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Movement Detection using Raspberry Pi 3 and AWS S3

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ABSTRACT

This project aims to detect presence in the room and sends notification on user's mobile if any movement is detected. The webcam attached to raspberry pi will save the images of the room to raspberry pi and check for the changes in an image every few seconds. If the movement was detected, user will be notified via text message and the imaged where the change was detected will be uploaded to Amazon simple storage S3. The text message will have a link to the web application where user can login and check the images.

AIM

When a person is away from home, he or she might feel the need to keep a watch on home for security purpose. Aim of this project is to alert the user who is away from his/her home if there is any movement detected in the room. Alerts are given using twilio messaging service which sends the link of web application to the user to check the images.

WORKING

The flow is as follows:

This is achieved by setting up a Raspberry Pi 3 and a simple camera module of Raspberry Pi. When script has started the camera will click the warmup image.

After that, the camera clicks an image of the empty room and names it as template image. The template image is used for the comparison of all the next pictures because the aim was to detect any presence in the room and not just the changes between last two images. The images are saved in the date wise folder on raspberry pi.

Camera will click the pictures of the room every two seconds and save them on Raspberry Pi. This time gap of two seconds can be adjusted in the script.

A script stored on Raspberry Pi will check for the changes. Script will convert the template image and test image in grayscale and calculate absolute difference between the two. It will pass this matrix to a function called calculate entropy. Entropy of the difference in the image is calculated based on the formula used by Galileo imaging team.[1]. The formula is as follows:

$$\text{Entropy} = -\sum_{i} P_i \, \text{Log}_2 P_i$$

Fig: Formula for entropy of an image.

If there is no difference between the two images, the entropy of the difference of the images will be close to 0.0 (meaning a black image) and maximum to 0.99 value.

If the entropy of the difference image is I the range of 1.10 to a value greater than 2.0 then there is likely change in the image which means that someone was there in the room.

If Raspberry Pi detects this change then it will send the image where the motion was detected to amazon simple storage s3, as well as send a text message through twilio to the user's phone.

There will be a link given in text message which will redirect user to a webpage. Images will be shown on the webpage where the changes were detected. The webpage is secured by the login so that the images will be accessible only to the user.Users are able to download the selected images of their choice onto their phone.

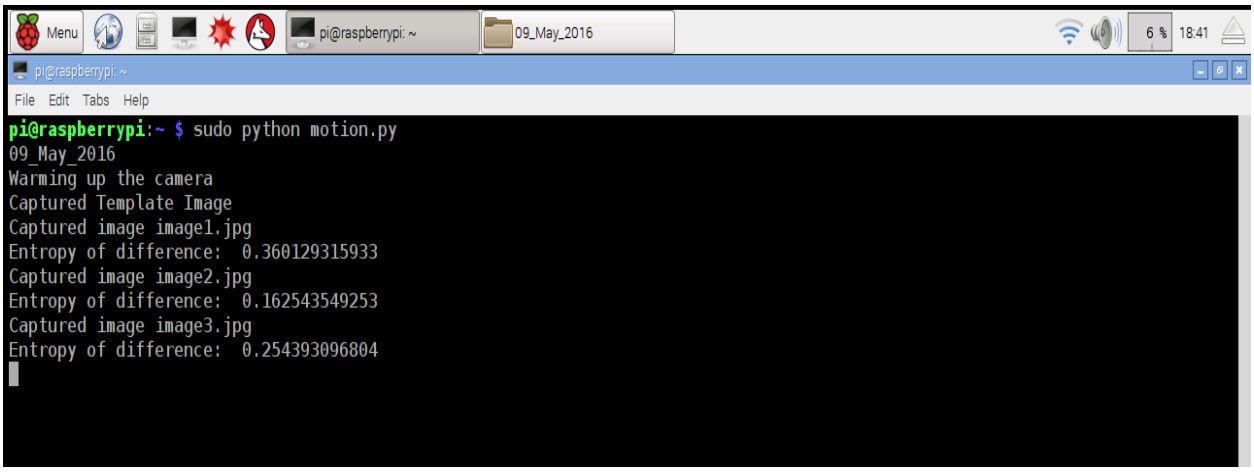
OBSERVATIONS AND RESULTS

I ran this script in various rooms (UTA Library, Home, and ERB). The use of template image is such that where ever the Raspberry Pi is kept it should detect the change in environment based on the template image.

The entropy value threshold when the change is detected stays approximately between the range of 1.10 to 1.50.

SNAPSHOTS

Snapshot of the scipt when no change is detected.



Snapshot of the script when someone enters the frame and change is detected.

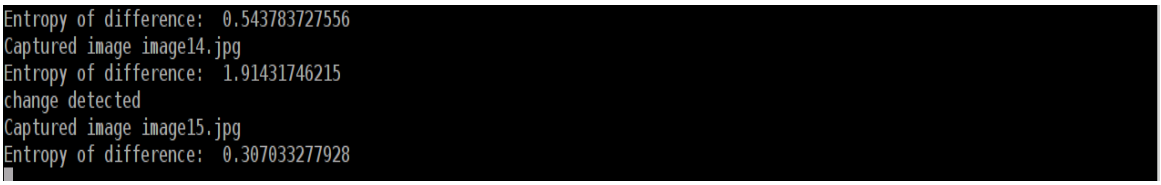
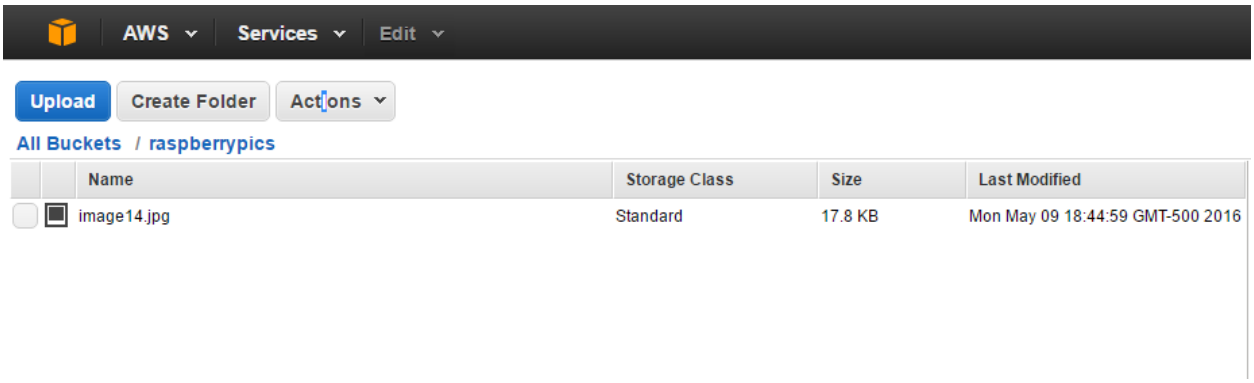
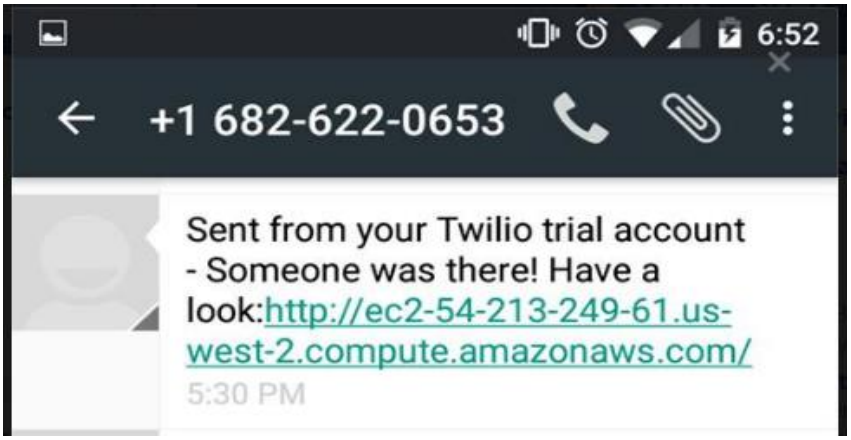


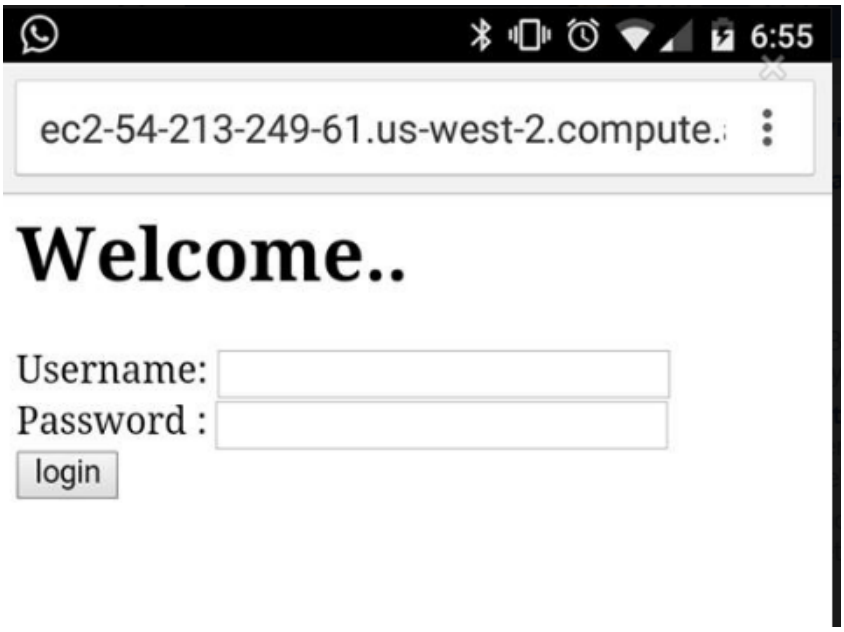
Image 14 is then uploaded to S3



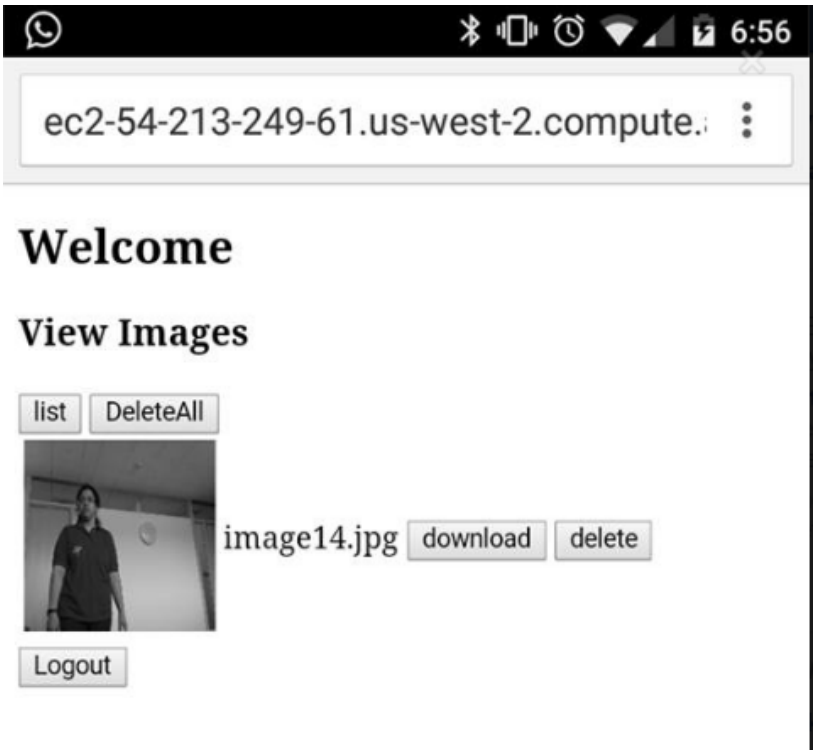
Twilio Message on my phone:



On clicking the link given:



After logging I can see the changed image.



I can choose to delete or download the image and the changes will be updated in amazon simple storage.

FUTURE ENHANCEMENTS

There is a lot of scope to improve this system. The images could be stored in S3 in date wise folder and displayed accordingly.

User may be able to talk to the person with help of an additional microphone module attached to the Raspberry Pi. In case of alarming situation where user might want to report to police of any suspicious movement, when user clicks ‘raise an alarm’ signal shall be sent to the Raspberry Pi to blink the light as well as call the police from user’s mobile.

Further enhancement could be able to send short length videos of two minutes to cloud service. Script present in the presence will process these videos. If the movement is detected in any video, cloud service will send the signal to Raspberry Pi to record longer video session, say five minutes and send that video to user’s mobile through a Multi Media Service (MMS).

REFERENCE

For Image Entropy Concept

[1] http://www.astro.cornell.edu/research/projects/compression/entropy.html

Other:

Python and Boto3 Documentation.