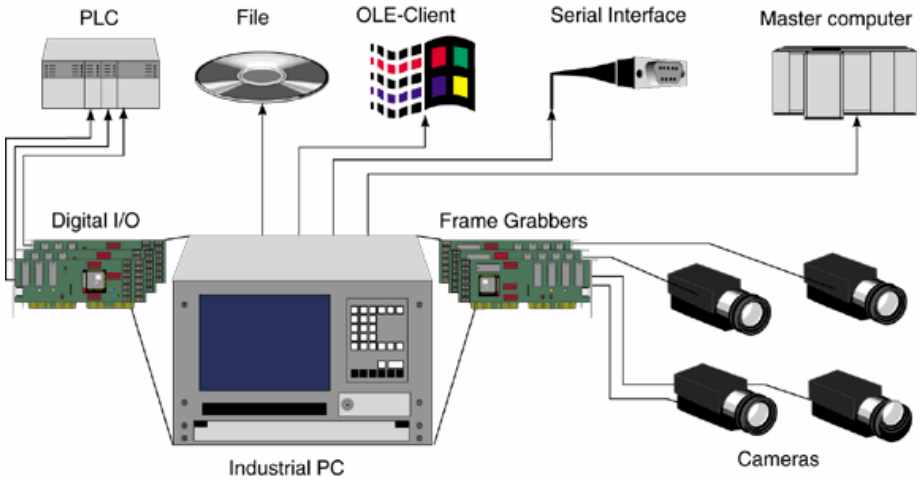
Exploring Vision Devices

Class 3: Machine Vision System Components



August 28, 2019

Don Wilcher

DesignNews

CEC CONTINUING EDUCATION CENTER

Presented by: Digi-Key ELECTRONICS

Class 3: Machine Vision System Components

Agenda

- What is driving the Machine Vision Market?
- Machine Vision System Components
- Lab Project: Part 1-Introduction to the Pixy2 Cam smart sensor

What is driving Machine Vision?...

Machine Vision enablers:

- quality assurance
- sorting
- material handling
- robotic guidance
- safety

What is driving Machine Vision?

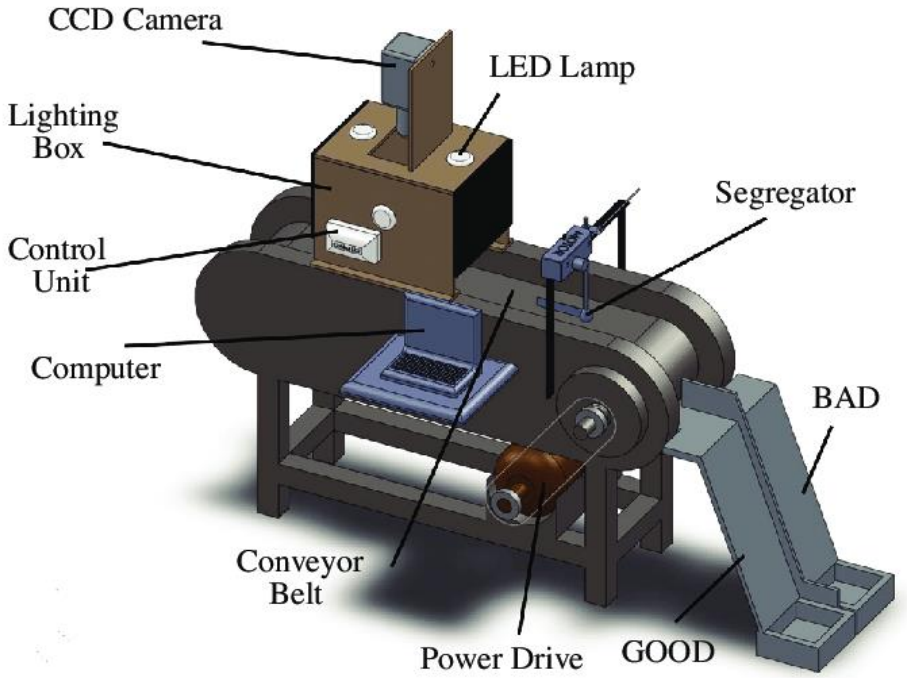
Quality Assurance:

- Visual quality assurance systems can inspect every stage of production
- Artificial Intelligence to self-adapt and self adjust to changes.

What is driving Machine Vision?...

Sorting: What attributes?

- Shades of color
- shape
- Textures
- size



Tomato Sorter: sorts on

- shape
- Size
- surface

Question 1:

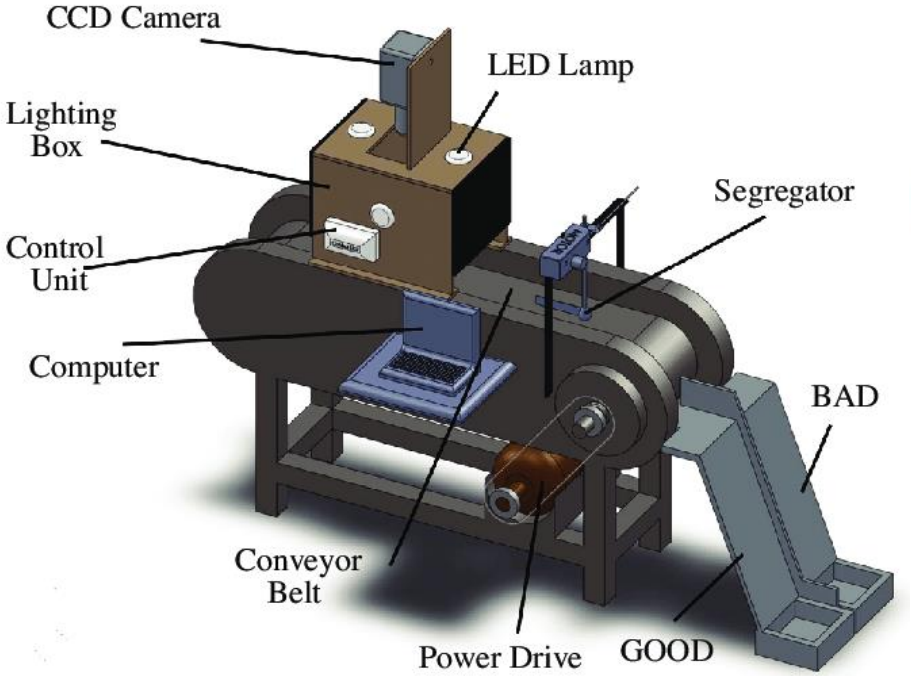
What enabler is incorrect?

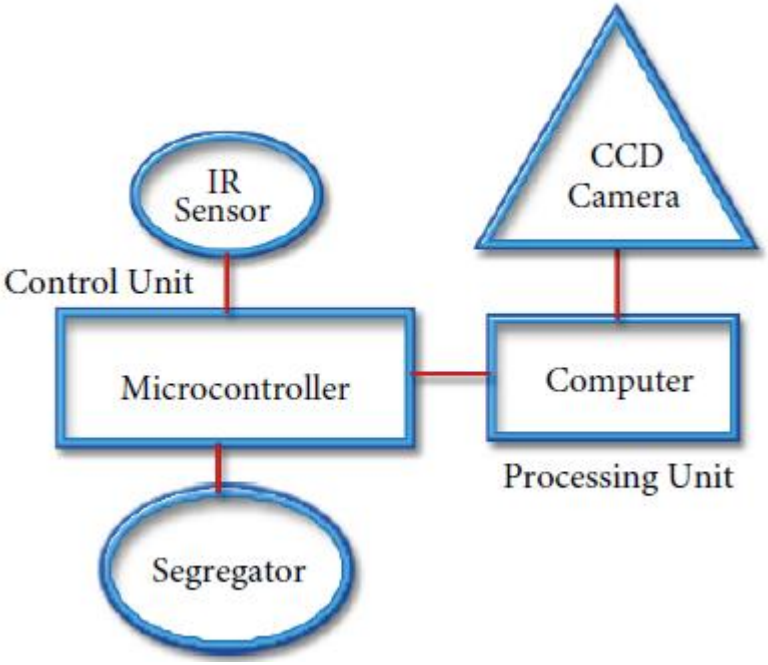
Machine Vision enablers:

- quality assurance
- sorting
- material handling
- robotic control
- safety

What is driving Machine Vision?...

Sorting: What attributes?...





Tomato sorter: Additional Details

What is driving Machine Vision?...

Material Handling: Robotic based

- improve productivity
- increase safety
- reduce labor

What is driving Machine Vision?...

Robotic Guidance:

- uses sensors for detecting
- textureless surfaces
- Lighting conditions
- used with cobots

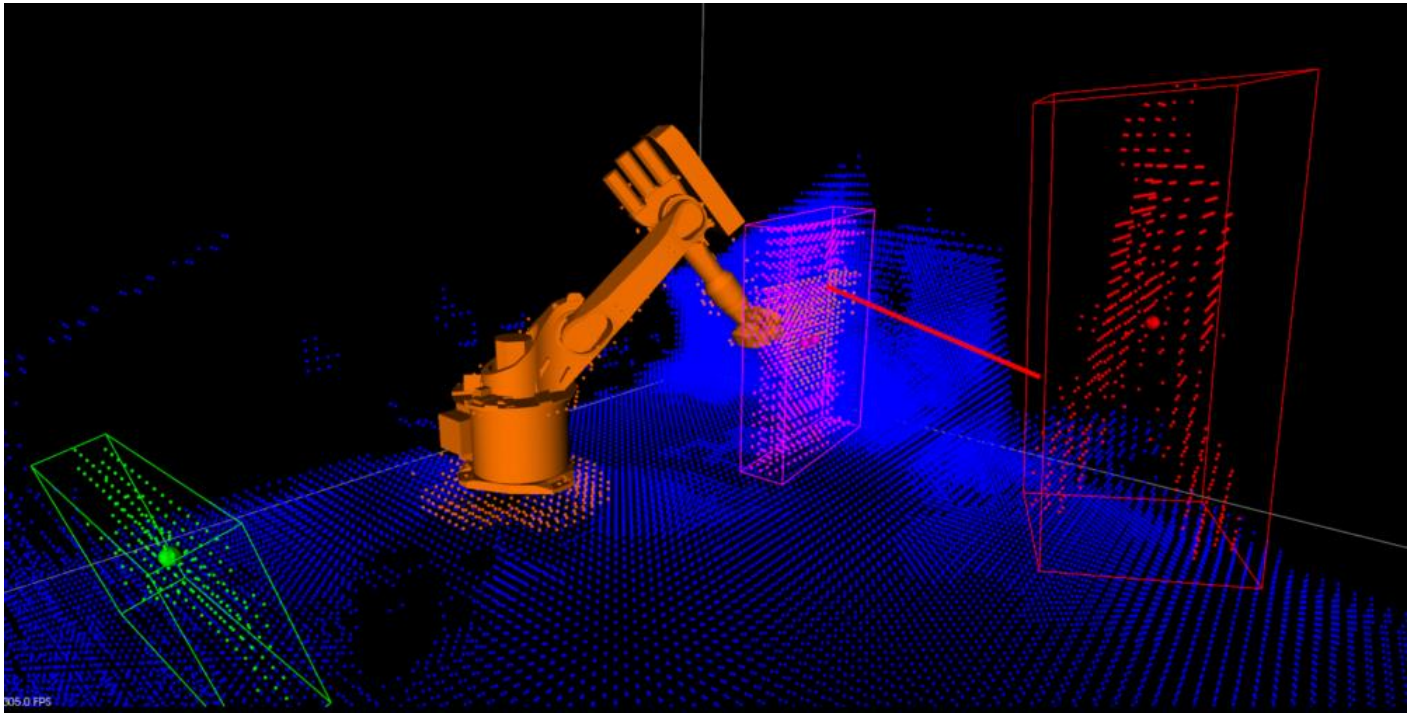
Question 2:

In reviewing the Tomato Sorter on slide 7 what hardware component can be replaced by the Raspberry Pi?

What is driving Machine Vision?...

Safety:

- Prevents contamination from humans
- Prevents humans from hazardous environments



Machine Vision Components

Five essential components:

- lighting
- lenses
- image processing
- image sensor
- communication

Machine Vision Components…

Lighting:

- Helps to produce a better image
- Types of lighting
  a) *Quartz*
  b) *Halogen*
  c) *LED*
  d) *Metal Halide*
  e) *Mercury*
  f) *Xenon*
  g) *High Pressure Sodium*

Machine Vision Components…

Lighting:

Lighting systems is selected based on

a) *life expectancy*

b) *cost effectiveness*

c) *heat output*

d) *stability*

e) *application flexibility*

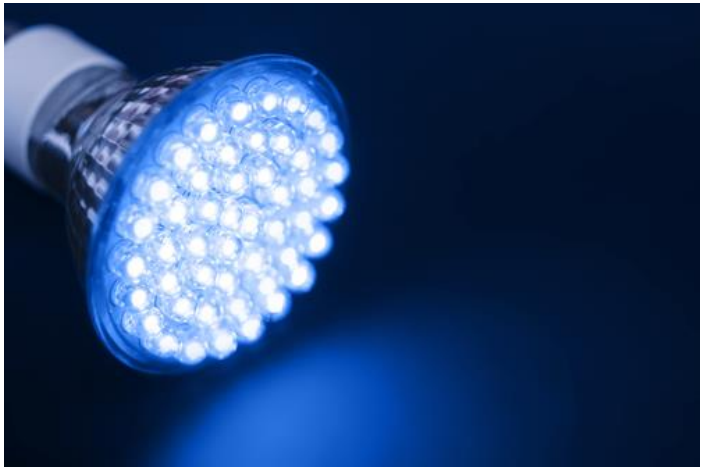
f) *intensity*

Machine Vision Components…

Lighting:

LED light has become the more predominate lighting system because of

a) *life expectancy*
b) *energy efficiency*
c) *application flexibility*
d) *intensity*



Question 3:

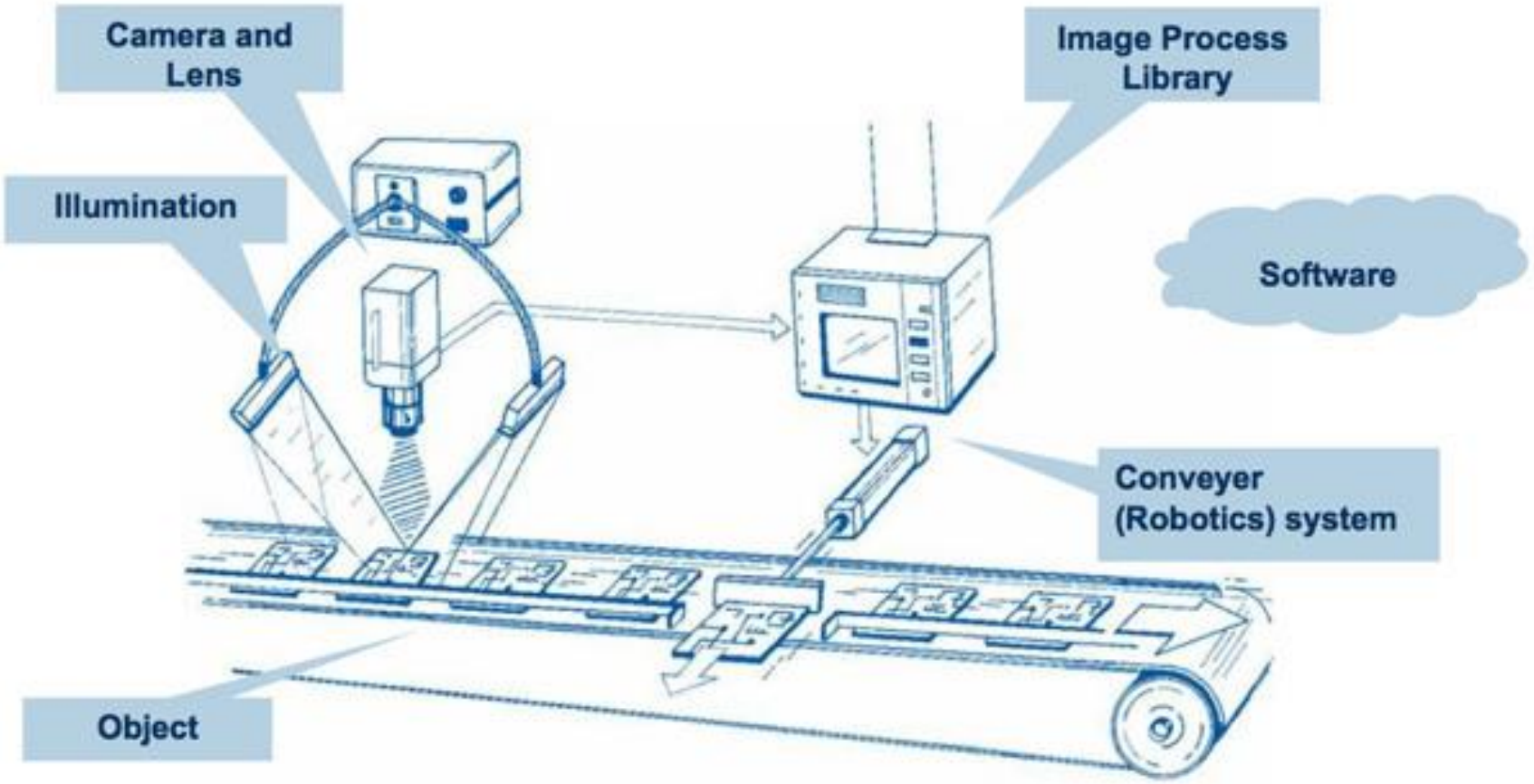
Which component is incorrect?

Five essential components:

- lighting
- lenses
- frame grabber
- image sensor
- communication

Machine Vision Components…

Machine Vision System: LED Lighting



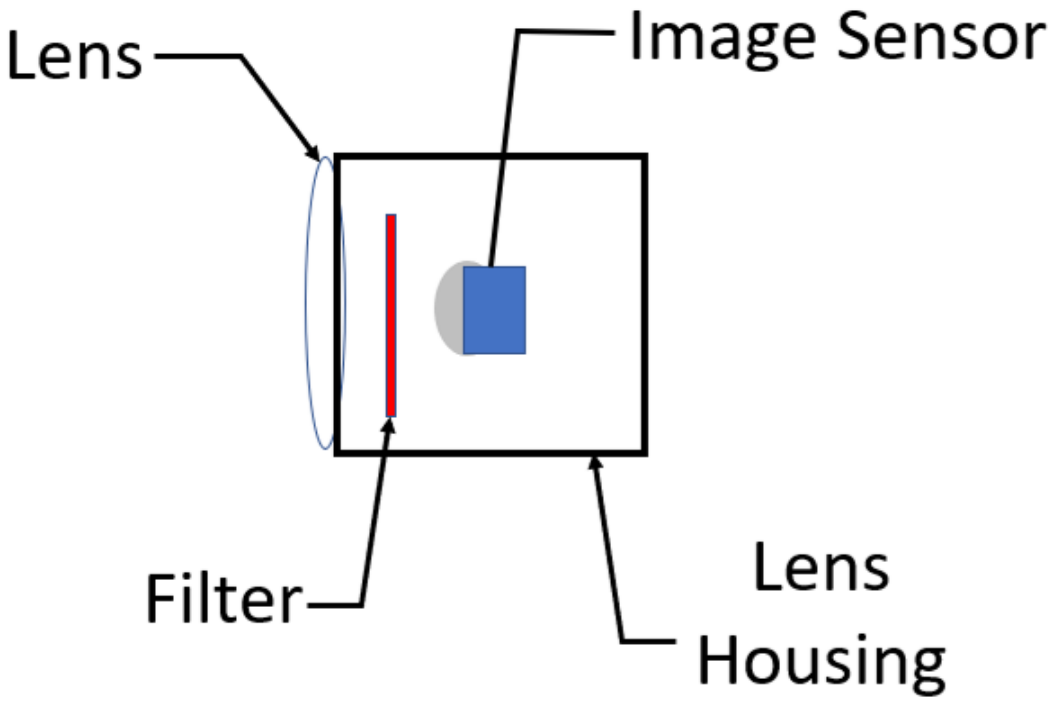
Machine Vision Components…

Lens:

- The camera will not be able capture an image without a lens.
- Two fundamental parameters
  a) *focal length*: determines the magnification of the projected image
  b) *maximum aperture*: the light intensity of the image
- Filters: use to filter out certain frequency of light

Machine Vision Components…

Lens: The Construction



Machine Vision Components…

Image Processing involves

a) *Image conversions*

b) *pixel value statistical analysis*

c) *Pattern recognition, Pattern matching: Optical Character Recognition (OCR)*

d) *Code extraction (Barcode, QR, etc)*

Machine Vision Components…

Image Processor known as

a) *Image Processing Engine*

b) *Image Processing Unit (IPU)*

c) Image Signal Processor (ISP)

- *The basic operation for an image processor is to improve the quality of the captured imaged base object.*
- *Digital Signal Processor (DSP) is another hardware method to improving the captured image quality.*
- *IPU functions can be configured using a User Interface.*

Machine Vision Components…

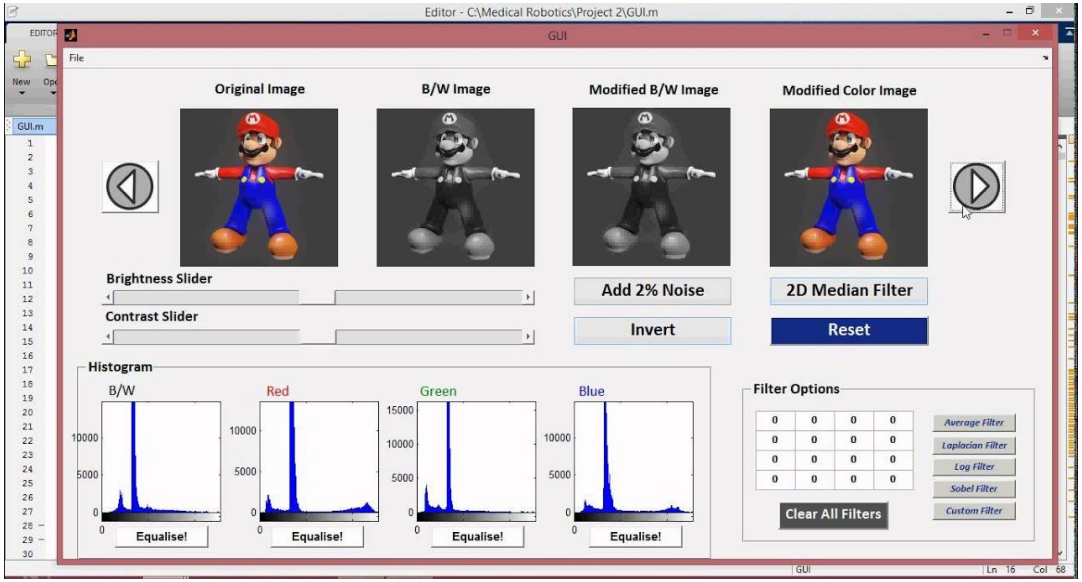
Image Processor Tools include:.

Popular open source libraries:

a) *OpenCV (2-D image processing and analysis)*

b) *ARToolkit (Augmented Reality library)*

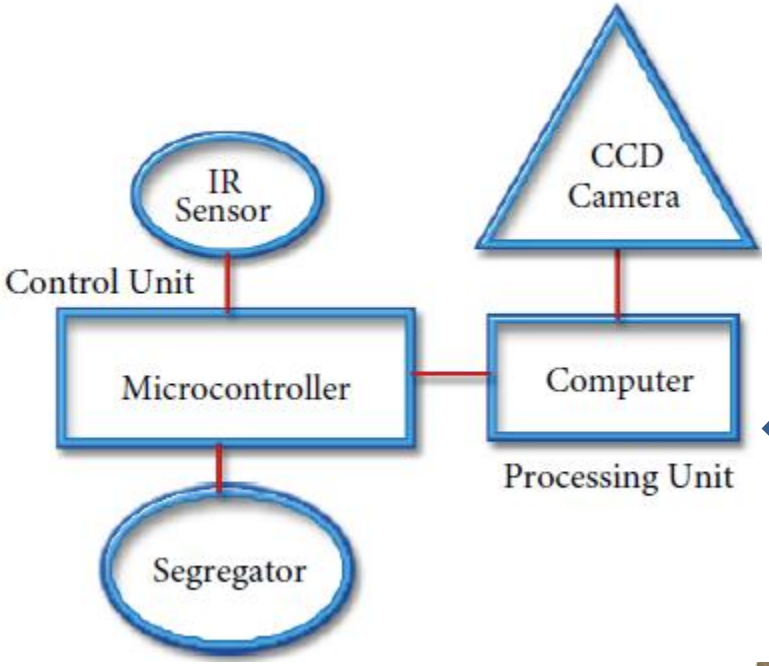
c) *PCL (3D Image Processing and Analysis)*



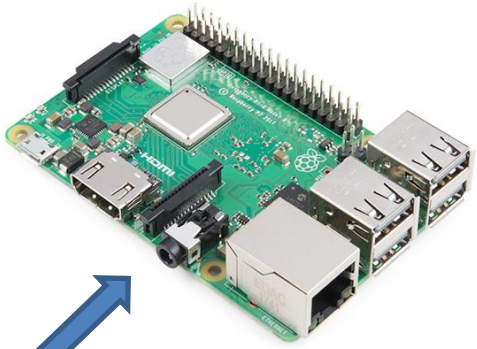
Matlab Image Processing GUI

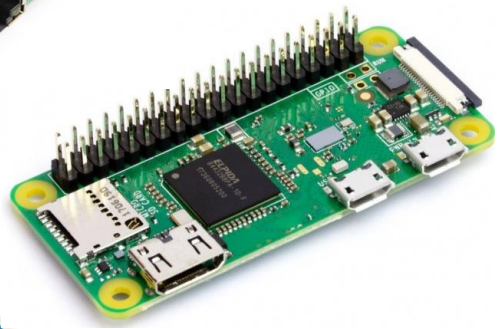
Machine Vision Components…

Tomato Sorter System Block Diagram



Possible Image Processing Units





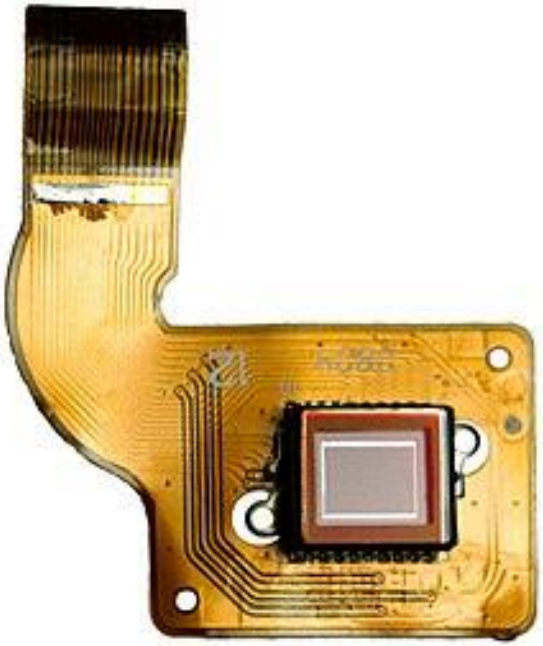
Machine Vision Components…

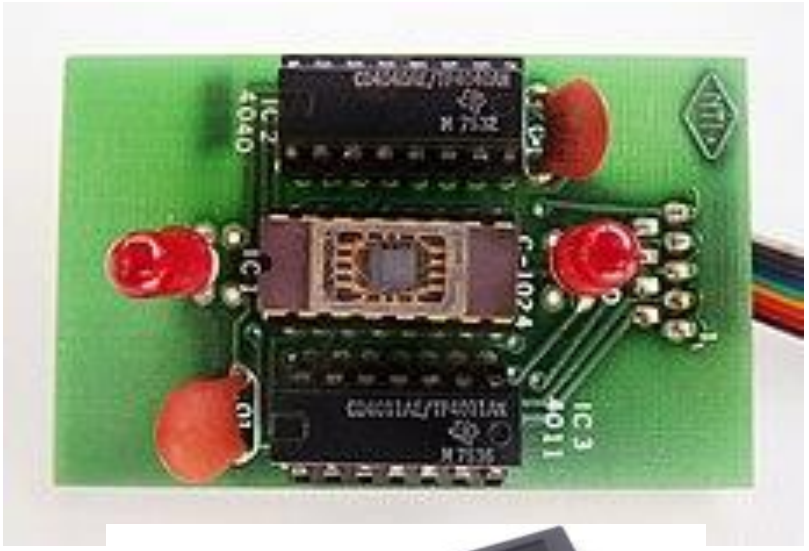
Image Sensor or Imager

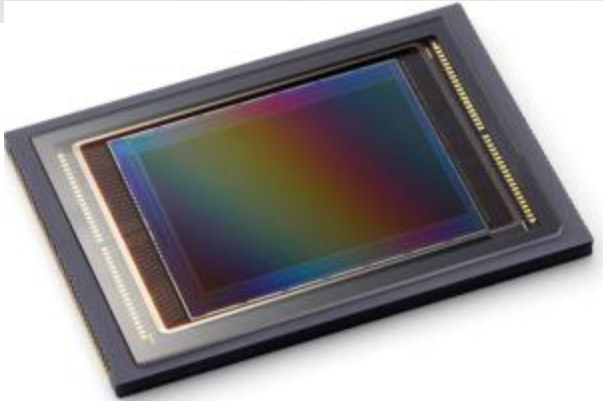
- An electronic sensor used to detect and convey an images information.
- Methods of conveying images information
  a) *converting the attenuation of light waves*
     i. pass through or
     ii. reflect off objects
  b) *converting into signals: small burst of current*

Machine Vision Components…

Image Sensors or Imagers







Question 4:

What is another name for Image Processor?

Machine Vision Components…

Communications involves relations

a) *between the operator of an inspection system*

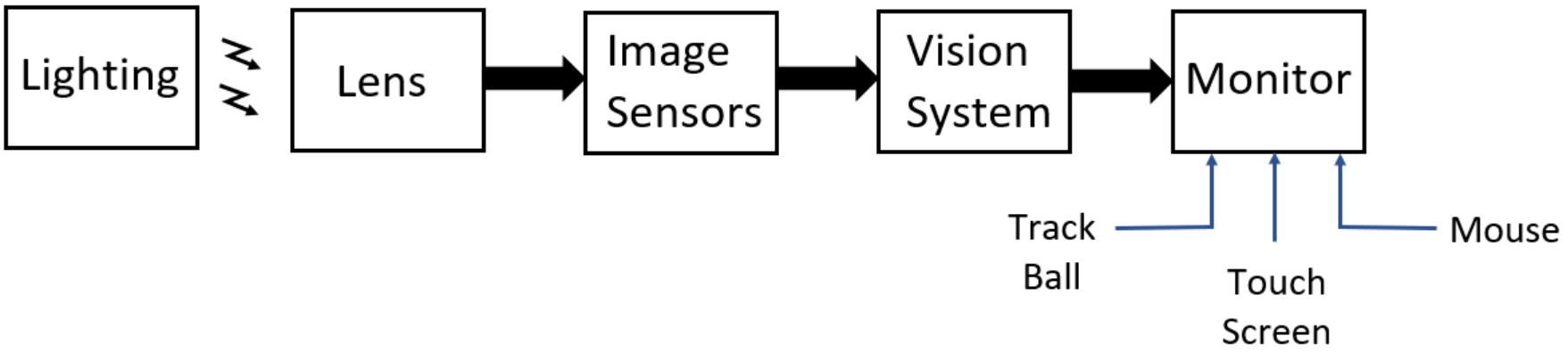
b) with *process controls*

c) *with the vision equipment used to inspect the process or object*

Communications to machine vision system include data-ethernet or discrete I/O connectivity

Machine Vision Components…

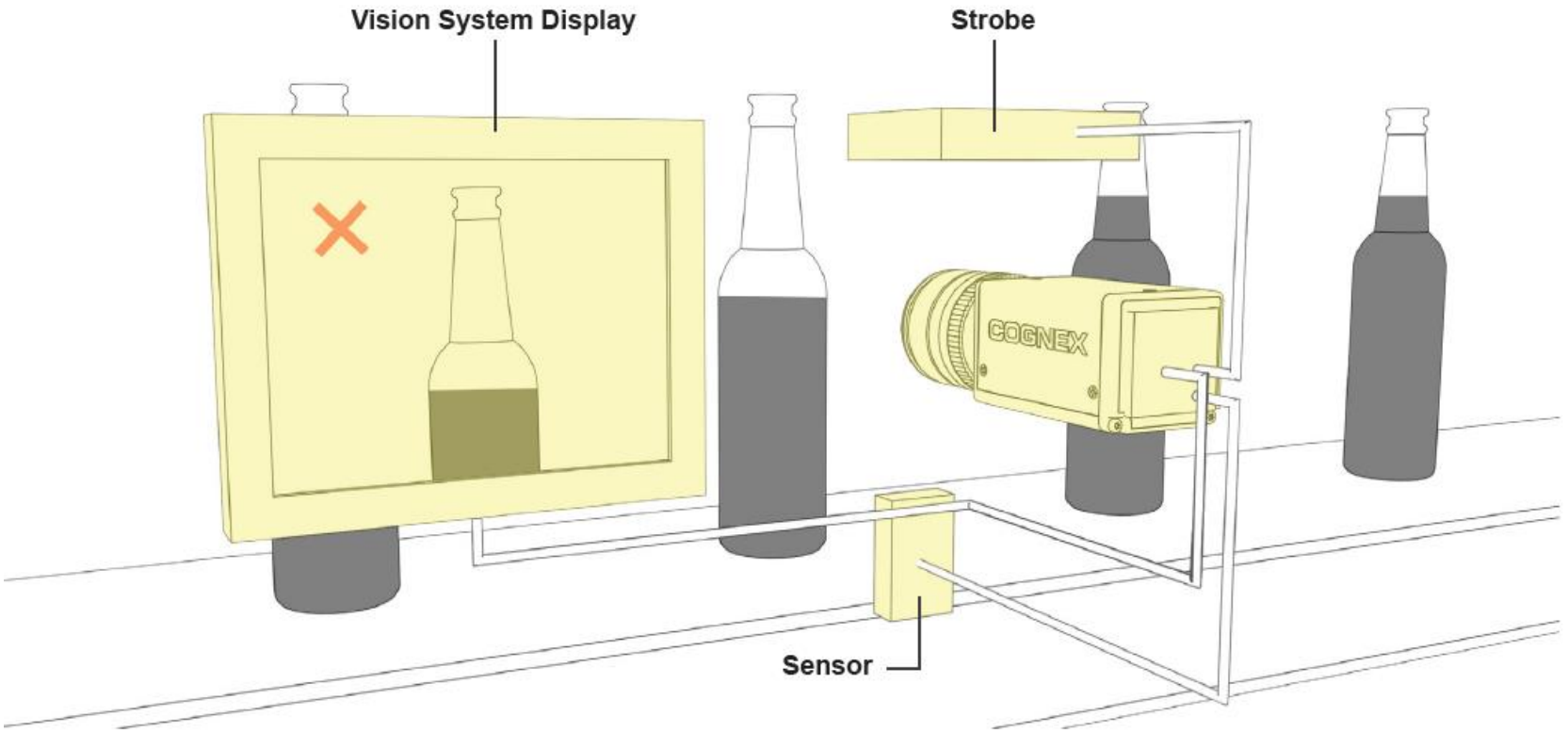
Five essential components:



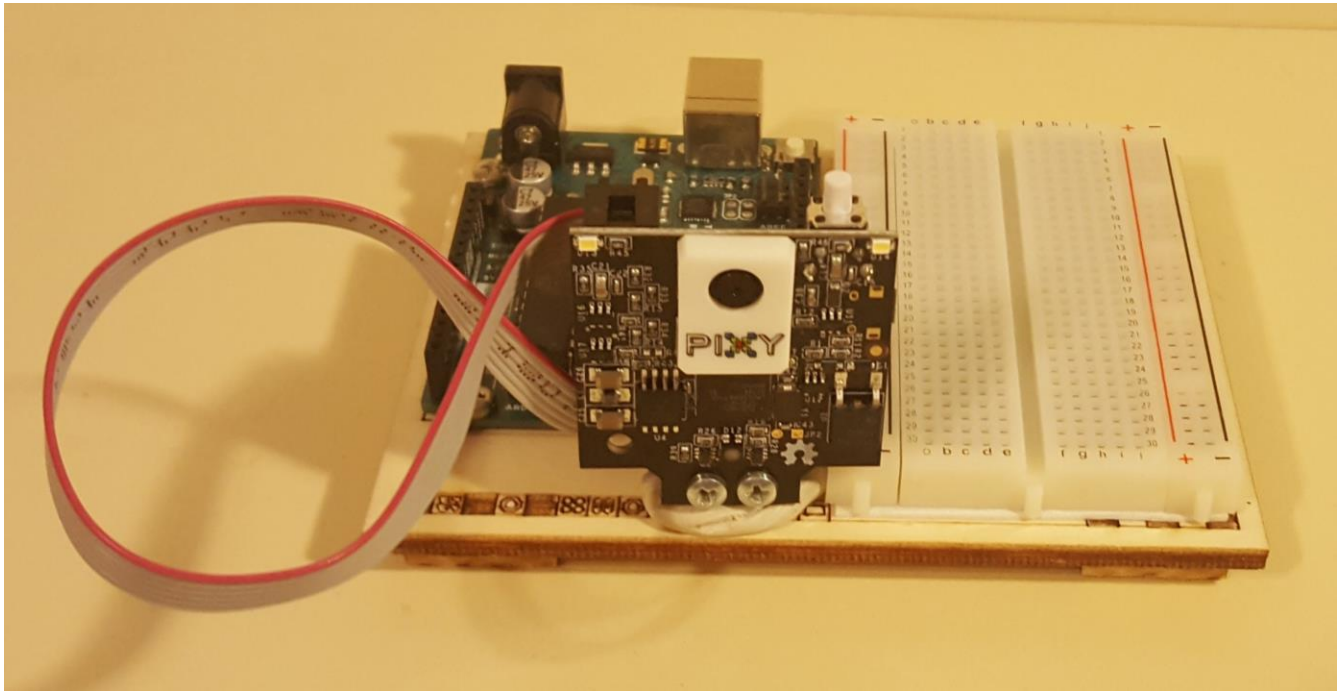
A typical System Block Diagram

Machine Vision Components…

Machine Vision System: Bottling Process



Lab Project: Part 1-Introduction to the Pixy2 Cam smart sensor



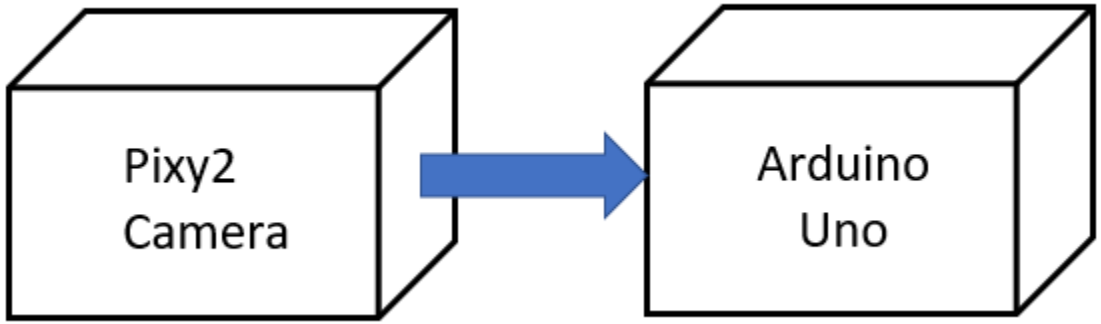
Lab Project: Part 1-Introduction to the Pixy2 Cam smart sensor

Lab Objectives:

- Learn how to add the *pixy2* library to the Arduino IDE.
- Learn how to attach a Pixy2 Camera to an Arduino.
- Learn how to test the Pixy2 camera with the ccc_hello_world code.

Lab Project: Part 1-Introduction to the Pixy2 Cam smart sensor…

Basic Concept



Lab Project: Part 1-Introduction to the Pixy2 Cam smart sensor

Download the pixy2 library from the following website.

https://pixycam.com/downloads-pixy2

Lab Project: Part 1-Introduction to the Pixy2 Cam smart sensor…

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Pixy2 Downloads

This page contains links to the most recent software/firmware releases for Pixy2. **These downloads will not work with the original Pixy!**

PixyMon v2

PixyMon v2 is the configuration utility for Pixy2 that runs on Windows, MacOS and Linux.

- Pixymon v2 Windows version 3.0.24 (exe)
  - installation docs for Windows Vista, 7, 8, 10
  - installation docs for XP
- PixyMon v2 Mac version 3.0.24 (dmg, High Sierra)
  - installation docs
- Linux Pixymon v2 is available through github
  - installation docs

Pixy2 firmware

Pixy2 firmware is code that runs on Pixy2 itself.

- Pixy2 general firmware version 3.0.13 (hex)
- Pixy2 LEGO firmware version 3.0.13 (hex)
  - installation docs

Arduino libraries and examples

The Arduino libraries allow your Arduino sketches/programs to talk to Pixy2.

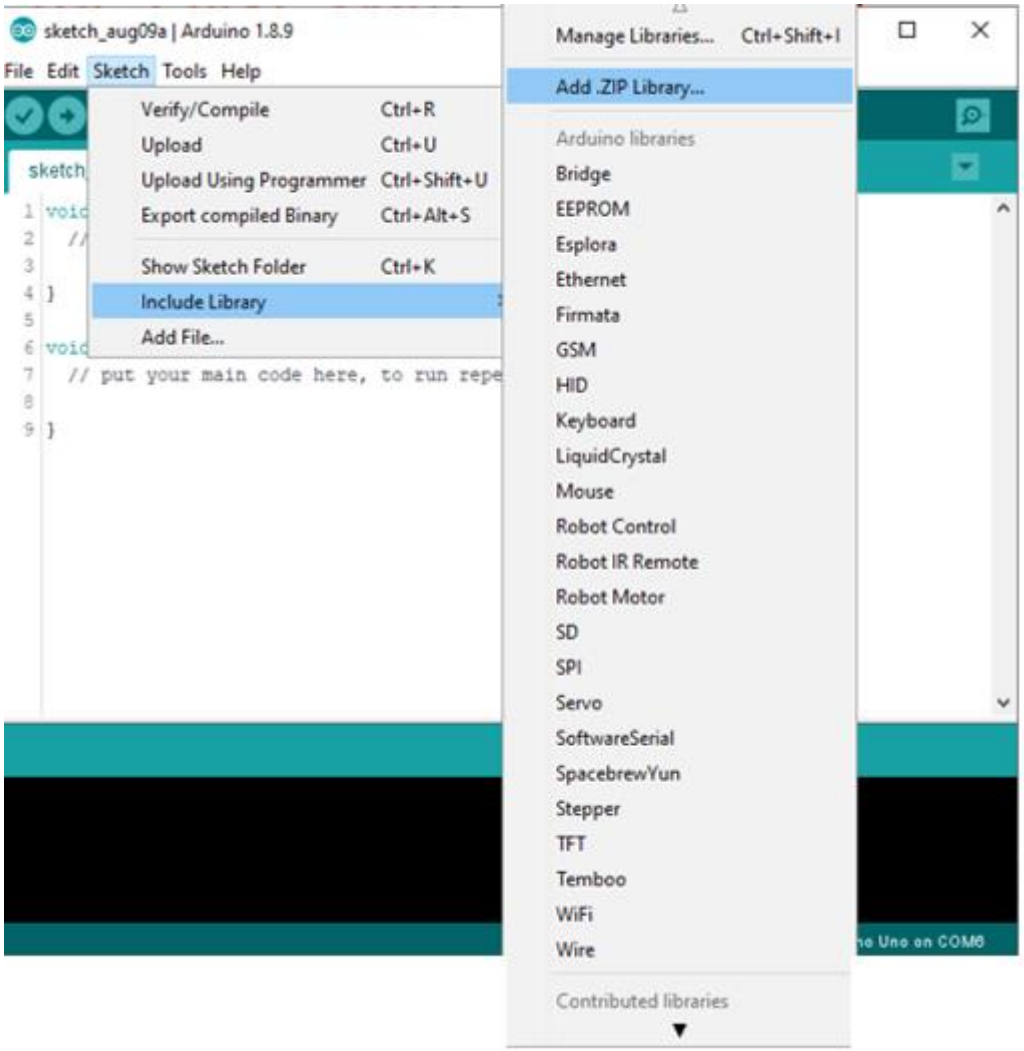
- Arduino Pixy2 library version 1.0.3 (zip)
  - installation docs

Libpixyusb2

Libpixyusb2 is a C/C++ library that allows your Linux-based controller (e.g. Raspberry Pi, BeagleBone) to talk to Pixy2 over USB.

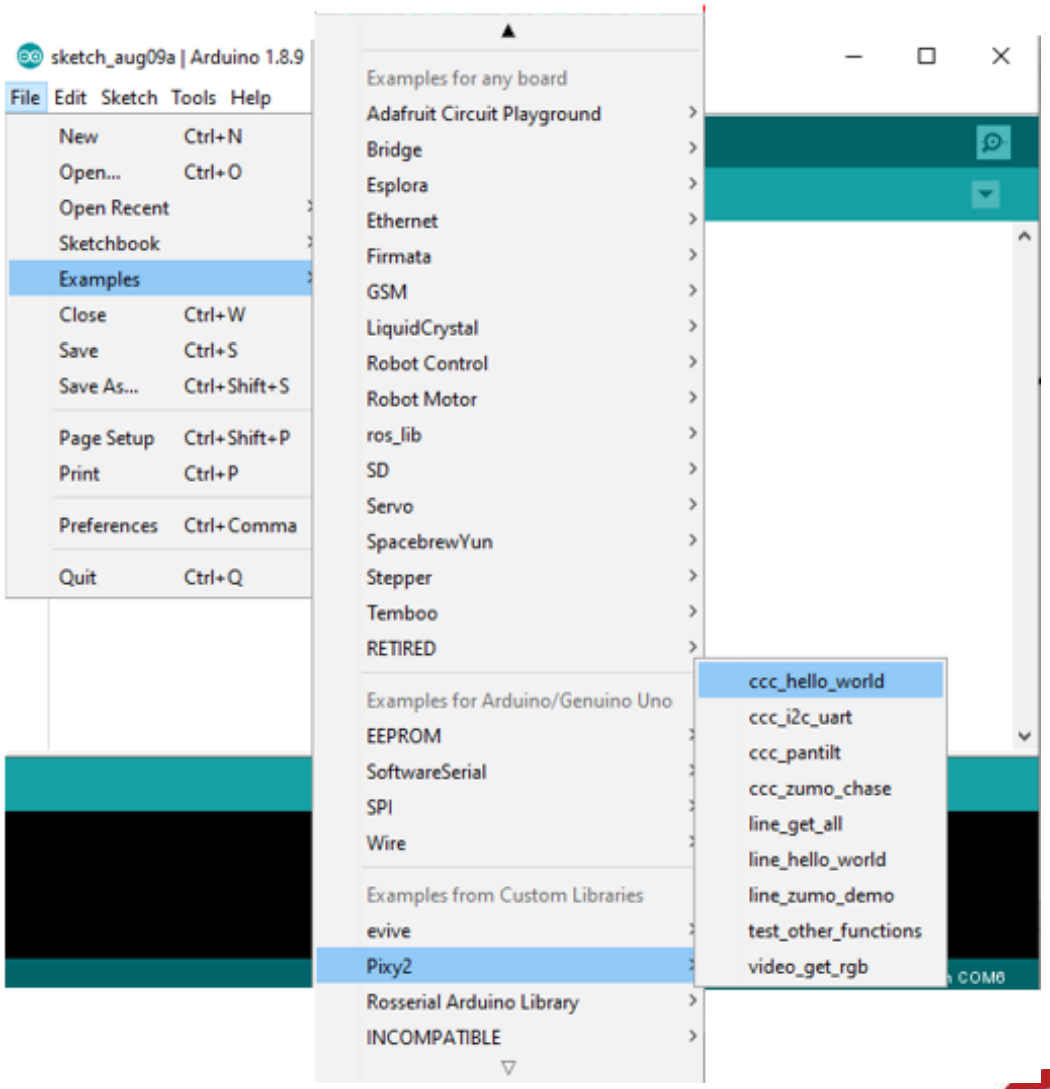
The Pixy2 download page

Lab Project: Part 1-Introduction to the Pixy2 Cam smart sensor…



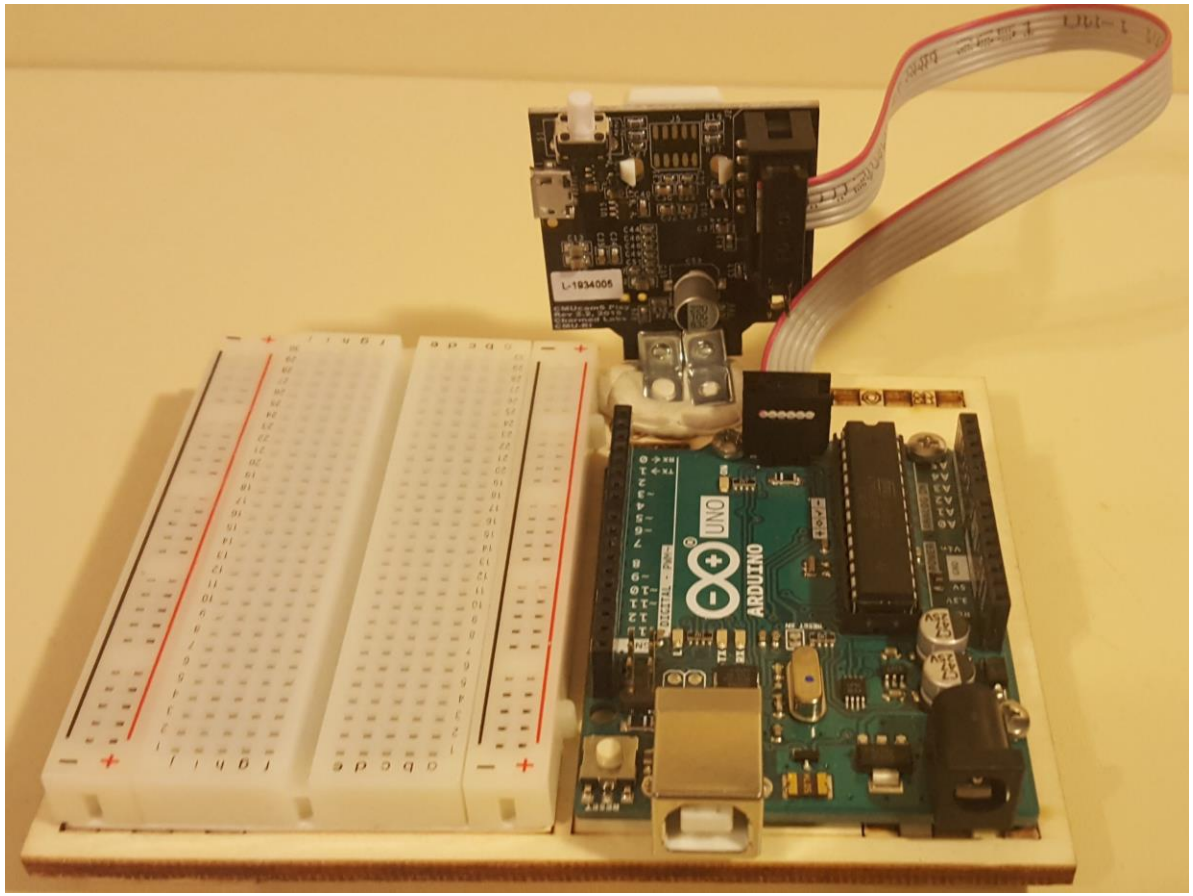
Adding the pixy2 library to the Arduino IDE

Lab Project: Part 1-Introduction to the Pixy2 Cam smart sensor…



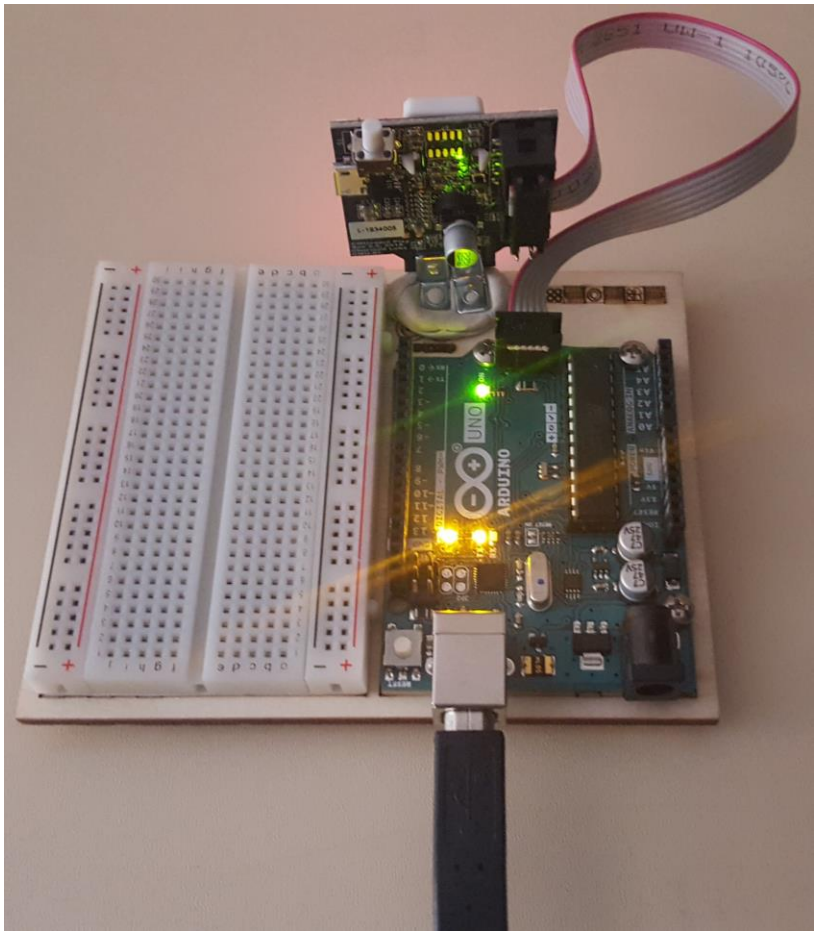
The Pixy2 examples added to the Arduino IDE

Lab Project: Part 1-Introduction to the Pixy2 Cam smart sensor…



Attaching ribbon cable to the Pix2y camera and the Arduino

Lab Project: Part 1-Introduction to the Pixy2 Cam smart sensor…



USB powering of the Pix2y camera through an Arduino

Lab Project: Part 1-Introduction to the Pixy2 Cam smart sensor…

The ccc_hello_world code

ccc_hello_world | Arduino 1.8.9

File Edit Sketch Tools Help

ccc_hello_world

```
// GNU General Public License v2 (http://www.gnu.org/licenses/gpl-2.0.html).
// Those wishing to use Pixy source code, software and/or
// technologies under different licensing terms should contact us at
// cmucam@cs.cmu.edu. Such licensing terms are available for
// all portions of the Pixy codebase presented here.
//
// end license header
//
// This sketch is a good place to start if you're just getting started with
// Pixy and Arduino.  This program simply prints the detected object blocks
// (including color codes) through the serial console.  It uses the Arduino's
// ICSP SPI port.  For more information go here:
//
// https://docs.pixycam.com/wiki/doku.php?id=wiki:v2:hooking_up_pixy_to_a_microcontrc
//

#include <Pixy2.h>
```

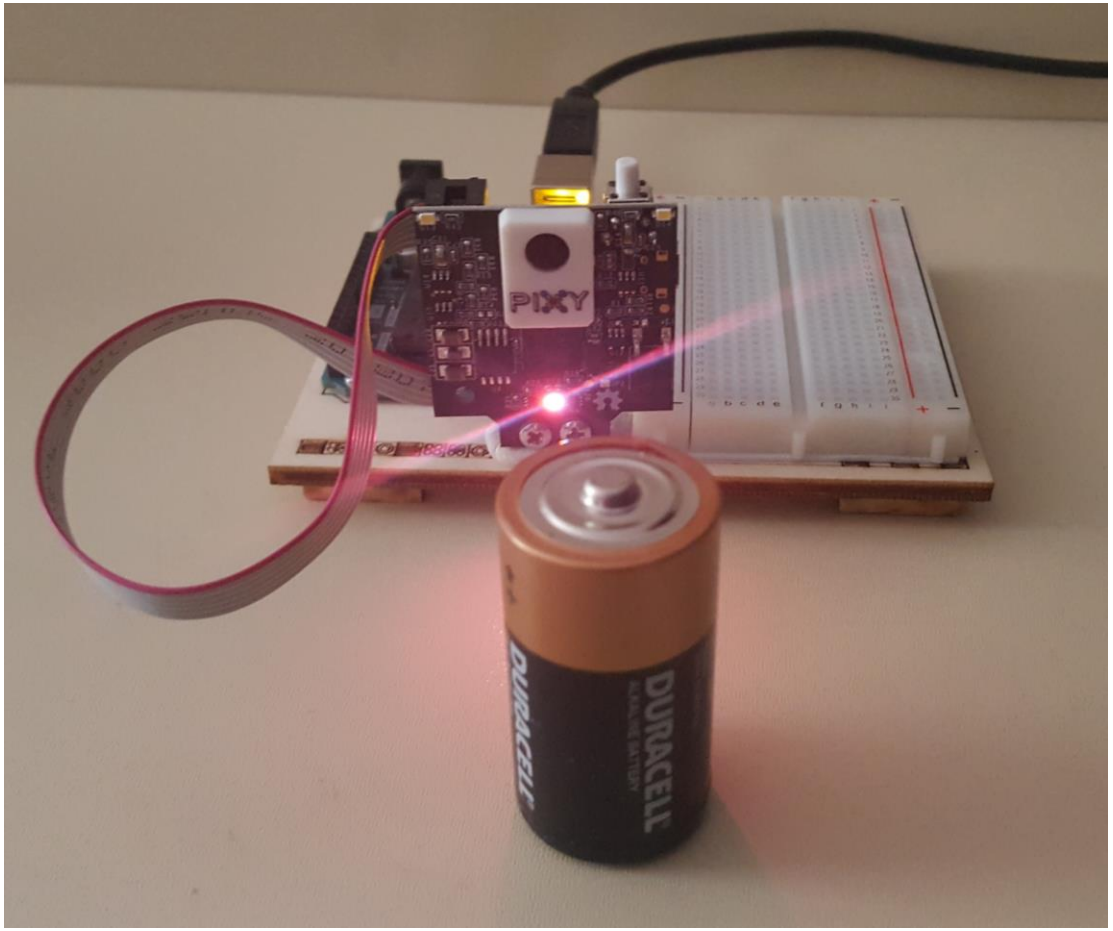
```
avrdude: 7532 bytes of flash verified

avrdude done.  Thank you.
```

1 Arduino/Genuino Uno on COM6

This sketch is a good place to start if you're just getting started with Pixy and Arduino.This program simply prints the detected object blocks (including color codes) through the serial console It uses the Arduino's ICSP SPI port.

Lab Project: Part 1-Introduction to the Pixy2 Cam smart sensor…

Upload the ccc_hello_world code to the Arduino



RGB turns on when object is detected by the Pixy2 camera smart sensor

Lab Project: Part 1-Introduction to the Pixy2 Cam smart sensor…

Pixy2 Camera Detection output displayed on the Serial Monitor

COM6

Send

```
  block 2: sig: 3 x: 128 y: 146 width: 12 height: 3 index: 160 age: 74
Detected 3
  block 0: sig: 3 x: 83 y: 103 width: 22 height: 11 index: 167 age: 67
  block 1: sig: 3 x: 184 y: 98 width: 28 height: 8 index: 163 age: 74
  block 2: sig: 3 x: 126 y: 132 width: 28 height: 6 index: 160 age: 76
Detected 3
  block 0: sig: 3 x: 83 y: 103 width: 22 height: 11 index: 167 age: 68
  block 1: sig: 3 x: 184 y: 97 width: 28 height: 8 index: 163 age: 75
  block 2: sig: 3 x: 140 y: 90 width: 16 height: 5 index: 160 age: 77
Detected 3
  block 0: sig: 3 x: 181 y: 101 width: 26 height: 7 index: 163 age: 76
  block 1: sig: 3 x: 126 y: 137 width: 28 height: 3 index: 167 age: 69
  block 2: sig: 3 x: 134 y: 122 width: 12 height: 6 index: 160 age: 78
Detected 3
  block 0: sig: 3 x: 184 y: 103 width: 28 height: 9 index: 163 age: 77
  block 1: sig: 3 x:
```

Autoscroll Show timestamp Carriage return 115200 baud Clear output

Question 5:

Using slide 28, what other input device can be used to interact with a monitor ?