What is PixyAdapter

The PixyAdapter serves as an interface between the PixyCam (CMUcam5 from Charmed Labs) and Lego Mindstorms related controllers. The PixyAdpater enables users to program the PixyCam as if it were an NXTCAM.

PixyAdapter with PixyCam does not send the image itself to NXT/EV3, however connecting PixyCam to a PC with USB cable, and using a Viewer and Configuration software (PixyMon), you can see the image on the PC.

PixyAdapter with PixyCam is compatible with NXTCam-v4 and NXTCam-v3 software and libraries.

PixyCam

For information, specifications, and configuration, please read the PixyCam documentation at http://www.cmucam.org/projects/cmucam5 and http://www.cmucam.org/projects/cmucam5/wiki.

For help with PixyCam refer to http://www.cmucam.org/projects/cmucam5/wiki or ask a question on the PixyCam forum http://cmucam.org/projects/cmucam5/boards. Mindsensors can only provide support for the PiXyAdapter.

PixyAdapter Communication

- PixyAdapter uses NXT/EV3 compatible I2C protocol for communications to controllers.
- PixyAdapter uses Serial protocol for communication with PixyCam.
- Supports Auto Detecting Parallel Architecture (ADPA) for NXT sensor bus. This means that PixyAdapter 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 PixyAdapter

Connector Cables

For runtime operations (on the robot, in autonomous mode), the PixyCam connects to NXT/EV3 on a sensor port using a standard connector cable that comes with NXT/EV3 (the one with jacks similar to phone jacks).

For offline operations (for programming and configurations), connect PixyCam directly to the PC using mini-USB cable. If PixyAdapter is connected to the NXT/EV3, connection will fail to establish with the 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.

Viewer and Configuration Software, PixyMon

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

Download PixyMon software for your operating system from the following location:

http://cmucam.org/projects/cmucam5/wiki/Latest_release

Installation Instructions for your operating system can be found at the following locations:

For MS-Windows XP:

http://cmucam.org/projects/cmucam5/wiki/Install_PixyMon_on_Windows_XP

For MS-Windows Vista/7/8:

http://cmucam.org/projects/cmucam5/wiki/Installing_PixyMon_on_Windows_Vista_7_or_8

For Mac:

http://cmucam.org/projects/cmucam5/wiki/Installing_PixyMon_on_Mac_2

For Linux:

http://cmucam.org/projects/cmucam5/wiki/Installing_PixyMon_on_Linux

Configuring PixyCam

To configure the PixyCam for communication with the PixyAdapter:

- Open the PixyMon viewer and configuration software.
- Select 'Configure' from 'File' Menu.
- Select the 'Interface' tab under the 'Pixy Parameters' tab.
- Make sure the UART baudrate is 115200 and click 'OK'.
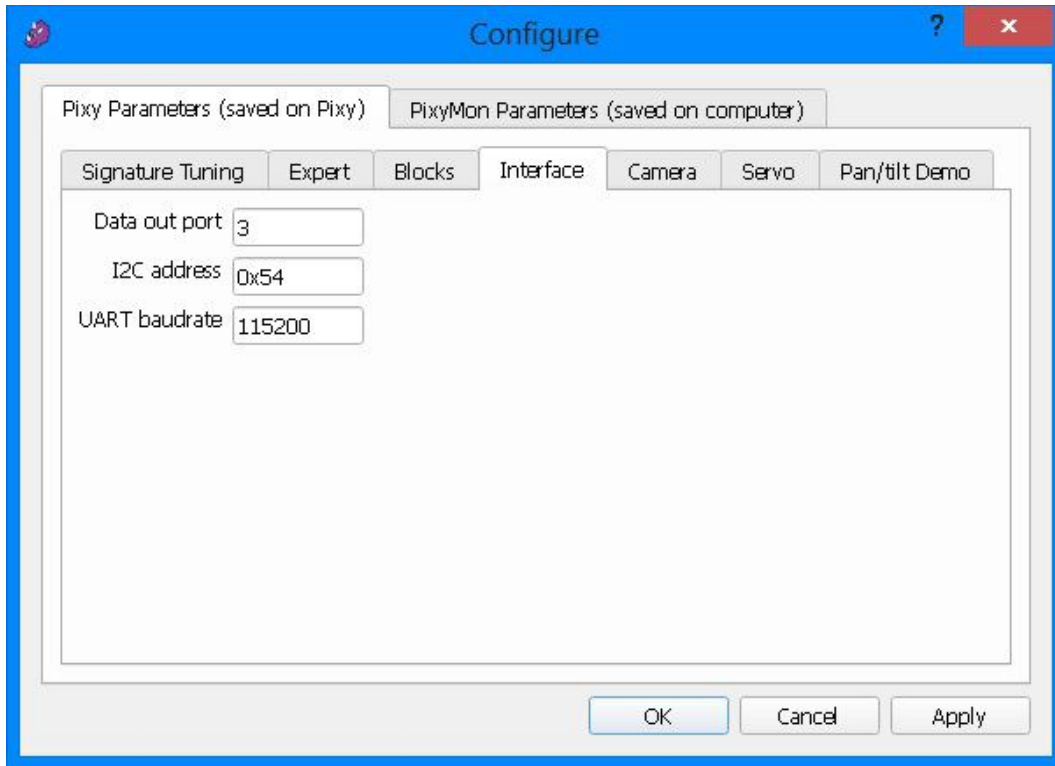
Programming Environment(s)

PixyAdapter is supported for use in the following platforms using software blocks/libraries designed for NXTCAM.

EV3:

To use capabilities of the sensor, please download EV3 blocks available at following URL:

http://www.mindsensors.com/index.php?module=documents&JAS_DocumentManager_op=viewDocument&JAS_Document_id=235

Installation instructions for EV3 block are available at:

http://www.mindsensors.com/pages/198

Download EV3 sample program from following URL and modify it to suit your needs.

http://www.mindsensors.com/index.php?module=documents&JAS_DocumentManager_op=viewDocument&JAS_Document_id=250

Note: While using with EV3, ensure to use firmware version 1.03H or 1.03E or higher on your EV3.

NXT-G:

Download the block from following URL:
http://www.mindsensors.com/NXTCam_NXT-G_Block.htm

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

If you need instructions on how to import this block in NXT-G, visit following url:

http://www.mindsensors.com/index.php?
module=pagemaster&PAGE_user_op=view_page&PAGE_id=81

Note: While using with NXT-G, ensure to use latest firmware version on your NXT (1.31 as of this writing).

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

NXC/NBC Library functions are available at:

http://www.mindsensors.com/index.php?
module=documents&JAS_DocumentManager_op=viewDocument&JAS_Document_id=
57

Arduino EVShield Library functions are available at:

https://github.com/openelectrons/EVShield

Connecting PixyAdapter

Wiring for PixyAdapter

PixyAdapter may be connected to any of the sensor ports of NXT/EV3 using standard NXT/EV3 connector cable. In your program, select the appropriate port number to which PixyAdapter is connected.

⚠ **WARNING**

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

During offline operations, such as programming and configuration, PixyCam must be connected to PC (using USB cable) .

During runtime (or autonomous) operations on NXT/EV3, the USB connection to PC must be removed to ensure proper tracking.

NOTE: While PixyCam is connected to PC, diconnect NXT/EV3 connector from the PixyAdapter. The Serial communication to the PC may be disrupted PixyAdapter is powered.

Connecting PixyCam

PixyAapter is designed for easy and stable mounting of PixyCam.

What you need:

- 2 – short stainless steel screws (provided with PixyCam)
- 2 – longer stainless steel screws (provided with PixyCam)
- 2 – 12mm spacers (provided with PixyAdapter)
- Small phillips head screwdriver

How to mount PixyCam:

- Place a longer stainless steel screw into one of the circular holes of the red side of the PixyAdapter.


- Hold the screw in place with the screwdriver and screw on a spacer to the connector side of the PixyAdapter.
- Repeat for second spacer. Your device should look like the picture below.
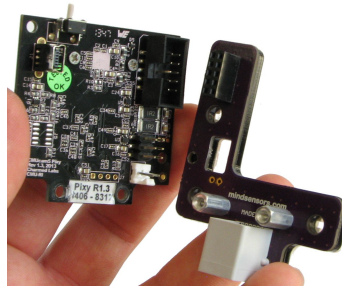
- Attach the PixyCam on the PixyAdapter so that the male pins on the PixyCam's black connector fit inside the black female connector of the PixyAdapter. Spacers should line up with the two bottom holes on the PixyCam.
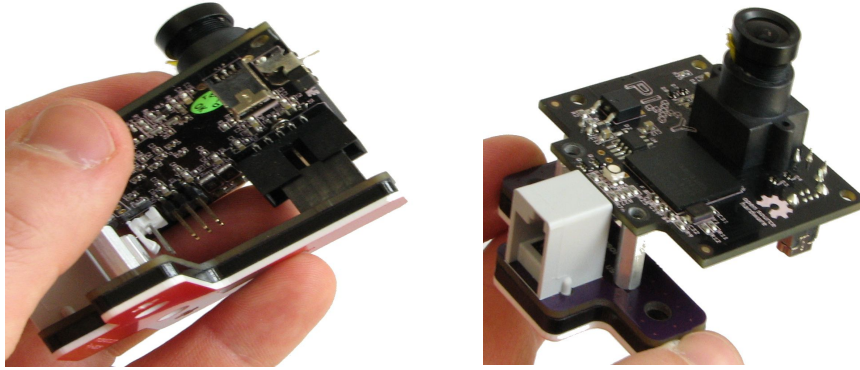
- Screw the PixyCam to the spacers using the two short stainless steel screws. Your device should look like the picture below.
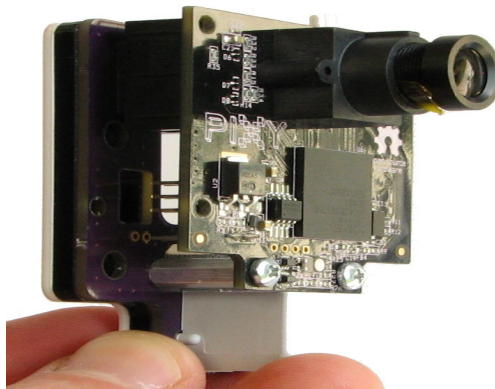
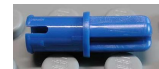**Mounting PixyAdapter on your contraption**

The holes on the PixyAdapter 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 PixyAdapter 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 Pin with Friction', as shown.

While disassembling contraption, leave the axles and/or pins on PixyAdapter to avoid damage to the device.

Tips on using PixyAdapter in your environment

Tracking Colored Objects

With the PixyCam you can track objects comprising of 7 distinct colors. While selecting colors, avoid any overlap between colors of different objects.

Lighting conditions

Lighting conditions will play a role in how well the PixyCam can track colored objects. You can adjust the PixyCam settings and tune it to suit your needs. The following url will guide you in this process:

http://www.cmucam.org/projects/cmucam5/wiki/Some_Tips_on_Generating_Color_Signatures_2

Focus

If your PixyCam image is out of focus, read the information at the following url to correctly focus your PixyCam:

http://www.cmucam.org/projects/cmucam5/wiki/The_image_in_PixyMon_is_out_of__focus

Timeout

Once the tracking mode is started, your program should read the object information from PixyAdapter within 9 seconds and continue to read at least at that interval. If there is inactivity of 9 seconds (or more), the tracking mode is stopped.

Changing the I2C Address

The factory default I2C address of PixyAdapter 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 for future reference.

Alternately, you can download device scan and address change programs from following URLs, and change them to suit your needs:

RobotC:

http://www.mindsensors.com/index.php?module=documents&JAS_DocumentManager_op=viewDocument&JAS_Document_id=18

NXC: http://www.mindsensors.com/index.php?module=documents&JAS_DocumentManager_op=viewDocument&JAS_Document_id=52

Troubleshooting communication

If PixyAdapter with PixyCam stops working, the PixyCam may have reset. Use PixyMon to reconfigure the PixyCam. Also, make sure that your batteries are fully charged. Low battery power can cause the PixyCam to reset.

During runtime (or autonomous) operations on NXT/EV3, the USB connection to PC must be removed to ensure proper tracking.

For more troubleshooting information see the Troubleshooting Guide at the bottom of the page found at http://www.cmucam.org/projects/cmucam5/wiki.

Reference Information

Open Source Software and Hardware

PixyAdapter uses software compatible with NXTCam 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 for Advanced Programming Resources and related docs.

I2C Operations

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

Following table lists the register definitions and setup commands:

Commands		Action
ASCII	Hex	
A	0x41	Sort tracked objects by size
U	0x55	Sort tracked objects by color
X	0x58	Do not Sort tracked objects
J	0x4A	Lock tracking buffer Tracking is going on continuously, and while you read buffer may be updated by the tracking engine. You can issue this command to Lock the buffer updates. After issuing this command allow 25 milliseconds for any updates in progress to finish. Then read the tracking information.
K	0x4B	Unlock tracking buffer. If you had locked the buffer before reading, ensure to unlock it after you are done reading.

While programming in NXC, you can use the API function NXTCam_SendCommand () to send the command to PixyAdapter. While using NXT-G block, most of the essential commands are enumerated in 'Operation'.

I2C Registers:

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

Register	Read	Write	Comments
0x00-0x07	Software version – *(Vn.nn)*	-	
0x08-0x0f	Vendor Id – *mndsnsrs*	-	
0x10-0x17	Device ID – *PixyAdpt*	-	
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	1st object color	-	This is the first object color as per the sorting method selected.
0x44	1st object - X upper left		Upper left X coordinate of first object
0x45	1st object - Y upper left		Upper left Y coordinate of first object
0x46	1st object - X lower right		Lower right X coordinate of first object
0x47[1]	1st object - Y lower right		Lower right Y coordinate of first object
0x48	2nd object color		
0x49-0x4C	2nd object co-ordinates		
0x4D	3rd object color		
0x4E-0x51	3rd object co-ordinates		
0x52	4th object color		
0x53-0x56	4th object co-ordinates		
0x57	5th object color		
0x58-0x5B	5th object co-ordinates		
0x5C	6th object color		
0x5D-0x60	6th object co-ordinates		
0x61	7th object color		

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[1] 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
0x62-0x65	7th object co-ordinates		
0x66	8th object color		
0x67-0x6A	8th 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 PixyAdapter.
0x6C	1st image sensor register Address	1st image sensor register Address	
0x6D^{2}	1st image sensor register Data	1st image sensor register Data	1st register Data read from image sensor or written to image sensor
………………………..	…………………………………….	……………………………	
0x7A	8th image sensor register Address	8th image sensor register Address	
0x7B	8th image sensor register Data	8th image sensor register Data	

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[2] If you need to read PixyAdapter 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 PixyAdapter 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'