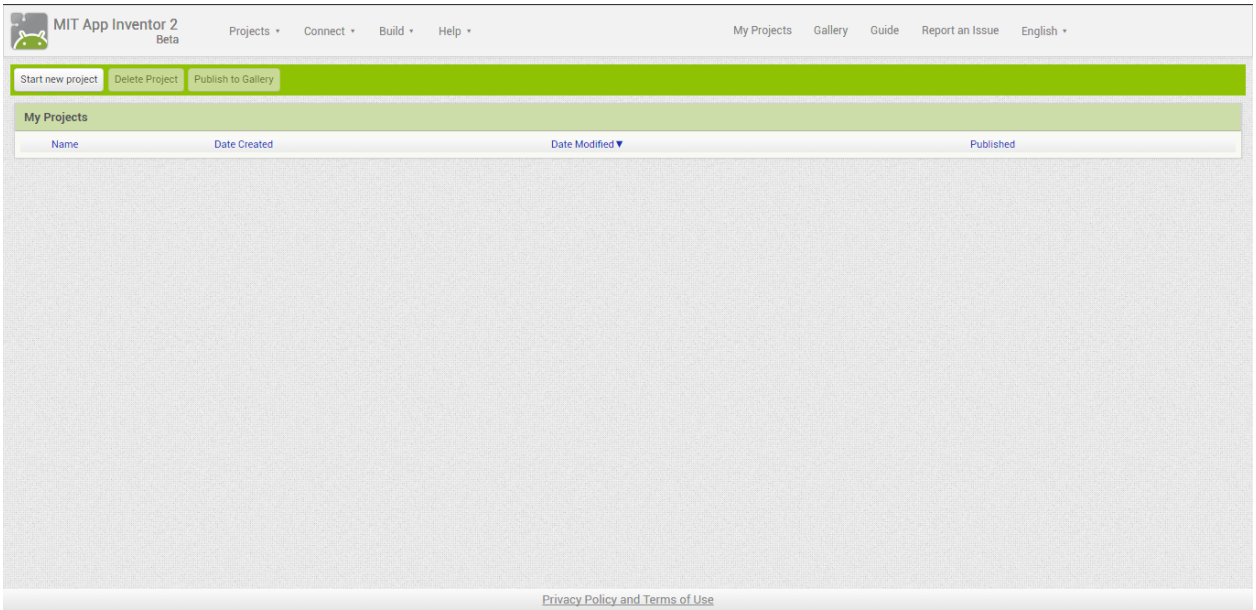
Procedure

This procedure includes an introduction to MIT App Creator. If you already know how to use it, you may skip it and import the source file directly to your MIT App Creator editor.

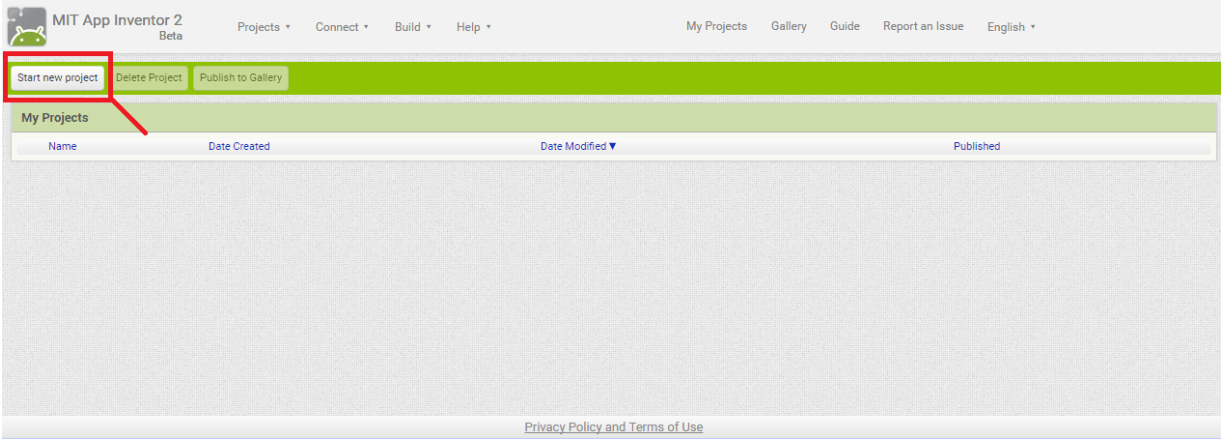
1. Introduction to MIT App Creator 2:
   Accessing MIT App Creator 2: go to http://appinventor.mit.edu/explore/# and press the orange Create Apps button.



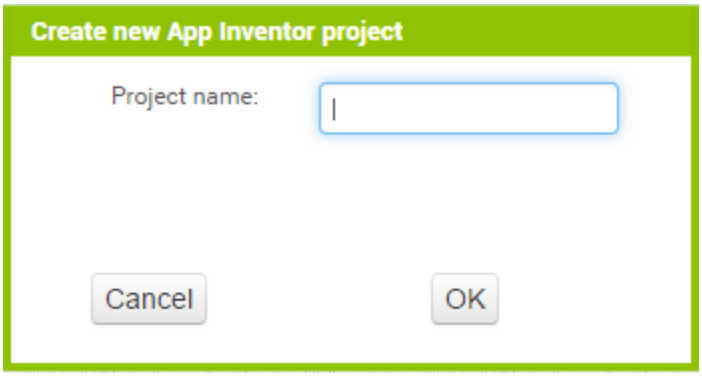
a. You will need to log in to your Google account. Create one if you don't have it. Follow the on-screen steps to log into MIT Creator 2. Once log in, you will see the build window as shown below.



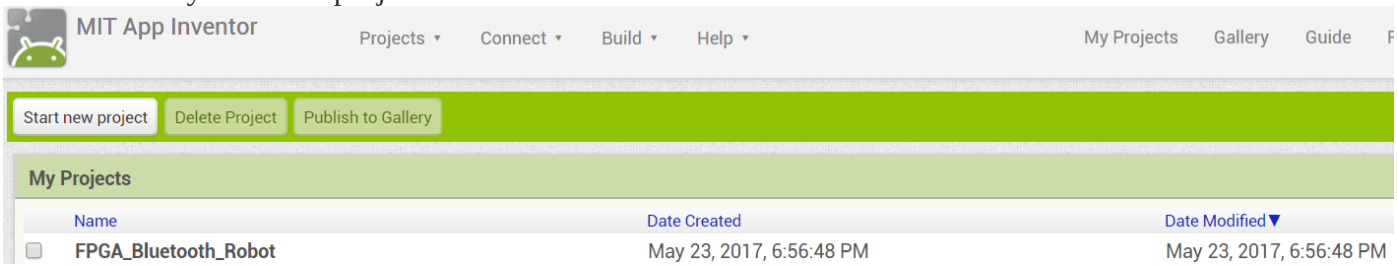
b. Next, click on Start New Project as shown.



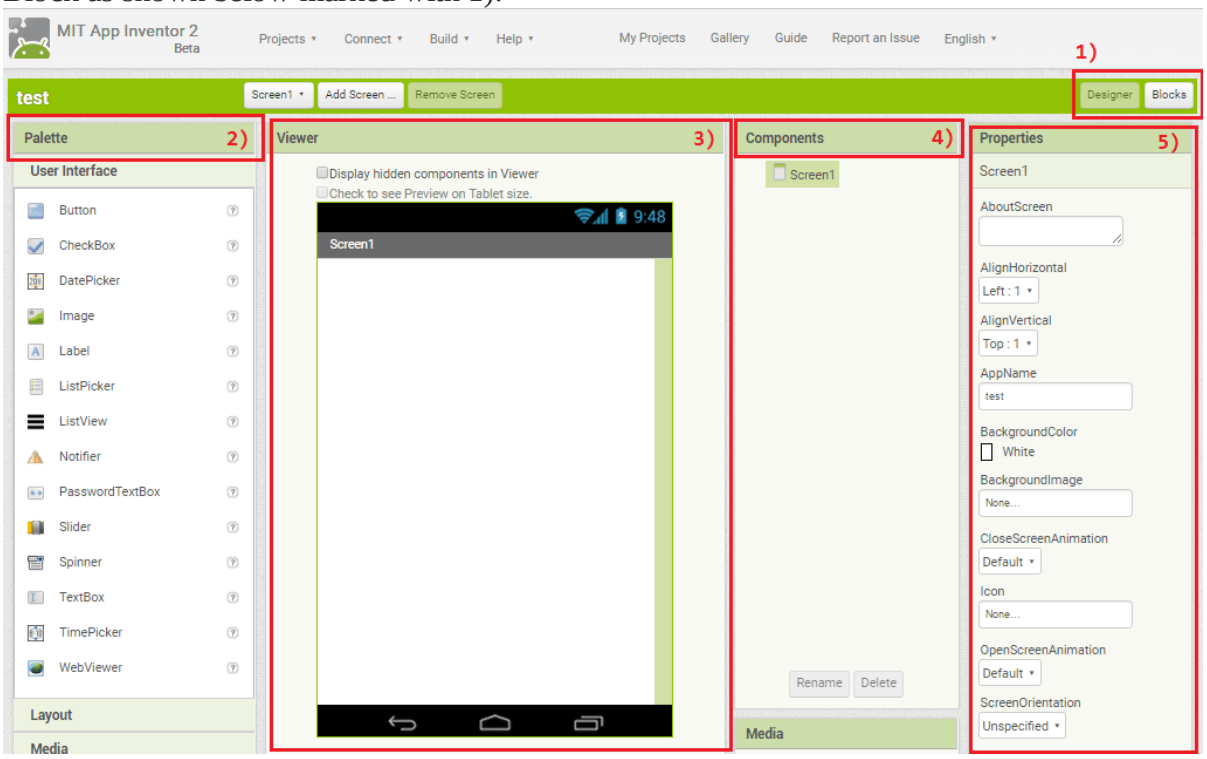
c. Next, name your project title (e.g. FPGA Bluetooth Robot)



d. Click **OK.** Your project is automatically saved. If you go to **Projects > My Projects** you can see all your saved projects.



e. Click on the project name to open the app builder if it is not open.
f. This app is mainly involved with two programming windows in MIT Creator – Designer and Block as shown below marked with 1).



The Designer and Blocks Editors: The designer editor gives you the ability to add buttons, add text, add screens and edit the overall app look, and the **Blocks** editor allows to create custom functionality for your app.

g. The **Palette** contains the components to build the app design like buttons, sliders, images, labels.

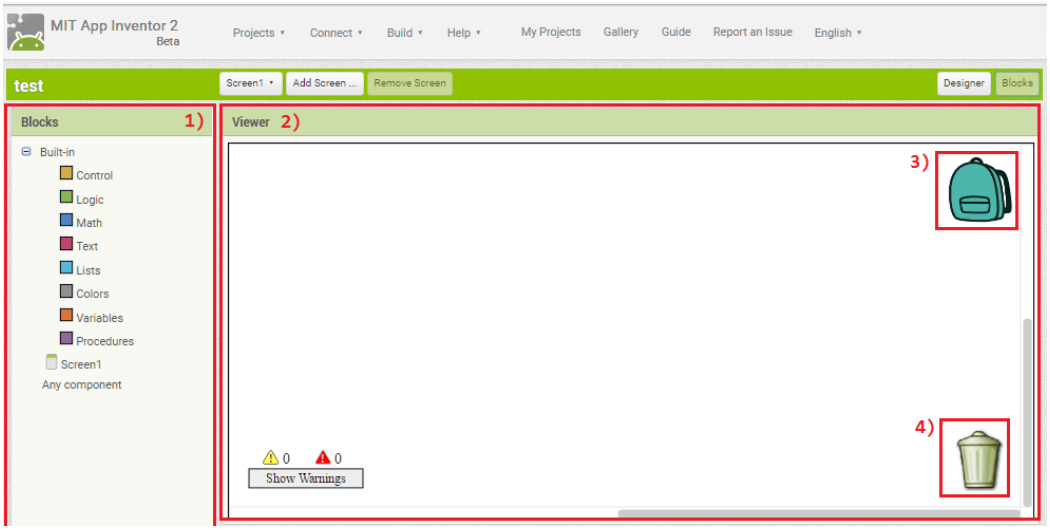
h. **The Viewer** allows to drag the components to build the app look in the viewer.

i. The Components allow to see all the components added to your app and how they are organized hierarchically.

j. **Properties** allows to select your components' properties like color, size and orientation.

Blocks Editor

Select the **Blocks** editor tab**.**

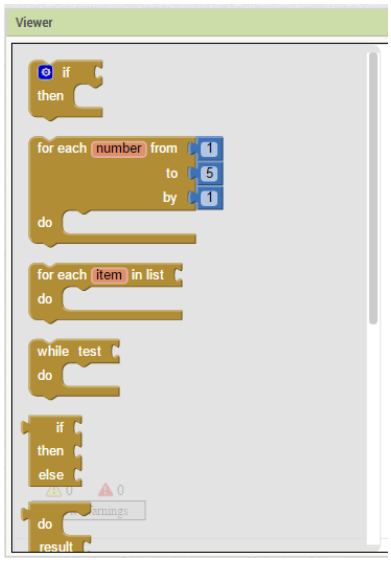


In the **Blocks** editor tab, you have several sections:

k. The Blocks contains the built-in blocks for creating the app's logic. This is what makes the app define the buttons functionalities, send commands to FPGA or microcontroller, or connect to the Bluetooth module. In addition, the blocks look like puzzle pieces that fit into each other. If you can't do something with certain blocks, they won't fit into each other just like the ways we play puzzle games.

l. We have several blocks grouped by categories:

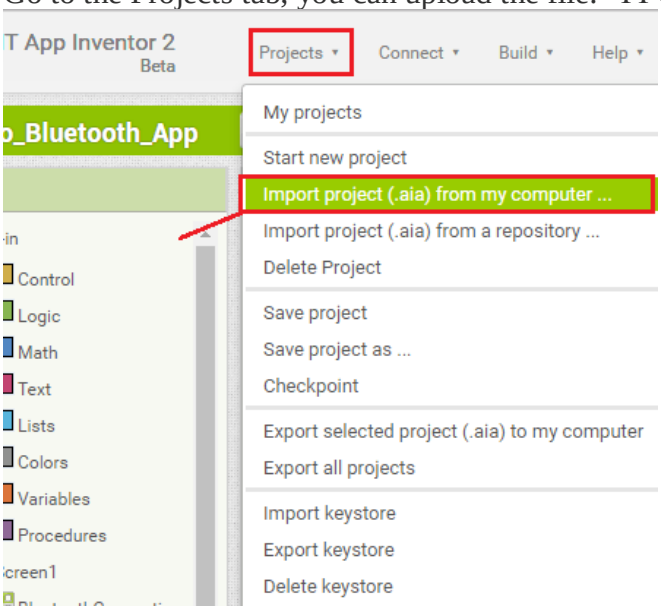
- **Control**: *if/else* statements, *while loops*, and more
- **Logic**: *True, False, equal, not equal,* and more
- **Math**: math operators
- **Text**: blocks that deal with text
- **Lists**: blocks for handling lists
- **Colors**: blocks to handle colors, like choosing a color, make color and split colors
- **Variables:** initialize variables, setting variables values, get variables values, and more
- **Procedures:** procedures are like functions. A procedure is a sequence of code blocks with a given name.



m. In the **backpack icon** where code blocks can be saved to use later. The blocks in the **dustbin** are to be deleted.

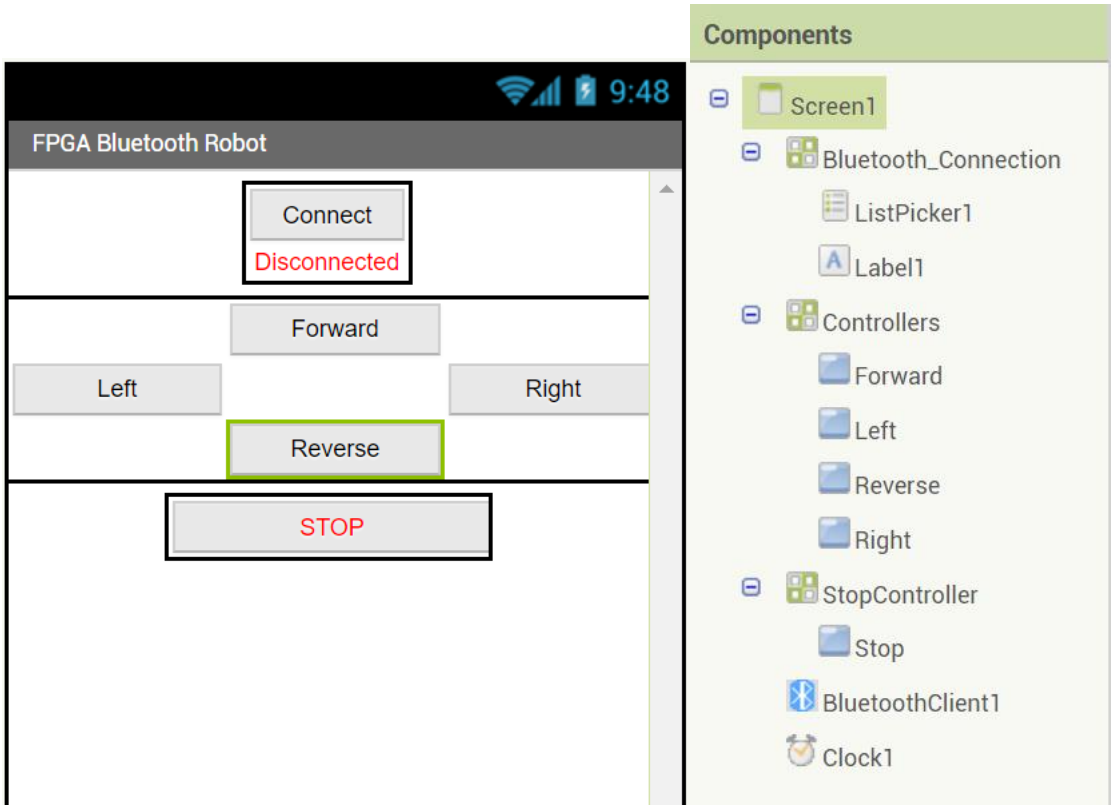
2. **Importing a source file to MIT App Creator Editor:**

a. Go to the Projects tab, you can upload the file: "FPGA Bluetooth Robot.aia" from D2L site.

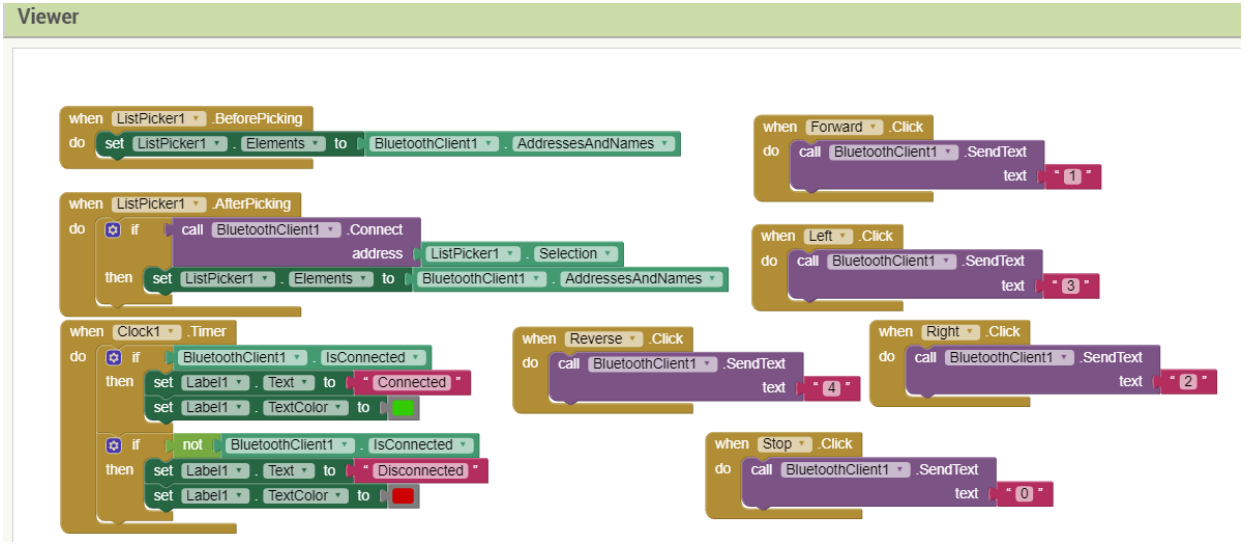


b. This is what the App looks like after the import on your laptop screen.

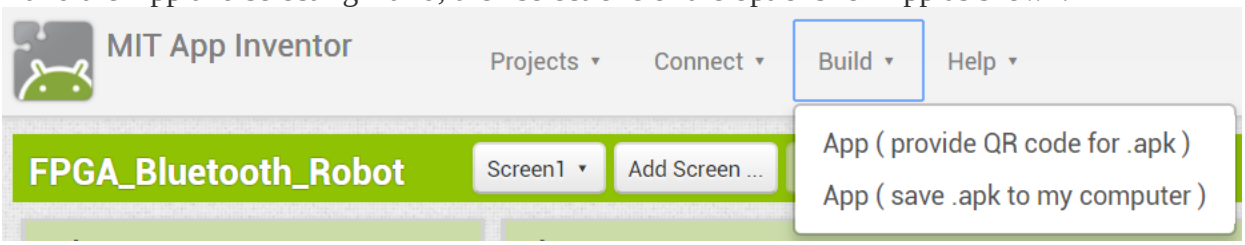
The Designer View:



The Blocks View:



c. Build the App and selecting Build, then select one of the options for App as shown.



d. Select a QR code for .apk.

3. **Wiring Connections on the FPGA Bluetooth Robot Cart**
   a. Use the wiring connection information below to wire up the Bluetooth module with the FPGA board on the breadboard area on the FPGA robot cart. Either of the following Bluetooth modules can be used for this lab: HC-06, or the Bluetooth made by Roving Network Inc from Sparkfun.

Connection from Bluetooth	Connection to FPGA
VCC	VCC
GND	GND
TXD/TX-O	GPIO Pin
RXD/RX-I	Not Connected
All Other Pins	Not Connected

   b. Now, connect battery or a USB cable to power up the FPGA board.
   c. Download the bit stream file of the code you developed in part 1 to the FPGA.

   d. The red LED on the Bluetooth module should be blinking when it is powered up.

   e. When power is connected to the Bluetooth module, it becomes discoverable by your Android devices. However, Bluetooth is a point to point connection device, so only one Android device can be paired up with a Bluetooth module each time. The first step is to pair your Bluetooth module with a Bluetooth enabled device (phone or a tablet). Follow the pairing instructions on your Android device, and if prompted for a pin number, **use 1234**.

   f. The following steps are used for FPGA to configure each button on your Android device. Each button on your App has a specific code to send to the Bluetooth module on the FPGA.

Button	Button Code	ASCII (hex)	LED[7:0]
Stop	0	30	0011 0000
Forward	1	31	0011 0001
Turn Right	2	32	0011 0010
Turn Left	3	33	0011 0011
Turn Back/Reverse	4	34	0011 0100

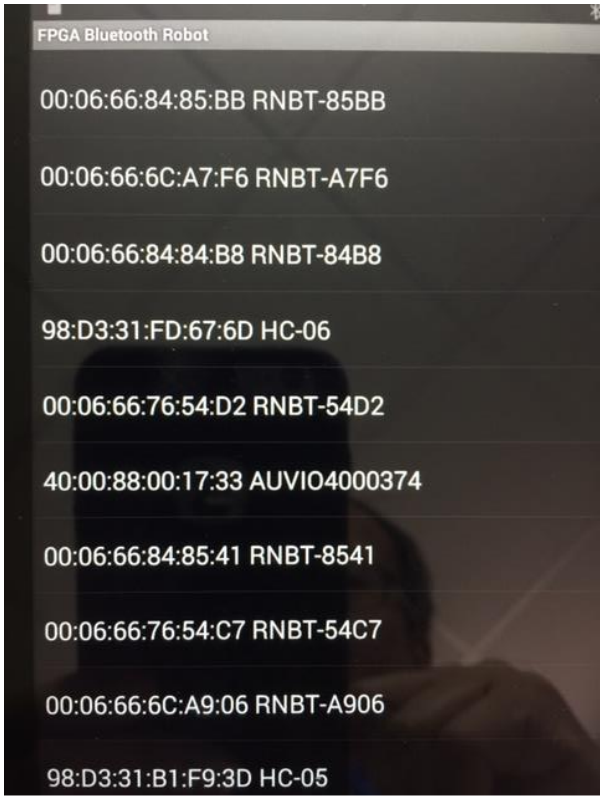
Connect your Phone or Tablet over WiFi to install the apk file

   g. The weblink below shows how you can connect your Android device over WiFi to install your App from MIT App Creator 2: http://appinventor.mit.edu/explore/ai2/setup-device-wifi.html#

h. Turn on the Bluetooth on your Android device.

i. Run the App on your Android device, and it should look like the picture below:

j. Tab on the Connect button on your Android device. You should see all possible Bluetooth connections floating for connection with your Android device, and then select HC-06 Bluetooth module if you are using HC-06 module, or select RNBT-xxxx if you are using the Bluesmirf BT from Sparkfun.



k. Once the Bluetooth modules connected, you should be able to navigate the robot carts with those buttons on the App.