Programming Guide (LabVIEW™ for LEGO® MINDSTORMS®)

Introduction
In this guide, code created with the FTC® templates will be explored and then run using the FCS. An FTC game starts with a period where only autonomous code can be used and then TeleOp code can be used for the remainder of the game. To simulate an FTC game, an autonomous program and a TeleOp program will be deployed onto the NXT Brick and run with the FCS. This guide is for use with the LabVIEW™ for LEGO® MINDSTORMS® programming language.

Review:
- To review how to install the FCS, review the documentation in the Samantha Module extension.

Getting Started:
1. Open the FTC Programming Extension sample program for LabVIEW for LEGO MINDSTORMS. This contains a robot project with all the files needed for this extension.
   a. Download the zip file and extract the files.
   b. Navigate to the robot project file and open it.

Explore the Autonomous Program:
2. Open the Autonomous Mode VI saved in the robot project and explore the code. This code was created from the autonomous template provided with the FTC add-on.
   a. Use the Context Help to get information about the FTC functions. Open the Context Help by pressing Ctrl-H.
   b. Observe the autonomous example code located inside the Sequence structure that programs the robot to perform the following steps in a loop: initialize the servos, move forward, grab an object, turn, move forward, drop the object, and move backwards.
   c. Deploy the program onto the NXT so it can be used during the autonomous mode of a FTC game. To do this, press the down arrow icon on the toolbar at the top of the block diagram window.

Note: The FTC functions are required to communicate with the FCS. The data communicated includes remote control inputs and the current mode. In this case, the functions will enable or disable the autonomous code located in the Sequence structure.

3. Open the TeleOp Mode VI saved in the robot project and explore the code. This code was created using the generate code option of the Remote Control Editor, which will be explored in the TeleOp extension.
   a. Use the Context Help to get information about the FTC functions.
   b. Observe the simple example code that programs a remote controller to move the DC motors with the left analog stick, move the Arm servo with the right analog stick, and move the Gripper servo with the buttons. The analog stick controls are located inside the Sequence structure and the button controls are located in the internal Case structure in their respective cases. Navigate to the cases by using the arrows on the Selector Label.
c. Deploy the program onto the NXT so it can be used during the TeleOp mode of a FTC® game.

Setup the TeleOp Program that Will Be Used in an FTC Match:
4. The Program Chooser VI will be used to choose the TeleOp program that the FCS will start when the TeleOp mode of the FTC game begins. First, deploy the program onto the NXT Brick.
   a. Open the Program Chooser VI located in the following folder in LabVIEW™ for LEGO® MINDSTORMS®: LabVIEW 2010\examples\FTC Toolkit\Program Chooser 2.0.
   b. Target the NXT by right-clicking Main Application Instance in the bottom-left corner of either the front panel or the block diagram and select the NXT being used.
   c. Deploy the program to the NXT.
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5. Next, the TeleOp program must be selected in the Program Chooser.
   a. Navigate to and run the Program Chooser on the NXT Brick.
   b. Use the arrow keys on the NXT Brick to navigate to the TeleOp program that is going to be used in the FTC® game, then press the orange button to select the program, and then press the orange button again to continue.

Setup a Practice FTC Match in the FCS:

6. After loading the autonomous and TeleOp programs on to the NXT Brick and configuring the Program Chooser, everything is ready to complete a practice FTC match using the FCS. The FCS must be setup first. Follow the FCS guide below.

Samantha Field Control System:
The Field Control System (FCS) is the software provided by FTC to setup matches, to keep a record of time, as well as to send messages from the joystick to the robot.

Teams participating in the FIRST® Tech Challenge must have the FCS installed and running on their computers to pass the software inspection.

Begin by opening the Samantha Field Control System.

Assign Controllers:
When the FCS has been opened, the Assign Controllers window will appear. All the joysticks that are connected to the computer will appear in the Controllers Available panel of the window.

To assign a joystick to a particular window, the driver of a team must press a button on the joystick when the question mark flashes next to the driver’s team.
If a new joystick has been connected to the computer and does not show up in the Controllers Available panel, use the Rescan button to make the FCS detect that joystick.

If a controller has been incorrectly assigned, click the Driver1 or Driver2 button next to that particular controller to undo the assignment.

Press the Reset All button to undo all assignments.

To continue on to the next screen, click OK.

Samantha Field Control System Application Screen:
Click OK on the Assign Controllers screen to navigate to the main screen of the FCS. The Setup Joysticks button can be used to return to the Assign Controllers screen.

The FCS window screen generally changes each season, depending on the format of the game for that season, as well as any new technologies that were introduced.

The image below is an image of the FCS before the Samantha Module has been connected to the FCS. To connect with the Samantha Module, click the Connect button.

After clicking the Connect button, the Teams Found window will appear. Click the appropriate name for the team's Samantha Module and then press OK.
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After selecting the correct Samantha Module, click Connect. If a program is running on the NXT Brick connected to the Samantha Module, the following screen will appear.

![Screen shot of Samantha Field Control System Application with options for Main Control, On Deck, Autonomous, and Current Teams with various buttons and information for FTC and Blue Team 1 and 2.]

When the Details button has been clicked, the relevant details of the Samantha Module will appear in the Details window. For additional details about the Wi-Fi network that Samantha is using, click the IP Address Link.

![Details window showing Team Logo, NXT Name, IP Address, Robot Battery Voltage, NXT Battery Voltage, Team Program Name, Current Running Program, Free Flash, Firmware, Protocol, and Last Error with OK and Display Logo on Timer buttons.]

When the IP Address link has been clicked, detailed information will appear in the default web browser window and can be studied as needed. Notice that the list of files stored in the NXT will not be available while Samantha is connected to the FCS. This information can be obtained by refreshing the page after the Samantha Module has been disconnected.
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Samantha Information
VERSION: V1.49/Nov 2 2010

SSID	AUTHENTICATION
PRIMARY: FTC_FIELD	[PSK]
SECONDARY: FTC_FIELD	[PSK]
OTHER:

HOSTNAME: NXXFTC
DHCPCHECKED: Enabled
IP ADDRESS: 192.168.2.104
GATEWAY: 192.168.2.1
SUBNET MASK: 255.255.255.0
DNS: 192.168.2.1
MAC ADDRESS: 00:1E:0C:01:0A:33
ACCEPTING FCS CONNECTIONS FROM: 192.168.2.186
FCS CLIENT IP ADDRESS: 192.168.2.186
BRICK STATUS: Connected
BATTERY VOLTAGE: 13.033V
USB VOLTAGE: 5.118V
LAST ERROR:

Total Message Stats
COUNT
BYTES
RECEIVED 480 584
SENT 479 6708

Joystick Message Stats
WAIT AUTONOMOUS: 0
AUTONOMOUS: 0
WAIT TELEOP: 0
TELEOP: 0

Lego Mindstorm Brick Information
BATTERY LEVEL: 8.172 volts
BLUETOOTH: On

# FILE NAME	FILE SIZE
1 NVConfig.sys	36
2 FTCConfig.txt	14
3 Advanced.rxe	1561
4 FTC Teleop.rxe	1581
5 FTC Autonomous.rxe	1542
6 Autonomous.rxe	800
7 Program Chooser.rtm	1044
8 Worts.rmx	4699
9 : Startup.rso	8161
10 : Click.rso	431
11 : Attention.rso	1733
12 faceopen.ric	316
13 faceclosed.ric	316
14 Touch.rtm	376
15 Sound.rtm	560
16 SONAR.rtm	1507
17 Light.rtm	322

File list is unavailable while FCS is connected
Another button available in the FCS is the **Setup Matches** button which can either be used to load matches from a file, save them to a file, or can be filled in by the user. This can be done by clicking once on the cell that needs to be changed and entering the value.

Click **OK** after setting up the matches to exit the window.

The last button in the FCS window is **Configuration**. It can be used to edit the length of matches, as well as the colors for warnings and errors. To undo any changes, simply click the **Defaults** button. An image of the Configuration window can be seen below.