

Camera setup

Procedure

- 1. Got to NCTCAMVIEWER upload the colormaps to the NCTCam. During this procedure, you don't need to have NXT program running, you can just run the NCTCamViewer on its own.**
- 2. Once the colormaps are uploaded to the camera, close the NCTCamViewer program, disconnect the USB cable from the camera from PC.**
- 3. turn on NXT, run the NXT software, open the program you want to download. Make sure I2C cable is connected to the camera and LED in the back of the camera is on. Now run the changaddr program on the NXT brick to check what address camera is connected to. Then make sure you assign that address to the camera in the program.**
- 4. download the program to the NXT brick and run the program.**

What is NXTCam

NXTCam is a real-time image processing engine. Think of it as a vision sub-system with on-board processor and a protocol interface that is accessible through a standard NXT sensor port. This interface provides high-level, post-processed information of the image NXTCam sees. The processed information contains the bounding box coordinates of the objects of interest in view of NXTCam, in line tracking mode, this information contains coordinates of line segments.

NXTCam does not send the image itself to NXT, however connecting NXTCam to a PC with USB cable, and using a Viewer and Configuration software, you can see the image on the PC.

NXTCam Feature List

The NXTCam provides following capabilities:

- Track up to 8 different colorful objects at 30 frames/second
- Configure the NXTCam using USB interface on Windows XP, Windows Vista.
- Supports two tracking modes: Object tracking and Line tracking.
- Provide real-time tracked object statistics (number of objects, color of objects, bounding box coordinates or line coordinates) through a standard NXT sensor port.
- Tracked image resolution of 88 x 144 pixels at 30 frames/second
- Perform full-resolution (176 x 144) pixels color image dumps to PC via USB port.
- Maximum power consumption (42 mA at 4.7 V)
- Uses NXT compatible I2C protocol for communications.
- Supports Auto Detecting Parallel Architecture (ADPA) for NXT sensor bus.

This means that NXTCam can coexist with LEGO or third party digital sensor on the same NXT port. ADPA support enables user to employ several sensors on the same port without the need of external sensor multiplexer, reducing the overall size without compromising the functionality.

What you will need before using NXTCam

1. Connector Cables

For runtime operations (on the robot, in autonomous mode), the NXTCam connects to NXT on a sensor port using a standard connector cable that comes with NXT (the one with jacks similar to phone jacks).

For offline operations (for programming and configurations), NXTCam connects to PC using mini-USB cable. (This is in addition to the cable you would use to connect NXT to your PC). Adjacent picture shows the mini-USB connector you would need on your USB cable, this connector is commonly used for digital cameras. If you need to acquire a cable separately, it should be a '5 wire' cable.

WARNING

Do not connect the NXTCam to any motor port, as the voltage applied by the motor port may damage the electronics of NXTCam.

During offline operations, such as programming and configuration, NXTCam must be connected to PC (using USB cable) as well as NXT (using standard NXT connector cable) while NXT is powered ON. During runtime (or autonomous) operations on NXT, the USB connection to PC must be removed.

NOTE: While NXTCam is connected to NXT as well as PC, the **PC communication takes priority over any other communication**. In other words, while NXTCam is connected to PC as well as NXT, if you run a program on NXT, it will not be able to talk to NXTCam.

2. Mounting NXTCam on your contraption

The holes on the NXTCam enclosure are designed for tight fit of Technic pins (or axles) with '+' cross section. The holes however are not designed for repeated insertions/removals of these pins. To mount NXTCam v2 on your contraption we suggest that you use two dark gray 'Technic Axle 3 with Stud' as shown. Insert axles from the front (lens side) of the NXTCam and secure with a bushing on the back or mount it on your contraption directly. Alternately, you may use blue 'Technic Axle' as shown.

While disassembling contraption, leave the axles and/or pins on



LED on NXTCam

The **yellow LED in the back** on NXTCam lights up whenever NXTCam is supplied with power. Under normal operations, **the power will be supplied by NXT from the sensor port**

3. USB Driver installation

In order for NXTCam to work properly, you will need to install USB drivers for your operating system. Currently support exists for:

- Windows XP (i386 and AMD processors)
- Windows Vista (i386 and AMD processors)
- Mac OS X v10.4.10 (PowerPC G4)

Download the drivers and installation instructions from following location:

http://www.mindsensors.com/NXTCam_Driver_Installation.htm

Installation instructions for Windows Vista

Login as Administrator

Download drivers and extract in a folder say: C:\User\Admin\nxtcam_v1p1

Connect camera and look for Found New Hardware window to appear.

In this window, select Locate and Install driver software (and give permission to continue).

Subsequently, select 'I don't have disc, show me more options...'

Then select the choice to 'Browse my computer ...' and select folder

C:\User\Admin\nxtcam_v1p1\nxtcam

Vista may popup a window informing 'Cannot verify the publisher of this driver software...'

At this point choose 'Install this driver software anyway'

Follow the same steps for second driver installation:

Go to C:\User\Admin\nxtcam_v1p1\nxtcam again

Instructions for Windows XP

Download USB Driver ZIP file to your disk and unzip in a folder, say c:\nxtcam_v1p1

Connect NXTCam to USB Port.

The New Hardware Wizard will pop up, in this wizard, select:

(*) Install from a list or specific location.

Next, uncheck

[] Search removable media

and check

[x] Include this location to search.

Specify path with 'nxtcam' subfolder. e.g. c:\nxtcam_v1p1\nxtcam **

In the next step, a dialog may inform you that the driver has not passes the Windows Logo test for compatibility.

Select 'Continue Anyway'.

Files Needed Dialog box:

In the next step, if a dialog box appears asking for path of sys files, provide the path you gave in prior step followed by \i386. (or directory for your processor)

e.g. c:\nxtcam_v1p1\nxtcam\i386 **

When the New Hardware Wizard pops up again, follow the same steps.

NXTCam is ready to use upon completion of these steps.

**** NOTE:** Depending on configuration of your NXTCam firmware you may have to use subfolder 'nxtcam' or 'ftdichip'.

4. Installation Instructions for NXT-block commands for the camera:

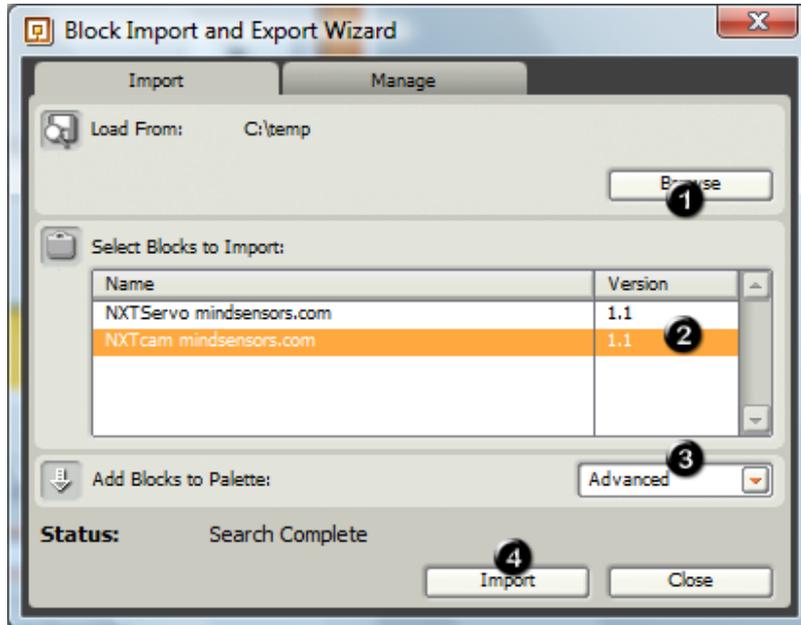
- a. Download the block(s) from:

http://www.mindsensors.com/index.php?module=documents&JAS_DocumentManager_op=viewDocument&JAS_Document_id=46

(filename: **NXTcam.zip**)

- b. Ensure that the downloaded file has .zip extension. If not, rename the file with .zip extension.
- c. Un-zip the files on your local machine (make a note of the directory.. the directory will be C:/.../NXT cam).
- d. Open NXT-G 'Block Import and Export' wizard (please see the figure below)
(If you are using NXT-G 1.0, you must have the Dynamic Block Update installed - from <http://mindstorms.lego.com/Support/Updates/>, but our version is 1.1 so you don't need to do this!!!!!!!!!!!!)

1. Click on the Browse button and Select the directory you extracted the files to and Click OK.
2. Select the block you need to install
3. Select the Advanced Palette
4. Click on Import Button



- e. Answer 'Yes' to any 'Replace ...' popup that might show up

5. Viewer and Configuration Software

To see the picture that's in the field of view of NXTCam, capture that picture for analysis and configure the Colormaps for onboard processing, you will need to install and use Viewer and Configuration software on your PC.

For MS-Windows XP/Vista, download Viewer and Configuration software from:

http://sourceforge.net/project/showfiles.php?group_id=203058/

For Macintosh, download Viewer and Configuration software from:

<http://www.mindsensors.com/index.php?>

[module=documents&JAS_DocumentManager_op=viewDocument&JAS_Document_id=](http://www.mindsensors.com/index.php?module=documents&JAS_DocumentManager_op=viewDocument&JAS_Document_id=)

53

Make sure you run and install the NXTCamView !!! After you have finish installation, please use the following video to help configurate the colormap for onboard processing:

1. [Setting up COMPorts \(300k\)](#) - how to configure the COMPort to connect to the NXTCam
2. [Capture and Select \(4meg\)](#) - how to connect to the NXTCam, capture an image, and select colors to track
3. [Testing Tracking](#) - how to test the tracking (*Sorry - this is not ready yet...*)
4. [Sample Capture \(48meg\)](#) - sample run of a capture, color selection and tracking. NOTE: This is a **BIG file** (48Meg) and may take a while to download!

The main purpose of NXTCamView is to teach the NXTCam which colors to track. Colors are setup in ranges that are uploaded and stored in the NXTCam.

To teach the NXTCam colors -

1. Download, install and start NXTCamView on your PC.
2. Ensure the two NXTCam drivers (USB-to-Serial and NXTCam) have been installed on your PC.
3. Ensure the NXTCam is plugged into one of your PCs USB ports.
4. In NXTCamView, setup communications to the NXTCam via **Tools\Options**. Often only the COMPort needs to be set.
5. **Connect** to your NXTCam.
6. **Capture** an image (or two) to check the focus and lighting conditions.
7. **Select** some colors to track by clicking on the image you captured. Colors are shown as ranges of red, green and blue (min/max values of each). You can add or remove colors from a range by holding down the "CTRL" key or "SHIFT-CTRL" keys while clicking.
8. **Upload** the color ranges into the NXTCam.
9. Test your colors in the **Tracking** window to see what object blobs are returned.
10. **Disconnect** NXTCamView from your NXTCam.

Now you're ready to start coding!

More on configuring colormaps in NXTCam

Default Object Colormap

The NXTCam is shipped with a default Colormap to track a light source. Download a test program or write a test programs, and try tracking a light source.

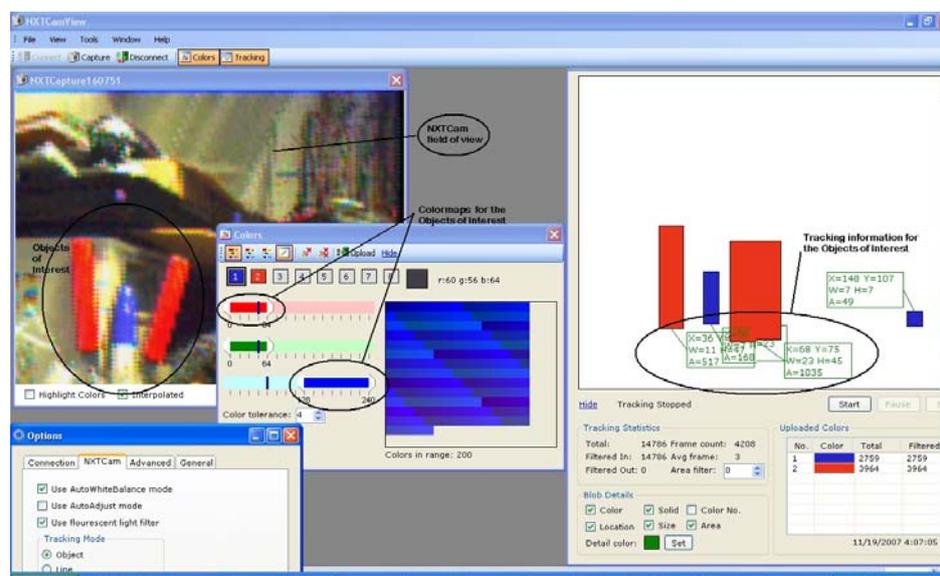
Objects of interest

Below are screen dumps of NXTCamView software, showing objects of interests and their tracking information.

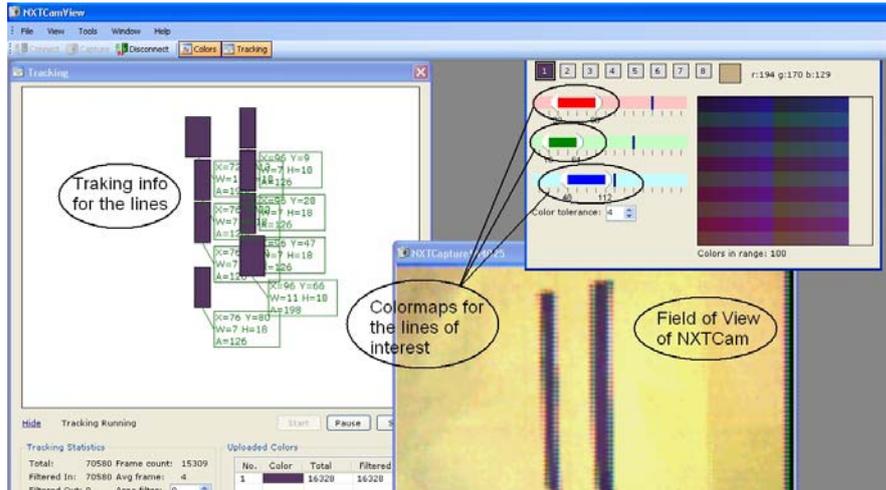
The top left window in the picture below shows the field of view of NXTCam.

The objects of interest from this view are the red and blue pens. In the object tracking mode, the bounding box coordinates are returned, as shown:

mindsensors



In line tracking mode, beginning point and end point coordinates of a line representing the object are returned. In the following picture, the bounding boxes are drawn for the line coordinates received from NXTcam:



More about Colormaps

The objects of interest are recognized by NXTCam by matching the stored color values with the captured image. To do that, color values of the objects of interest need to be stored on NXTCam. These color values are known as Colormaps. NXTCam can store up to 8 Colormaps and provide processed information of the objects matching those Colormaps.

For more information on how to pick Colormap values of your objects of interest and how to store them on NXTCam using the NXTCamView software, please refer to section 'teaching NXTCam colors' from URL: <http://nxtcamview.sourceforge.net/> Also watch a demo video 'Capture and Select' at following URL: <http://nxtcamview.sourceforge.net/DemoScreenCam.htm>

Tips on using NXTCam in your environment

Object Colors in Line Tracking Vs Object Tracking Modes

In the object tracking mode, you can track objects comprising of 8 distinct colors. While selecting colors, avoid any overlap between colors of different objects. In line tracking mode, only the first color from the Colormap is used, and it is recommended to limit the number of colors to one.

Lighting conditions

The NXTCam is designed to operate under **white fluorescent light**. If you notice **reddish image color, which tends to happen when your environment has lot of ambient Infrared light**, try to find the source of Infrared light and reduce it by replacing it with fluorescent light.

For advanced operations it is possible to change color gain, brightness and contrast of NXTCam by manipulating the I2C register values.

Focus

As a factory default, NXTCam lens is set for optimal focus **between 2 and 4 feet**. The lens is screwed in it's holder and it is designed to be tight to prevent accidental rotation and loss of focus. **To refocus the lens, gently turn the lens from the holder, capture images and see if the new focus is satisfactory. Do not apply excessive force, as it may damage the lens. For better grip while turning lens, you may wrap a rubber-band around the exposed threads of the lens.** To check the focus, you can use Viewer software and perform a 'capture' and see the results.

Updating your Colormap

Human eye (and brain) is conditioned to adapt to ambient light conditions and see. Whereas based on ambient light, the colors of objects appear different to a camera CCD. In other words, a blue ball in your laboratory lighting conditions will appear to be a different shade of blue than in Gymnasium lighting. Considering this aspect, **ensure to update your NXTCam Colormap based on your final lighting conditions.**

Changing the I2C Bus Address

The factory default I2C address of NXTCam is 0x02.

This address can be changed. To set an address different from default address, send sequence of following commands on the command register:

0xA0, 0xAA, 0xA5, <new I2C address>

Note: Send these commands with no break/read operation in between. This new address is effective immediately. Please note down your new address carefully for future reference.

Alternately, you can download address scan and change functions written in RobotC from following URL, and change them to suit your needs:

http://www.mindsensors.com/RobotC_Utility_Programs.htm

Troubleshooting NXTCam communication

Troubleshooting NXTCam communication with your PC

To ensure USB drivers are installed properly, follow these steps:

1. Ensure to install the USB drivers as mentioned in this document.
2. Connect the NXTcam using a USB cable to your computer.
3. From Start menu -> Right click on Computer, select 'Properties', select 'Hardware' tab, and select the 'Device Manager'.
4. Expand the 'Universal Serial Bus Controller' entry.
5. You should see 'NXTCam' listed.
6. In the same Device Manager, Expand 'Ports (COM & LPT)' entry.
7. You should see a COM port listed for NXTCam (this is the COM port you should use for your viewer software configuration).

To ensure actual USB communication, follow these steps:

1. Connect the NXTcam using a USB cable to your computer.
2. Run Hyperterminal: Start -> All Programs -> Accessories -> Communication -> Hyper Terminal
3. Give a name for the configuration, say 'mynxtcam'.
4. In the next dialog box specify:
Connect Using: <NXTCam COM Port> (the port you noted from Ports (Com and LPT) entry in Device Manager)
5. Click OK.
6. In next window Specify:
Bits per second: 115200
Data bits: 8
Parity: None
Stop bits: 1
Flow Control: None
7. Click OK.
8. In the main terminal window, just press <enter>
You should get a response from NXTCam as 'NCK'
9. In the same window, type:
GV<enter>
You should get a response from NXTCam as 'NXTcam V n.n' (where n.n is your NXTcam version number)

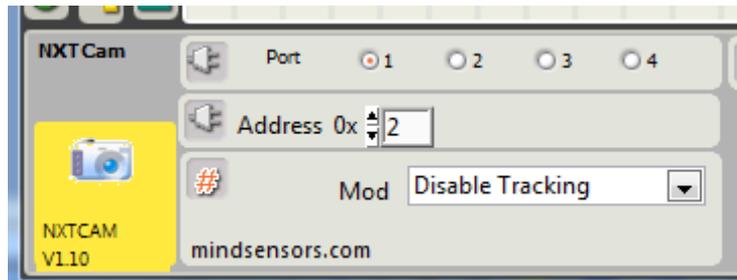
Troubleshooting NXTCam communication with your NXT

Ensure to install NXT-G blocks for NXTCam as mentioned above in the document.

1. Connect your NXT to your PC using its standard USB cable.
2. Connect your NXTCam to NXT Port 1 using standard NXT sensor cable.

3. Run NXT-G software on your computer.
4. Power on the NXT.
5. Start a New Program (say Untitled-1), and from Advanced Block Palette, drag and drop the NXTCam block in it.
6. Click on the block, and examine the bottom left corner of NXT-G window (where block control panel is located).

7. You should see NXTCam version number shown in the bottom left corner, as shown in the adjacent picture.



8. If the NXTCam is not connected correctly to your NXT, this status will indicate 'No Device'. If that happens, ensure the port and Address in your program match to what's on NXTCam.

More references on NXTCam

Welcome to the NXTCam community wiki! This is an **open public wiki**, so anyone can add or edit content. Please help grow the NXTCam knowledgebase by contributing to these pages.

-

FAQ	Frequently Ask Questions
Camera Registers	Registers accessible via NXTCamView
I2C Interface	Commands, registers and their usage
Code Samples	Code samples in RobotC and other languages
Projects	Add your cool NXTCam project here!
Known Issues	Current issues
Line Traking Mode	Example of Line Traking Mode

1. What is NXTCamView?

NXTCamView is a Windows application that configures and controls the NXTCam produced

by [mindsensors](#). NXTCam is a camera sensor that provides real-time vision recognition to NXT Lego robots. It uses simple color recognition to detect objects in its view. NXTCam is based on AVRCam and AVRCamView by John Orlando and Brent Taylor at [jrobot](#).

2. Do I need a camera from mindsensors?

Yes - NXTCamView is intended for use with the [NXTCam camera sensor](#) produced by [mindsensors](#), however, it should still work with original AVRCam by jrobot.

3. I don't see NXTCam as a valid COMPort in the Options/Connections page

You may not have installed the 2 drivers needed by windows to connect the NXTCam as a USB serial port. One driver is for NXTCam, the other is for UBS to Serial conversion. Details on downloading and installing the drivers can be found at the [mindsensors download page](#).

4. Why do my captures looks fuzzy?

The NXTCam does not capture at a very high resolution so the pictures will never be as clear as those on a modern digital camera, however, you do need to make sure the camera lens is focused on the object you are capturing. To change the focus you twist the lens on the front of the camera. You can keep capturing until you get a clear image. If your pictures don't improve with focus, you can try changing some of the capture options under Options/NXTCam. You can change the AutoWhiteBalance and AutoAdjust settings to see if that improves your capture.

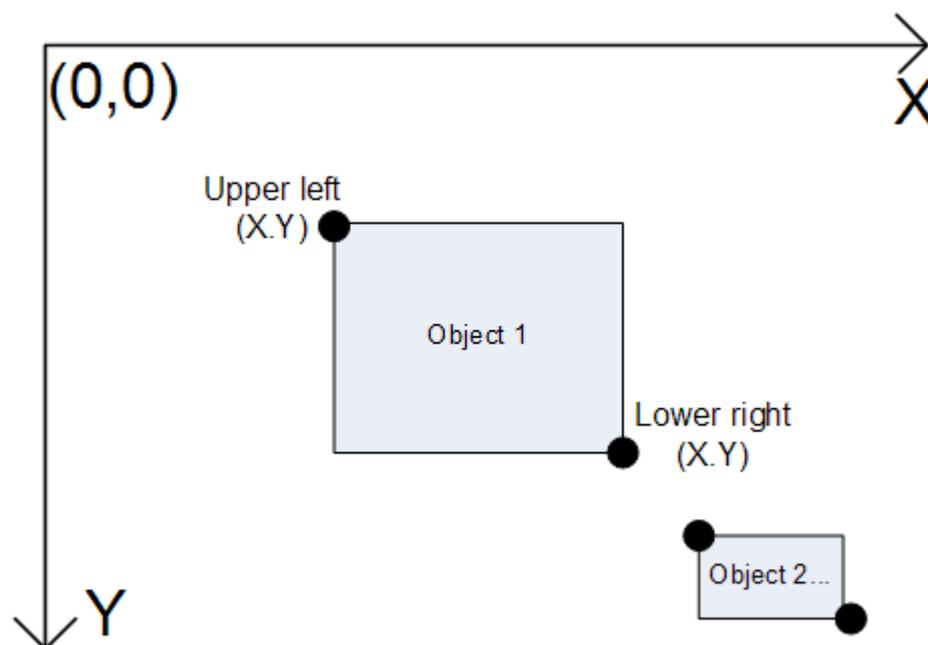
5. What is the meaning of "upperleft" and "bottomright" returned by NXTCam?

These are the coordinates of two corners on a rectangle for each color object found. The

horizontal axis (x) starts on the left of the image and increases moving right. The vertical axis (Y) starts at the top and increases moving down. The coordinates for a detected object are the points at the topleft and bottomright corners of the rectangle that represents the object. There may be more than one object detected, so generally you should enable the sort-by-size mode and use the first object given.

You can use NXTCamView to see these objects moving in real time using the Tracking mode after you have uploading your color settings.

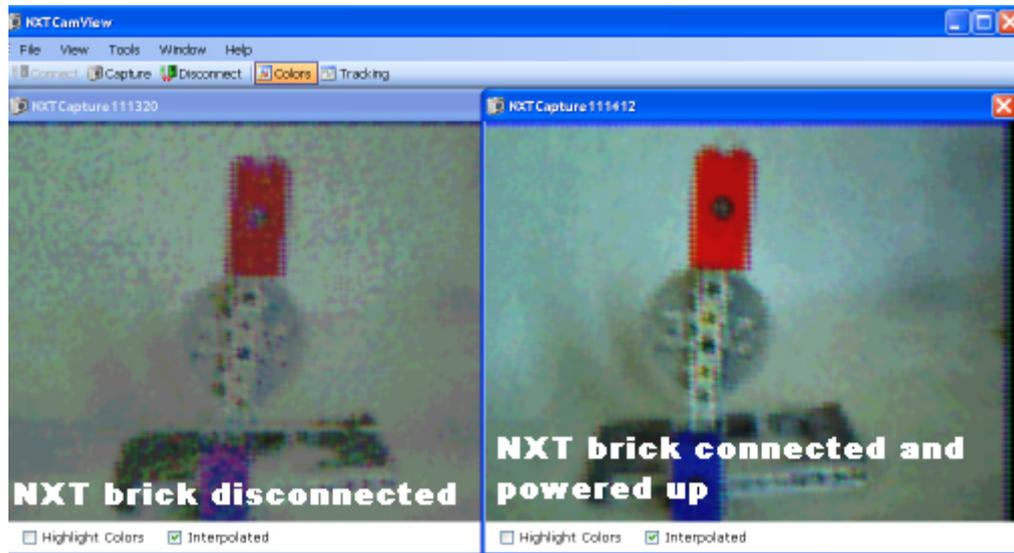
This diagram show the placement of the axis and two objects with their relevant corners.



6. How can I get better color recognition with the NXTCam?

In my experience I have found that capturing images from the NXTCam with the brick (sensor cable) disconnected from the NXTCam will return subdued colors in the image. With the NXTCam connected to the brick and brick power up, the colors captured in NXTCamView are

much richer.



When using the richer colors to create and upload colormaps I get better object tracking when running a program on the brick (with USB-PC cable disconnected).

Note: The act of disconnecting the USB-PC cable sometimes causes the NXTCam to crash (return zero objects when running a program on the brick). I fix this by power cycling the brick (turn off the brick, disconnect the NXT sensor cable and the USB-PC cable, count to five (about 5 seconds), connect the NXT sensor cable, turn on the brick and run the program).

6. How to Use the NXTCam on NXT?

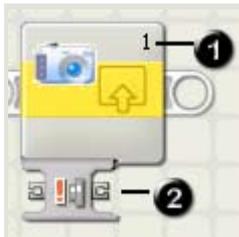
First you must teach the camera to identify color you want using nxtview software you just installed.

This block interfaces with NXTCam from mindsensors.com.

At setup time, NXTCam allows you to define object(s) in its environment by color.

At runtime, it can track object(s), and provide you its color and bounding box.

Display Settings

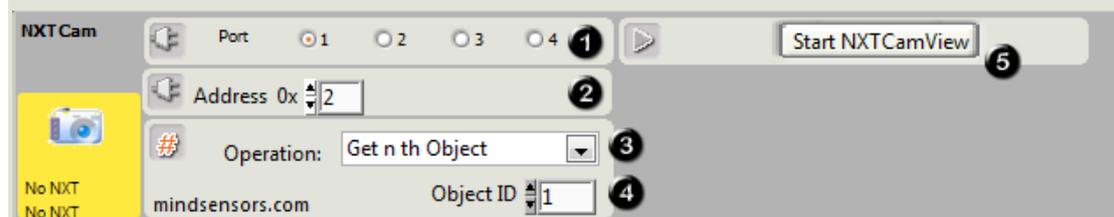


The number (1) above shows which of your NXT's ports are connected to the NXTCam.

Number (2) above shows the mode of operation.

You can change this number in the configuration panel if you need to.

Configuring the NXTCam Block



In your NXT-G program, to begin tracking operation, you should add a block with "Enable Tracking" operation.

This block should then be followed by a block to 'Get First Object'.

At this time, from this block you can read the number of objects being tracked.

If you have more than one objects, subsequently, you can use 'Get n th Object' to get information of 'n'th object.

Note: if 'n' value supplied is larger than number of objects found, 'Get n th Object' operation will yield invalid data.

In other words, if NXTCam finds 3 objects, Get n th Object operation for 4th/5th/6th/7th/8th object will yield invalid data.

When you are done tracking, to conserve power, insert a block with 'Disable Tracking' Operation.

1. The Port number to which NXTCam is supposed to be connected. Ensure that the connector cable is connected to correct port. You can change this value to suit your configuration.
2. The I2C address of this device. Usually you will not need to change this.
3. The mode of operation for NXTCam, supported operations are as follows:

1. Disable Tracking - stop the tracking, do this to conserve the battery power.
2. Get First Object - Upto 8 objects are tracked by NXTCam, for most applications first object is of utmost importance.
3. Get n th Object - For advanced applications to get a specific object.
4. Enable Tracking - when you are ready to start tracking your objects, this energizes the camera chip (consuming power) and begins processing the images.
5. Sort Objects by Size - the objects tracked could be of varying sizes, this option sorts them by the size before while processing the image. (Get First Object will return you the largest object).
6. Sort Objects by Colors - the objects tracked could be of varying colors, this option sorts them by color while processing the image. (Get First Object will return you the object with color 0)
7. Illumination on - For future use.

8. Illumination off - For Future use.
9. Write Colormap - Write the Colormap to NXTCam memory.
10. Camera Settings - For advanced operations.
11. Line tracking mode - NXTCam supports Line Tracking mode and Object tracking mode. This option enables Line tracking mode.
12. Object tracking mode - This enables Object tracking mode on NXTCam. This is also the default mode (factory set).

4. Object ID - you can enter the object ID when you select 'Get nth Object' mode of operation.
5. This button starts NXTCamView program. If you have not already, please install NXTCamView program [developed by Paul Tingey from here](#).

NXTCam Block's Data Hub Plugs



1. Port number to which NXTCam is supposed to be connected.
2. I2C address of this sensor.
3. This plug allows you to select mode of operation, use appropriate numeric value for your mode.
4. Total Tracked Objects : Total number of objects found (you may retrieve these objects using subsequent block with 'Get n th Object' operation).

- This value ranges from 0 to 8, 0 indicating no objects found.
- When this value is 0, remaining values (X/Y coordinates and color number will not be valid)

5. Color: Color number from the colormap of the current object identified.
 6. X Upper Left : The Upper left X coordinate of the objects' bounding box.
 7. Y Upper left : The Upper left Y coordinate of the objects' bounding box.
 8. Y Lower right : The Lower right Y coordinate of the objects' bounding box.
 9. X Lower right : The Lower right X coordinate of the objects' bounding box.
- a. Boolean value for successful tracking.
 - b. Object ID you want to track when your operation is 'Get nth Object'.

- This value is ignored if you specify Operation as 'Get First Object'.

For further details, please [download the User Guide](#).

SAMPLE programs

<http://nxtcamview.wiki.sourceforge.net/Projects>

<http://nxtcamview.wiki.sourceforge.net/>

Additional Info on setup the camera please refers to the link:

http://www.mindsensors.com/index.php?module=pagemaster&PAGE_user_op=view_page&PAGE_id=78

Reference Information

Wiki for NXTCamView, NXTcam and related Projects and findings

Visit following URL for the wiki

<http://nxtcamview.wiki.sourceforge.net>

Open Source Software and Hardware

NXTCam is based on [AVRcam](#), and is Open Source using GNU license. We encourage you to improve the source code and features and inform us the changes for inclusion in future releases. Visit following URL to download the source code and related docs.

http://www.mindsensors.com/NXTCam_Source_Code.htm

Programming Environment(s)

NXTCam is supported for use in NXT-G using a custom block.

Download the block from following URL:

http://www.mindsensors.com/NXTCam_NXT-G_Block.htm

This block provides functionality for tracking objects based on the Colormaps downloaded on NXTCam.

Follow the installation instructions provided at this URL to install the block.

Note: While using with NXT-G, ensure to use firmware version 1.05.

LeJOS API's are available at:

http://lejos.sourceforge.net/p_technologies/nxt/nxj/api/lejos/nxt/NXTCam.html

RobotC API's are available at:

<http://www.mindsensors.com/index.php?>

[module=documents&JAS_DocumentManager_op=viewDocument&JAS_Document_id=50](http://www.mindsensors.com/index.php?module=documents&JAS_DocumentManager_op=viewDocument&JAS_Document_id=50)

I2C Operations

Pins used: SDA(1), GND(2), SCL(3), +5V(4)

Following table

Commands		Action
ASCII	Hex	
A	0x41	Sort tracked objects by size
B	0x42	Select Object tracking mode
C	0x43	Write to Camera Registers <i>Use extreme CAUTION when using command C since this can stop your camera working properly. In case this happens, please power off your NXTCam</i>

		and power it on again.
D	0x44	Disable Tracking
E	0x45	Enable Tracking
G	0x47	Get the Color map from Camera Engine
H	0x48	Read data from the Camera Registers
I	0x49	Illumination on (Future)
L	0x4C	Select Line tracking mode
N	0x4E	Set ADPA mode ON (setting stored in NVRAM)
O	0x4F	Set ADPA mode Off (default) (setting stored in NVRAM)
P	0x50	Ping camera Engine
R	0x52	Reset Camera Engine
S	0x53	Send the color map to camera Engine
T	0x54	Illumination Off
U	0x55	Sort tracked objects by color
V	0x56	Get camera Engine firmware version No, Read resulting string at 0x42 (12 bytes).
X	0x58	Do not Sort tracked objects

I2C Registers:

The NXTCam appears as a set of few registers as follows.

Register	Read	Write	Comments
0x00-0x07	Software version - (Vh.nn)	-	
0x08-0x0f	Vendor Id - mndsnrs	-	
0x10-0x17	Device ID - NXTCam	-	
0x41	-	Command	This register is command register. A command written here will be executed.
0x42	Number of objects detected	-	Shows how many objects are being tracked. Zero indicates that there are no objects being tracked.
0x43	1 st object color	-	This is the first object color as per the sorting method selected.
0x44 ¹	1 st object - X upper left		Upper left X coordinate of first object
0x45	1 st object - Y upper left		Upper left Y coordinate of first object
0x46	1 st object - X lower right		Lower right X coordinate of first object
0x47 ²	1 st object - Y lower right		Lower right Y coordinate of first object
0x48	2 nd object color		
0x49-0x4C	2 nd object co-ordinates		
0x4D	3 rd object color		
0x4E-0x51	3 rd object co-ordinates		
0x52	4 th object color		
0x53-0x56	4 th object co-ordinates		
0x57	5 th object color		
0x58-0x5B	5 th object co-ordinates		
0x5C	6 th object color		
0x5D-0x60	6 th object co-ordinates		

¹ In case of line tracking mode, these are coordinates of beginning and end points of the line.

² This repeats for all 8 objects. Please note that object position and coordinate are overwritten if new

object is detected, otherwise previous value is retained.

Register	Read	Write	Comments
0x61	7 th object color		
0x62-0x65	7 th object co-ordinates		
0x66	8 th object color		
0x67-0x6A	8 th object co-ordinates		
0x6B	No. of registers to Read	No. of registers to Write	This is the number of registers you need to read or write from camera image sensor
0x6C	1 st Camera register Address	1 st Camera register Address	
0x6D ³	1 st Camera register Data	1 st Camera register Data	1 st register Data read from image sensor or written to image sensor
.....	
0x7A	8 th Camera register Address	8 th Camera register Address	
0x7B	8 th Camera register Data	8 th Camera register Data	
0x80 ⁴	Color map data Red 0	Color map data Red 0	0x80 - 0xAF - These registers are used for Colormap data reading and writing
0x80	Color map data Red 0	Color map data Red 0	
0x81	Color map data Red 1	Color map data Red 1	
0x82	Color map data Red 2	Color map data Red 2	

³ If you need to read image sensor register 0x00 (i.e. 1 register) then follow this:

Write 0x01 to register 0x6B, Write 0x00 to register 0x6C

Run command 'H'

Results will be stored in register 0x6D

If you need to write to image sensor register 0x00 (i.e. 1 register) then follow this:

Write 0x01 to register 0x6B, Write 0x00 to register 0x6C, Write data to register 0x6D

Run command 'C'

⁴If you need to read Colormap data from camera engine, then follow this:

Run command 'G'

Read registers 0x80 – 0xAF.

If you need to write Colormap data to camera engine, then follow this:

Write your color map data in registers 0x80 – 0xAF,

Run command 'S'

Register	Read	Write	Comments
0x83	Color map data Red 3	Color map data Red 3	
0x84	Color map data Red 4	Color map data Red 4	
0x85	Color map data Red 5	Color map data Red 5	
0x86	Color map data Red 6	Color map data Red 6	
0x87	Color map data Red 7	Color map data Red 7	
.....	
0x8F	Color map data Red 15	Color map data Red 15	
0x90	Color map data Green 0	Color map data Green 0	
0x91	Color map data Green 1	Color map data Green 1	
.....	
0x9F	Color map data Green 15	Color map data Green 15	
0xA0	Color map data Blue 0	Color map data Blue 0	
0xA1	Color map data Blue 1	Color map data Blue 1	
.....	
0xAF	Color map data Blue 15	Color map data Blue 15	

Set up old RCX sensors and motors to NXT

1. please make sure you use the compatibility cable as shown

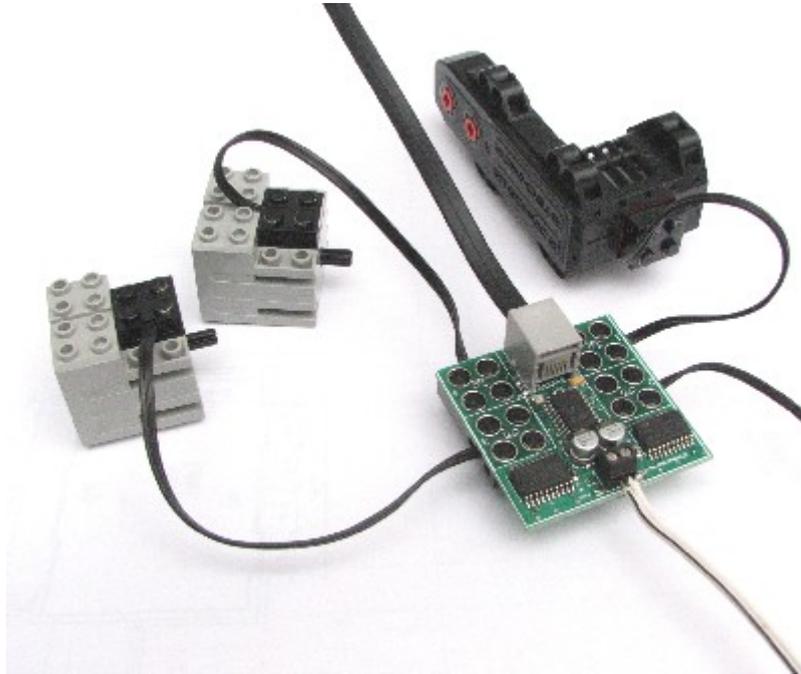


This cable allows you to use your old RCX sensors and motors with the NXT.

2. As of this writing, programming software of the retail version of NXT kit (8527) doesn't support the use of some RCX sensors such as rotation sensor, light sensor or temperature sensor. The old touch sensor will work fine when used with NXT touch sensor block. RCX motors will work too with NXT motor block but of course all advance features that depends of the built-in rotation encoder can't be used.
3. If you want to use all the sensors and motors with its original commands, please go to <http://mindstorms.lego.com/support/updates/> And download a file called **Legacy Block Library**. Uncompress the file and use the procedure described earlier in the NXT camera for the Installation Instructions for NXT-block commands and upload the library to the NXT program and you should be able to start using a NXT-block command specially design for the old RCX motors and sensors. Please remember that only way to control the duration of the motor require user to define a time loop for the motor now. Please ask your instructor if you are not sure what to do.

Motor multiplexer setup

Example Connections of MTRMX-Nx

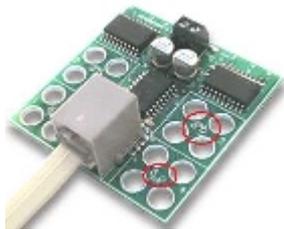


Picture here shows two RCX motors and one RC motor connected to the MTRMX-Nx. To conserve your main NXT batteries, the power hungry motors are supplied electricity from external battery connected to the white/black wire above.

Related Contraptions

[Deriving power from NXT to run MTRMX-Nx by Philo](#)

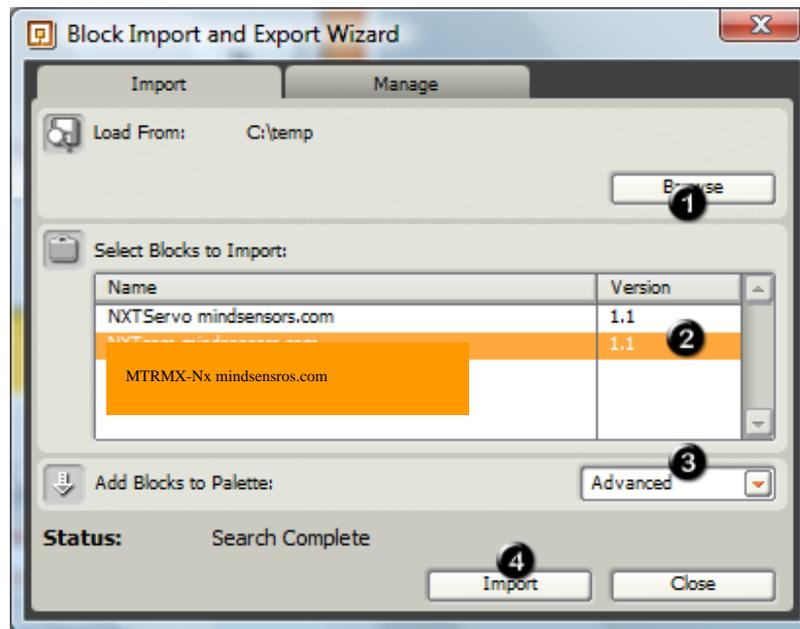
If you wish to connect regular DC motors to this -



You can connect regular DC motors (max 35 volts, 500 mA) to this MTRMX-Nx by attaching motor pins to the holes shown in adjacent picture. Connect your power supplied expected by DC motors to the power pins on MTRMX-Nx. The controller will provide same forward/reverse rotation with speed control as it would for RCX motors.

Installation Instructions for NXT-block commands for the motor

multiplexer:



- a. Download the block(s) from http://www.mindsensors.com/index.php?module=documents&JAS_DocumentManager_op=viewDocument&JAS_Document_id=31 (file name: **MTRMX-Nx.zip**)
- b. Ensure that the downloaded file has .zip extension. If not, rename the file with .zip extension.
- c. Un-zip the files on your local machine (make a note of the directory.. **most likely c:/...../ MTRMX-Nx**).
- d. Open NXT-G 'Block Import and Export' wizard
(If you are using NXT-G 1.0, you must have the Dynamic Block Update installed - from <http://mindstorms.lego.com/Support/Updates/>)
 1. Click on the Browse button and Select the directory you extracted the files to and Click OK.
 2. Select the block you need to install
 3. Select the Advanced Palette
 4. Click on Import Button
- e. Answer 'Yes' to any 'Replace ...' popup that might show up

Programming Techniques

NXT-G Method:

Download the block from Mindsensors' website.

RobotC Method:



You can use example program in C and robotC compiler to use MTRMX-Nx on your NXT robot.

NBC Method:

You can use example program in NBC and NBC compiler to use MTRMX-Nx on your NXT robot.

What is MTRMX-Nx

MTRMX-Nx is a legacy motor port expander for NXT. You can use it to attach up to 4 RCX motors to your NXT robot.

Following sections provide operation commands and register summary.

MTRMX-Nx Feature List

- Uses NXT compatible I2C protocol for communications.
- Drives four Lego motors with 255 speed steps and brake, float, forward and reverse options
- Is able to apply variable braking power.
- Able to drive any motor rated up to 35V/1A.
- Reverse polarity protection on motor supply side.

Connections

Connect MTRMX-Nx to any of the sensor ports of NXT by using standard NXT cable. Motors can be connected to MTRMX-Nx using standard legacy Lego cable.

Register	Read	Write
0x00-0x07	Software version - <i>V1.10</i>	-
0x08-0x0f	Vendor Id - <i>mndsnsrs</i>	-
0x10-0x17	Device ID - <i>MTRMUX</i>	-
0x41	-	Command
0x42	Direction Motor 1	Direction Motor 1
0x43	Speed Motor 1	Speed Motor 1
0x44	Direction Motor 2	Direction Motor 2
0x45	Speed Motor 2	Speed Motor 2
0x46	Direction Motor 3	Direction Motor 3
0x47	Speed Motor 3	Speed Motor 3
0x48	Direction Motor 4	Direction Motor 4
0x49	Speed Motor 4	Speed Motor 4

Motor speed can vary from 0 to 255. Direction register contains information about direction.

Following list provides possible values for commands in command register:

Value	Command
x00	Float
0x01	Forward
0x02	Reverse
0x03	Brake

I2C Bus address

Factory Default Address: 0xB4

Changing the I2C Bus Address:

MTRMX-Nx is shipped with a factory default I2C bus address.

Should you need to configure it then write following sequence on the command register without any break or read operation:

0xA0, 0xAA, 0xA5, <new I2C address>

New address becomes effective immediately. Please note down your new address of the device for future reference.

You can download the address change and scan functions from our

website at www.mindsensors.com. These functions are written in RobotC.

Sensor multiplexer setup

Features



RXMux allows you to connect upto 4 RCX style sensors to NXT.

RXMux supports following sensors:

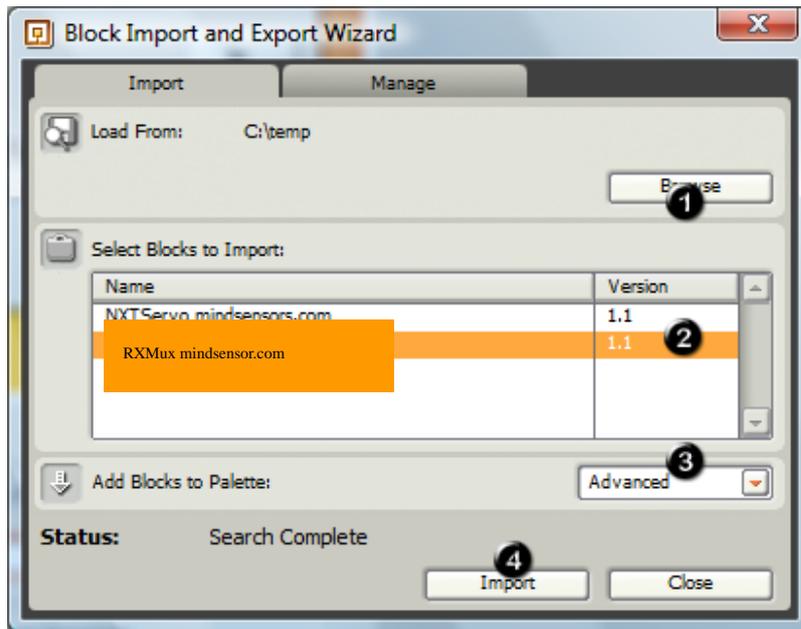
- RCX Touch Sensor
- RCX Light Sensor
- RCX Rotation Sensor
- RCX Temperature Sensor

Example



Picture above shows RCX Light sensor connected to RXMux.

Installation Instructions



- a. Download the block(s) from http://www.mindsensors.com/index.php?module=documents&JAS_DocumentManager_op=viewDocument&JAS_Document_id=43 (filename: **RXMux.zip**)
- b. Ensure that the downloaded file has .zip extension. If not, rename the file with .zip extension.
- c. Un-zip the files on your local machine (**make a note of the directory most likely c:/...../ RXMux**).
- d. Open NXT-G 'Block Import and Export' wizard
(If you are using NXT-G 1.0, you must have the Dynamic Block Update installed - from <http://mindstorms.lego.com/Support/Updates/>)
 1. Click on the Browse button and Select the directory you extracted the files to and Click OK.
 2. Select the block you need to install
 3. Select the Advanced Palette
 4. Click on Import Button
- e. Answer 'Yes' to any 'Replace ...' popup that might show up

What is RXMux

RXMux is a multiplexer designed to attach RCX style sensors to your NXT.

This can be used to attach upto 4 RCX sensors to NXT. Individual sensor can then be selected to read from. RXMux consumes between 2 to 4 micro Amps

depending on number of sensors attached.

Supported Sensors

RXMux supports following sensors:

- RCX Touch Sensor
- RCX Light Sensor
- RCX Rotation sensor *
- RCX Temperature sensor



NOTE

RXMux multiplexes between its channels. i.e. When one sensor channel is selected to read, other channels are not being read. In particular this needs to be considered while using a Rotation sensor on RXMux, while a different channel is selected, the rotations of that sensor are not registered.

Programming Techniques

NXT-G Method

Use the RXMux block to select the channel of the sensor you wish to read.

After selecting the channel, to read from that channel, use the usual NXT-G block designed for that RCX sensor.

The RXMux block may be downloaded from site:

http://www.mindsensors.com/index.php?module=documents&JAS_DocumentManager_op=viewDocument&JAS_Document_id=43

You may need to download the NXT-G blocks for RCX sensors from 'Legacy Block Library' section of LEGO website at:

<http://mindstorms.lego.com/Support/Updates/>

A sample NXT-G program is available at:

http://www.mindsensors.com/index.php?module=documents&JAS_DocumentManager_op=viewDocument&JAS_Document_id=27

Connections

Connect RXMux to NXT using standard NXT cable supplied with Mindstorms kit or Flexi-cable from mindsensors.com.

Connect your RCX sensors to the RXMux using the standard cables supplied with RCX kit. These cables are connected from the bottom of the RXMux as shown. While connecting, ensure to connect all four studs with electric contacts to RXMux.

While connecting a touch sensor directly to RXMux,



ensure to connect all four electric studs of Touch sensor to RXMux, as shown in adjacent picture.

Address and channel ID's

The I2C address for RXMux is 0x7E. To select a channel, write following command to RXMux at address 0x7E.

Deselect all channels	0xFF
Select Channel 1	0xFE
Select Channel 2	0xFD
Select Channel 3	0xFB
Select Channel 4	0xF7

RobotC Method

RXMux User Guide

Copyright © 2008 mindsensors.com 2/3

To select the channel of the RXMux, you need to send an I2C message to the RXMux indicating your channel number, and then read your sensor with usual RobotC API.

The function to select RXMux channel is as follows:

```
void RXmuxChannel(const tSensors RXMuxPort, byte RXMuxChannel)
{
  SensorType[RXMuxPort] = sensorI2CCustom9V;
  const byte RXMuxMSG[] = {2, RXMuxID, RXMuxChannel };
  while (nI2CStatus[RXMuxPort] == STAT_COMM_PENDING) {
    ; // Wait for I2C bus to be ready
  }
  sendI2CMsg(RXMuxPort, RXMuxMSG[0], 0);
}
```

The section 'Address and Channel ID' below explains the channel value to use.

This library function and a sample program for RobotC is available at:

http://www.mindsensors.com/index.php?module=documents&JAS_Document_Manager_op=viewDocument&JAS_Document_id=58

NBC/NXC Method:

To select the channel of the RXMux, you need to send an I2C message to the RXMux indicating your channel number, and then read your sensor with usual NXC API.

Use the library function and sample program at following URL:

http://www.mindsensors.com/index.php?module=documents&JAS_DocumentManager_op=viewDocument&JAS_Document_id=59