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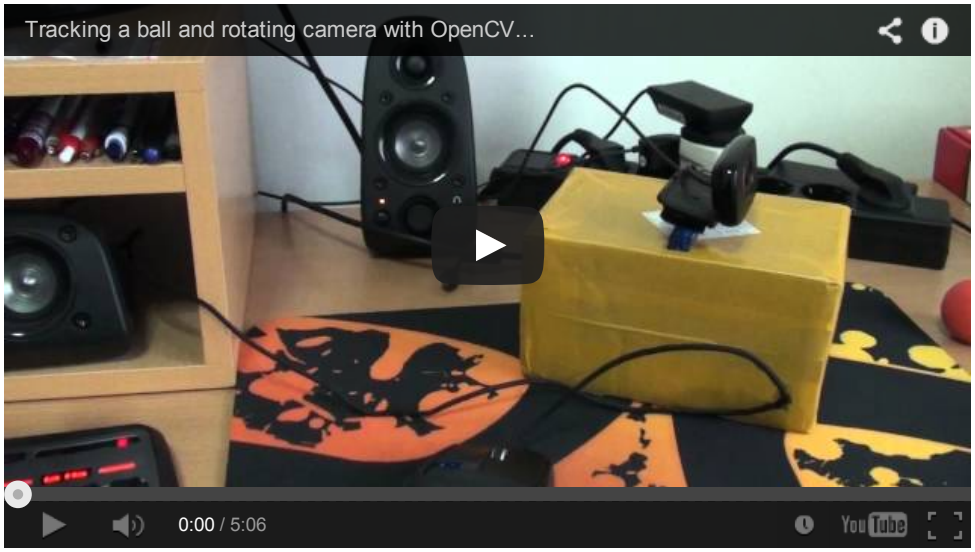
Tracking a ball and rotating camera with OpenCV and Arduino

by Ethan Hunt on May.20, 2013, under Code, Hardware, IT

I recently started playing around with the OpenCV library and one of the first tutorials I did dealt with tracking a ball with the camera. I expanded on that concept a bit by having the camera rotate and continue tracking the ball even if it goes off screen. I did this by connecting the camera to a small servo controlled by an Arduino Uno, which receives commands from my PC via a serial connection.

The base project I used can be found here. I decided not to reinvent the wheel and used that code as a starting point so props to the author. However I did modify the code slightly and also added some more things to make it work for my project. The modification refers to changing the color model from RGB to HSV as I found out that it's much easier to specify a tracking color by using the Hue value rather then finding a good RGB value. The additions refer to the code for serial connectivity and the Arduino instructions send via the serial connection itself.

You can see how the project ended up looking and working in this short YouTube video I made:



You can download the OpenCV (C++) code here, and the Arduino code here.

I hope you enjoy this little project and feel free to post any questions or comments you might have regarding it.

:arduino, ball, camera, opencv, rotating, servo, tracking

38 Comments for this entry

- *Andrei Cosofret*
  June 10th, 2013 on 10:52 PM

  Hello !
  I had an issue when i was trying to repeat this project.
  I installed MS Visual C++ 2010 Express and openCV 2.2 .
  I ran the c++ program in MS Visual C++ using as webcam my integrated laptop webcam and it worked. The two windows (original and processed) along with the cmd prompt showed up, but the laptop webcam being too weak it was difficult for it to distinguish the colors and to track them and impossible to connect to a servo motor :).
  So I tried a webcam (Microsoft LifeCAM VX-800) but when a ran the program the original window is grey and I don't know what should I do to make the MS webcam working. Please help me ! my email adress : andreicosofret@gmail.com

  Reply

  - *Ethan Hunt*
    June 11th, 2013 on 11:13 AM

    Did you connect the MS webcam to the same computer (laptop) which already has an integrated webcam on it? If so, you may want to try and change the webcam that is being used by OpenCV.

    Look for the line that says: "p_capWebcam = cvCaptureFromCAM(0);" The number zero basically refers to the first webcam connected to the system. Try changing this number to 1 or something even higher. Based on how your OS detects the webcams they don't always end up at the zero spot. You can also try it with -1, which means that OpenCV will use any camera it finds.

    Try it out and let me know

    Reply

    - *MaxonTan*
      April 14th, 2014 on 6:54 PM

Based on Andrei Cosofret problem and the solution given by you. I had face this king of problem too abd i had tried the value from 0 til 100 (as well as negative) and yet the screen still appear in gray colour. Bro, is that got any coding can replace with “p_capWebcam = cvCaptureFromCAM(0);”? Reply me ASAP thanks bro

Reply

- 
doel
June 24th, 2013 on 3:10 PM

0 down vote favorite

I’m using OpenCV in Visual Studio 2010 to detect sleepiness eye of the camera, and I try to send a value to the Arduino to activate buzzer (alarm) and the dc motor will stop after the eye drowsiness is detected (covered) by the camera. I am using the Arduino Uno. I have completed C + + code, but I have trouble sending this data to the Arduino. I am currently using the RS-232 cable for this. I use a type-B USB cable to program my Arduino and RS-232 to try to send data from Visual Studio for Arduino. How can I do it …which for opencv and arduino code

Reply

  - 
Ethan Hunt
June 24th, 2013 on 7:25 PM

Take a look at the C++ code I used in my project. It contains the code needed to send commands to the Arduino via RS-232. You can see how to open the serial connection and how to send data. Notice the “WriteFile()” method I’m using to do this.

Also, you can take a look at my other project located here: http://aleksandarkrstikj.com/mm-sorter-using-opencv-and-arduino/ . It also utilizes the “ReadFile()” method if you want to send commands from the Arduino back to the PC.

In case you communication via the RS-232 cable doesn’t go through, try communicating with the Arduino directly through the virtual serial port it creates when you connect it via USB to your PC. That’s how I was using it. Just make sure to note which is the serial port that’s opened on your PC. My code expects the serial port at COM3 but yours may be different, so adjust accordingly.

Let me know if that helps you. All the best.

Reply

- 
pi
July 5th, 2013 on 12:02 PM

how do the instructions for sending serial commands from pc (OpenCV + +) to the Arduino.?

I made the driver’s drowsiness detection devices with camera

that at pc = if you have found sleepiness (“alarm active”) then ..

that in Arduino (hardware)
1 = bazer will live
2 = the wheels initially inactive to die (dc motors)
3 = posts lcd “danger”

how i can do it .. please help me

Reply

  - 
Ethan Hunt
July 5th, 2013 on 4:49 PM

Please read the response I gave to the user ‘doel’ above.

It will point you in the right direction as far as serial communication between a PC and an Arduino is concerned.

You can take a look at the code I have posted in projects here to see how I managed to send commands to and from the Arduino.

Reply

- 

  GPS
  July 16th, 2013 on 1:55 PM

  Hi! We’re using Visual Studio and OpenCV in our project to detect the red ball with the laser attached to the servo motor. We can’t seem to transmit the data from Visual Studio to Arduino Uno to control the servo motor via USB cable. We also tried to try the code you’ve posted but still, it doesn’t control our servo motor. What do you think can be the possible problem?

  Reply

  - 

    Ethan Hunt
    July 16th, 2013 on 5:25 PM

    Can you successfully send the Arduino commands over the serial console of the Arduino IDE? I would try that first just to make sure something else isn’t causing the issues.

    Other than that, make sure that the COM port that the Arduino is attached to matches the COM port in the serial connection in Visual Studio. I had it setup to work for me but yours might be different.

    I can’t really say much more without some additional information like source code.

    Reply

    - 

      GPS
      July 17th, 2013 on 5:01 PM

      Good day,

      finally i was able to get your codes working. it was just a matter of using the com port recognized by the pc.

      Moreover there is one more thing that i would like to achieve and may I ask for your opinion

      It’s basically about tracking a red ball, however the camera shouldn’t be moving and is placed still only in one position. There will be a low cost laser pointer that will be attached to the servo motor instead which will then be controlled to track the target object.

      In addition to that, we are planning to make use of the extracted y coordinate from the program, so what happens now is there will be actually 2 servo motors, one for handling x values and the other to handle the y values which are working concurrently as the ball is being tracked.

      How are we able to point the laser pointer in such a way it is precisely matched to that of the x-y positions calculated from the image frame?

      Any insights from you will be highly appreciated

      Thanks and more power!

      Reply

      - 

        Ethan Hunt

July 18th, 2013 on 3:44 PM

Sound like an interesting project. To be honest, I'm quite busy these days so I haven't given this too much thought but here's what I'm thinking:

You'll get the x and y coordinates from OpenCV. You'll need a way to calibrate the lasers, that is the servos to the coordinates. In my mind, this would be a trial and error thing.

Since 1px on screen isn't equal to 1 servo step you'll need to find some ratio that matches. For example 1 servo step for every 10px.

You can then take let's say the x coordinate, and divide it by 10 (or whatever number you end up with) and end up with the number of steps you need to move.

You'll just have to make sure that the servo starting mid position is the camera mid position (both x and y) so that you can equally move left and right. Otherwise you might end up in a situation where the servo is at its end but the x coordinate is still to the left or right. Of course, if your servo can move 360 degrees forget I said that (my servos aren't continuous)

Same thing goes for the y coordinate. However since you'll need to move the whole 'y-assembly' along when you're moving your 'x' make sure that the whole thing is light enough for the servos to handle. Again, I'm thinking of my servos but if yours are some state of the art mega servos don't worry about it

Hope it helps!

Reply

- *GPS*
  July 19th, 2013 on 2:28 PM

  thanks for the insightful suggestions! we're now actually working on trial and error calibration. at the same time figuring out the most optimal ratio of pixel to degrees for the tracking part.

  thanks again and more power to you! we might be back for more inquiries

- *Harry*
  July 17th, 2013 on 1:10 AM

  Hi, thanks for sharing. I'm also planning to implement something similar with multi cameras and your work puts me on track.

  Reply

  - *Ethan Hunt*
    July 18th, 2013 on 2:49 PM

    Happy to help

    Reply

- *Sloppy*
  July 19th, 2013 on 1:23 PM

  First of all let me say thank you. Thank you for the time and effort you put into this.
  From a noob in openCV standpoint this really helps understanding how to start working with openCV.

  I am using VS2010. I downloaded OpenFrameworks that include openCV.

However, I cannot combine your code with the openCV libraries.

I dont understand how all of this should be together for it to build correctly.
as much as I understand, I should create a new win32 project. then in the folder created I should place the opencv and opencv2 folders.

however, the 3 include statements say they cannot find the source file.

what am I doing wrong?

thank you very much again!

Reply

- *Fadil*
  August 19th, 2013 on 6:04 PM

  i cant open up a serial port…cn u pls help???o provide me a code or some article???i had tried tserial by Thierry.but no code seems to work..

  Reply

  - *Ethan Hunt*
    December 24th, 2013 on 11:21 PM

    To be perfectly honest, I also had serial port issues when I started doing this project.

    What I found out is that different operating systems behave differently as far as opening serial ports is concerned. So doing this on Win XP may not be the same as doing it on Win 7 or another OS. The reason behind this is the availability of libraries to open a serial connection.

    I would suggest that you do a search tailored for your OS and programming language. While I was searching, I found several different libraries that could manage a serial connection. I ended up going with this one because that worked for me, but there were a bunch of options out there.

    Some of them were outdated though, working only on older OSs, going as far back as Windows 98, so take that into consideration. Make sure that what you end up using is confirmed to work with your setup. After you get precise search results, it's relatively simple to find examples and tutorials to set it up properly.

    Reply

- *abdul*
  August 31st, 2013 on 6:54 AM

  hi..where I found the reference face tracking with OpenCV template matching method..can you see link for me..

  Reply

  - *Ethan Hunt*
    December 24th, 2013 on 10:41 PM

    I'm not sure I understand your query, can you elaborate some more?

    Reply

- *keithpang*

October 20th, 2013 on 6:12 AM

A really nice job due!
By the way, is it possible to generate the tracking signal to robotics? Like ABB and FANUC robot. I got a robot and it is programmable, I'm trying to apply this to the robot but it is new for me. Do you have any advise? Again, really great job bro! Keep in touch:)

Reply

- 

  Ethan Hunt
  December 24th, 2013 on 10:46 PM

  Sorry, but my work with robotics usually boils down to some home-made flying-by-the-seat-of-your-pants robots built using home made materials. I haven't worked with production-grade programmable robots such as the ones you mentioned, so I wouldn't be able to offer any concrete advice.

  Reply

- 

  Pedro
  October 26th, 2013 on 9:04 PM

  Hi, If I have a stepper motor instead of a servo motor. What changes will I need make in the project?

  Reply

  - 

    Ethan Hunt
    December 24th, 2013 on 10:40 PM

    Take a look at the 2nd OpenCV project I did here (http://aleksandarkrstikj.com/mm-sorter-using-opencv-and-arduino/). I'm using a stepper motor over there, so you'll find some code examples on how to use them.

    Basically, the difference would mainly be in the Arduino code itself. Unfortunately, I don't have stepper motor code for this particular project that I can paste to you.

    Try something out and let me know how it works out, so maybe I'll be able to help you further.

    Reply

- 

  Fadil
  October 29th, 2013 on 5:56 AM

  hey Alex!
  can u pls tell me step by step how i can communicate with arduino????i am struggling a lot
  thank you!

  Reply

- 

  Jomar
  November 27th, 2013 on 4:24 PM

  sir! good day! do u know how to write a program that lets opencv compute and detect the location of an object and send commands to the motors via arduino to move the robot on that location? thx in advance!

  Reply

Ethan Hunt
December 24th, 2013 on 11:28 PM

Sorry, I don't really have any code written that could help you with your project. This is very different than the project I've done here, so I don't think you can reuse something other than some small code snippets related to hardware/software communication.

Reply

Gagan
January 13th, 2014 on 6:58 PM

Hi, Your project is quite interesting. I would like to know if a program can be written in Arduino using Open CV libraries ? Is it possible to burn the program onto a Arduino controller thus the camera not needing to interface with a computer ?

Reply

Ethan Hunt
January 14th, 2014 on 1:44 AM

Hmmm, interesting question. I have to admit I haven't really looked into this myself, probably cuz I already had the USB webcam interfaced to my PC and didn't want to bother. But now that you mentioned it, I got a few ideas myself which involve a camera directly connected to an Arduino Microcontroller.

Well, obviously a regular USB webcam wouldn't be able to interface with an Arduino directly due to drivers and stuff (at least not to my knowledge). It got me thinking that perhaps there's a camera shield for the Arduino or something like that. A quick search revealed the following websites: http://www.arducam.com/tutorial/ and http://learn.adafruit.com/ttl-serial-camera/overview . It seems there are cameras which can connect to the Arduino or to a shield like I mentioned before.

However, now there's the question of using OpenCV libraries to do the processing. Personally, I was using the C++ flavor of OpenCV to do my processing which isn't compatible with the Arduino. However, I believe OpenCV exists in a C variant as well, so perhaps that will work. I haven't tried it myself, and I doubt it will work on my Arduino Uno due to the slow processor, and small amount of memory the micro-controller has. I just don't think you'll be able to fit an OpenCV program on it, yet alone have the power to process an image, not to mention a video stream. Perhaps some of the more powerful Arduino models might be able to do something. I really can't say.

It's a very interesting question though, so I hope another reader jumps in to shed some light on the matter. Feel free to share if you find something else yourself. I might implement something like that in a future project.

Long story short, my current thoughts are that I need a PC in order to process the complex video stream fast enough, and then send simple commands to the Arduino running the small simple program for servo control.

Reply

jairam naik
January 17th, 2014 on 4:18 AM

hi,
without serial communication can we track a object with arducam shield? I am looking code for object recognition in arducam shield and without using serial communication. if possible give reply to jairamsms2@yahoo.com

Reply

Ethan Hunt

January 17th, 2014 on 5:25 PM

As I mentioned in the post just above yours, I haven't done this myself, and I don't really believe it can be done due to the limitations of the Arduino platform.

I think that the micro-controller just doesn't have the power to process video in real time. Additionally, most of the code I've seen for the arducam shield and Arduino cameras in general seem to only capture low resolution images, so this kind of confirms my original thoughts.

Perhaps it might be able to capture one still image and do some low-level slow processing on it (using OpenCV in C), but real time video seems out of scope.

Again, I haven't experimented with this too much, so I can't say anything for sure.

Reply

- 
Anthony Stark
January 17th, 2014 on 2:39 PM

Hello …am trying to do something similar to what u have done but using the x and y position. i am kinda of confuse cause am new to this environment of programming. did u only use the x coordinate in your code? how did u allocate it to the servo or was the x coordinates allocated to the "servoPosition" in ur codes? if i was to use the y co ordinates, do i edit the "servoOrientation"?

Reply

  - 
Ethan Hunt
January 17th, 2014 on 5:30 PM

Awesome, Iron Man is reading my blog 😀

What I did was to get the x coordinate as a pixel position on the image. I then "translate" the pixel position into servo motor degrees. So if 90 degrees orientation is pixel 100, then if I move to pixel 110, I'll move my servo to let's say 95 or 100 degrees. Same goes for the other direction.

Now, I'm not really sure what you're doing that requires x and y. Could you explain a bit more, so maybe I could help you? It doesn't make sense to me to apply x and y to one servo. Perhaps you have two servos, one for horizontal and another for vertical movement?

Try to explain your setup as best as you can, and we'll go from there 😀

Reply

    - 
Anthony Stark
January 17th, 2014 on 7:24 PM

sorry about that, i forgot to mention i was going to use 2 servos for the horizontal and vertical axis. i want to one servo to collect data for x and the other for the y. hope that explains better cause am finding a bit difficult trying to accomplish that. thanks
FYI am no iron man lol

Reply

- 
Sandeep Yadav
March 4th, 2014 on 2:42 AM

Hi there,Hope you all doing well. Im doing that project for my final year project. Im doing electrical engineering so that is bit hard for me as it's more relatively to electronics and computer science engineering. Can anybody help me please…how servo motors are communicating with Camera and Arduino board? Can we use other microcontroller for same application?

why we choosed Arduino as a controller? is there anything that is related to electrical in this project. Thanks in advance… hope to hear from someone soon.

Reply

- 
  Suraj Nair
  March 7th, 2014 on 4:54 PM

  Hey there! Thank you so much! Am working on something similar. My tracking code works fine. I've been trying to use your code for Serial communication. My arduino is connected via USB to my computer, and the port created is COM15. However, your code returns that the port does not exist. Any suggestions?

  Reply

  - 
    Ethan Hunt
    March 7th, 2014 on 8:41 PM

    My code, as posted here, tries to connect to "COM3″ as that's what I was using. You can see this in the second line of the main method. Change the port to whatever works in your case. Let me know if it works out.

    Reply

- 
  Nauman
  March 26th, 2014 on 5:23 AM

  Where is Circuit diagram of this project ?

  Reply

- 
  Masoud Salehi
  March 30th, 2014 on 5:30 PM

  hi
  how can i determined blue HSV range for scalar() in, inRange() function?

  please help me .
  thanks for your favor

  Reply

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- *M&M Sorter using OpenCV and Arduino « Aleksandar Krstikj.com*
  June 27th, 2013 on 2:09 PM

  [...] my first OpenCV project which dealt with object tracking, I decided to do something a little more challenging and complex, [...]

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