Motion Detection

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Abstract

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When we want to watch if interesting something has been recorded by our security camera, usually we spend a lot of time watching long recorded videos. Our project comes to suggest a simple solution for that problem: detecting true motion and events that should be recorded, ignoring false triggers. This is done by learning the background for certain amount of frames, concluding useful information, then analysing frames to detect true motion.

1. Introduction

Here are some points you may want to cover in your Introduction section.

- the main goal of our project is providing a functionality to security cameras allowing recording only when there is a real need to record. We think this is important because in addition to saving us useless long recorded hours of video, it can save much valuable disk space.

- the main problem we may face is distinguishing true motion from noise. in some cases it is pretty easy and trivial to detect true motion, for example: when background is static, it is easy to recognize when motion occurs. However in other cases it is not so trivial, for example: when there is background motion at first. The challenge becomes to detect the real true motion that requires treatment, ignoring noise or background motion.

- Most common approaches dealing with motion detection ,that used in the industry, is doing this using sensors: one is using Passive Infra-red that detects body heat. the other approach is using microwaves, it sends out microwave pulses and measures the reflection off a moving object.

- Frame or picture is not more than a matrix, while each cell represent one pixel by its RGB color values. Therefore, each frame has its own unique signature by this mixture of values.We can take advance of this feature and use it to compare frames recognizing differences between them. Each pixel has a three tuple representation, which called RGB color system, each value in the tuple ranges between 0 to 255. This system constructs all the colors from the combination of the **R**ed, **G**reen and **B**lue colors. (see Figure 1)

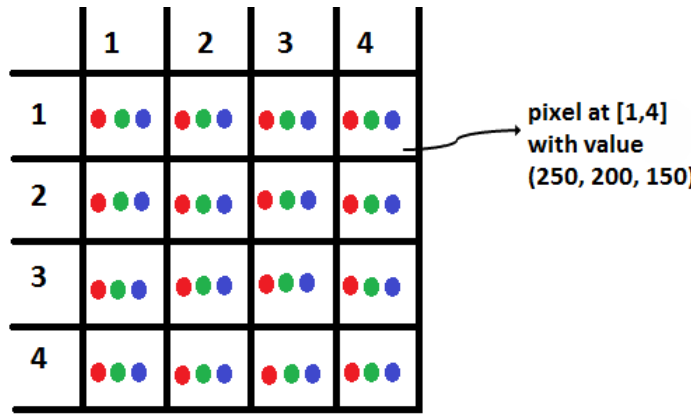

Figure 1: RGB matrix representation

2. Method

As we have mentioned before, every frame has its unique ”DNA” which represented by a matrix of 3-value tuples. The main idea of our algorithm is to calculate the average colors value for every frame by calculating the average of red, green and blue values for all the cells, then averaging the three averages. The process is done by the following formula:
Frame3ColorsAvg = (cv2.sumElems(frame)[0] + cv2.sumElems(frame)[1] + cv2.sumElems(frame)[2]) / 3.

At this stage we will get a unique value which represents this frame. Now we need to model and learn the background, so we can distinguish between background/background motion and foreign body or motion enters the picture. We do it by applying same procedure for a certain number of frames, for example X frames. After we got the ”DNA” of all these X frames (clean background frames), we extract from those frames the average and maximum deviation.

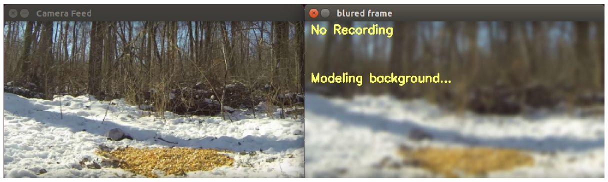

Figure 2: Learning background Level

Now we have two important parameters, which can help us recognize a foreign body or movement from a clean background. We do that by comparing the average (DNA) of every frame with our previously calculated average and maximum deviation, if the current average value is deviant of the main average by more than max deviation, we raise a flag!. Whenever we get a reasonable number of flags in a row, it is a signal of a true motion not just a noise. In other words a foreign body has entered the picture.

The greatest challenge while implementing the algorithm was eliminating noises, such as sensor noise or sudden light changes and false motion alarms. We have overcome these difficulties by using two main techniques:
1. Gaussian blurring frame pixels - which is a great way to eliminate local pixel noise. This has been done by the following formula:
bluredframe = cv2.GaussianBlur(frame, (21, 21), 0)
2. Verifying motion detection - by ensuring row of raised flags as a signal of foreign motion entered the picture. this is an effective way to eliminate false flags raised as a result of sudden and momentary changes of frame pixels, which often go back to its normal state.

3. Results

Here we present a result of running the algorithm on a sample video, as we can see at the beginning (see Figure 2) there is no special motion at the background except of slightly moving branches. At this level we study the background.
However, when we are suspecting a motion, like the bird jumping through the picture (see Figure 3), we raise a flag as a signal of a potential motion.
At this stage we have pretty ensure that a foreign body has entered the picture and there is a motion detected, so we start recording (see Figure 4).

4. Conclusion

We have seen that frame and pixels analysing is very useful at many cases, such as detecting motion and changes in a picture. However, the algorithm we discussed above has its Weaknesses. since it is relying on average of frame pixels colors, it may fail to recognize a motion if the total average of colors has not changed noticeably. (see Figure 5 and Figure 6)

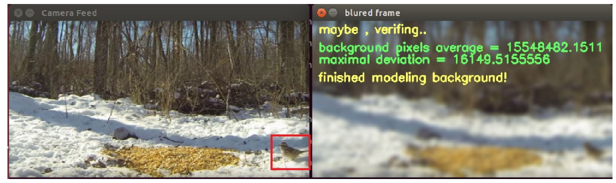

Figure 3: Verifying detected motion

Figure 4: Motion verified. Recording started

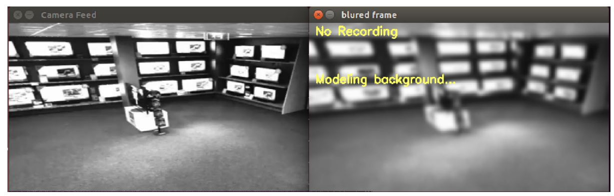

Figure 5: Learning background Level

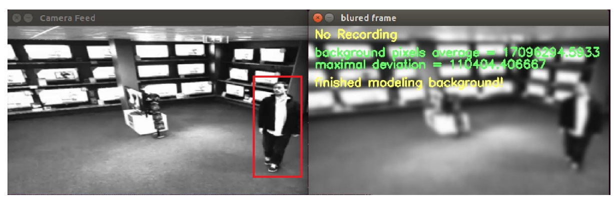

Figure 6: failed to detect motion