Use of ICT´s to Generate Real-Time Alerts Based on the Automatic Analysis by the Artificial Vision System That Monitors Eruptive Processes

Christyan Mario Cruz

Universidad de las Fuerzas Armadas ESPE - Ecuador

Departamento de Energía y Mecánica

General Description of the Sistem

- The great potential, reliability and the high number of applications made through artificial vision, are fundamental for the development of a monitoring system pyroclastic flows for active volcanoes.
- Platforms as Raspberry Pi based on free software (Ubuntu), have a great potential to run several software for the application of computer vision techniques
- Data acquisition
- Fast processing
- Control outputs

Objectives

- Implement an artificial vision system through a free platform.
- Create a layer of selection of tonalities for lava and pyroclastic flows.
- Design a system of preventive alarms
- Centralize an object in an area of interest
- Combine the system in just one program

ICT´s

- The use ICTs to develop and deploy new applications that generate large-scale utility in risk areas, provides a great social contribution in the event of a natural disaster of volcanic character.

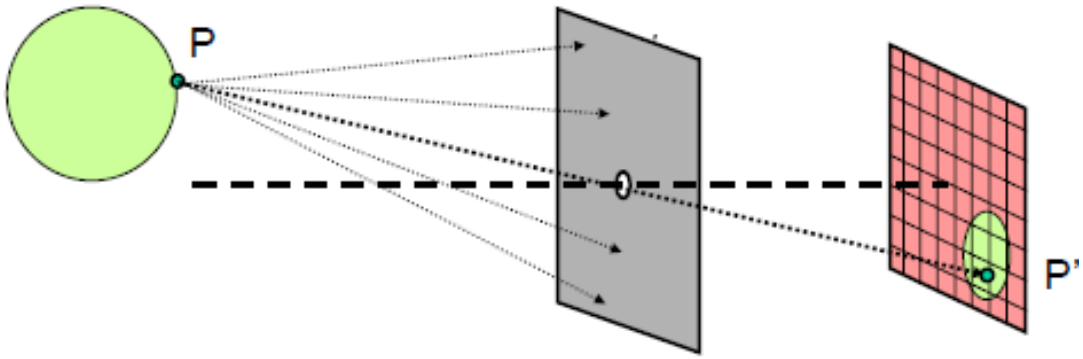
- Raspberry Pi whose functionality embedded system is the main aspect that can be highlighted as allows data acquisition, processing and generating signals[1,9] through its ports, which combined with free programming language

Raspberry – Pi

- Alarm systems actived in case of eruption may be sound and light type, where the use of GPIO ports (Inputs and Outputs General Purpose), provide connections from the control board to the external environment, before processing performed

Images acquisition

The main objective of digital image processing is find information within a matrix of pixels[2,3], in this case is the pursuit of lava and pyroclastic flows within a sequence of images (video), captured through a sensor (camera)



Artificial vision

After capturing the image, this is in the RGB color space (Red, Green and Blue), but for processing must be passed to HSV (Hue, Saturation and Value), because it facilitates the recognition of palettes specific between minimum and maximum values, in addition to separating the layer brightness

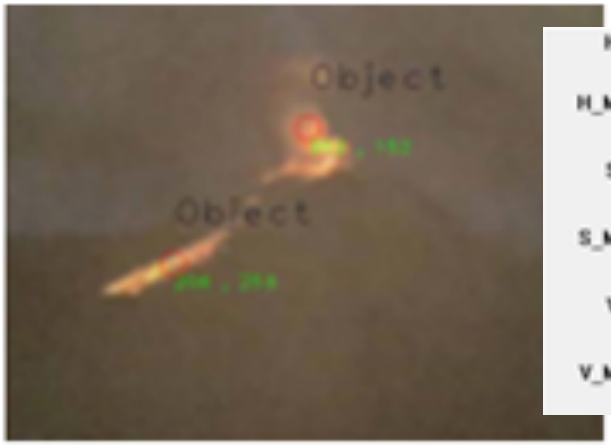
Alarm and communication systems

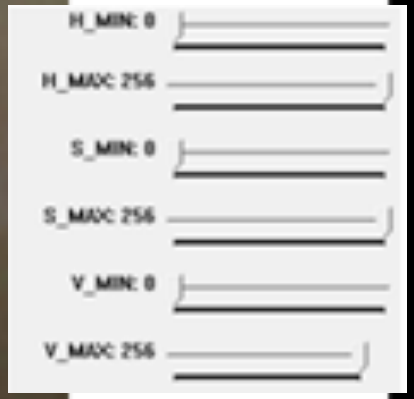
- One of the key parts for early warning to the surrounding communities of a volcano and to prevent risks that could cause an eruption, are visual alarms placed in strategic locations and areas of high visibility for communities and high-risk sectors
- Visual Alarms
- Sound Alarms
- Notifications

Image processing and detection of variables

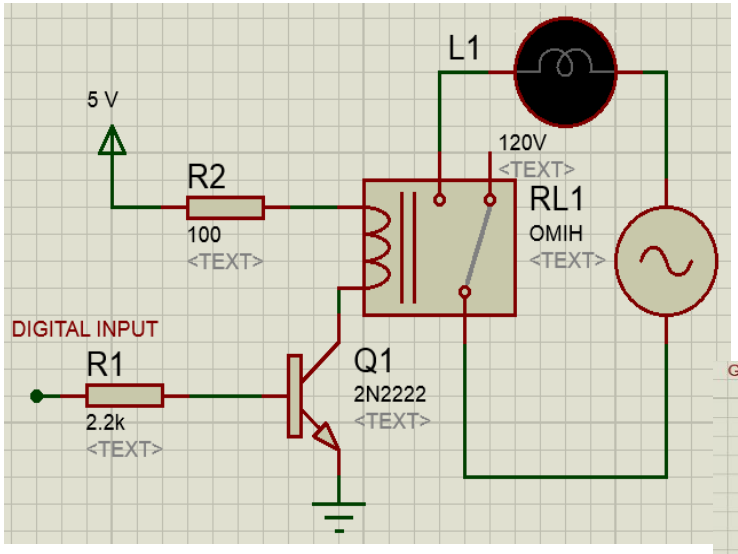
- Applying layers of erosion and dilation, to improve the morphology and better define the contours of an image.

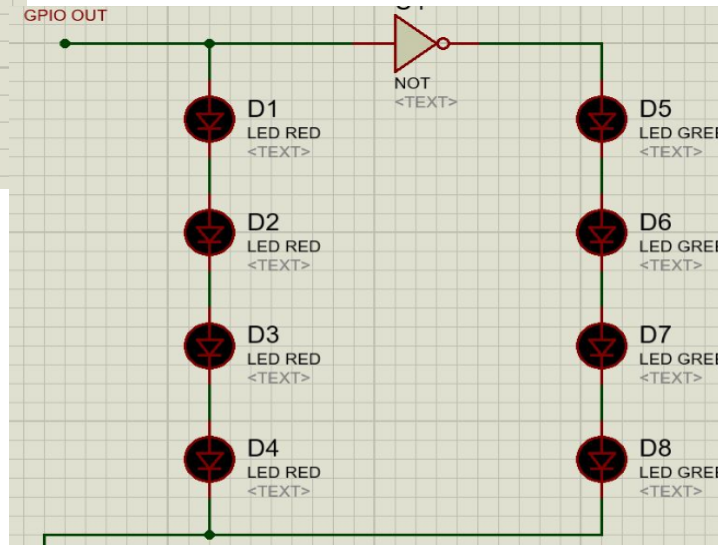
- To improve the image is necessary a Trackbar to modify the maximum and minimum HSV parameters, those values will be used to create a mask, which will function as a filter allowing passage only nuances in a set range, this range will consist of shades of lava and pyroclastic flows



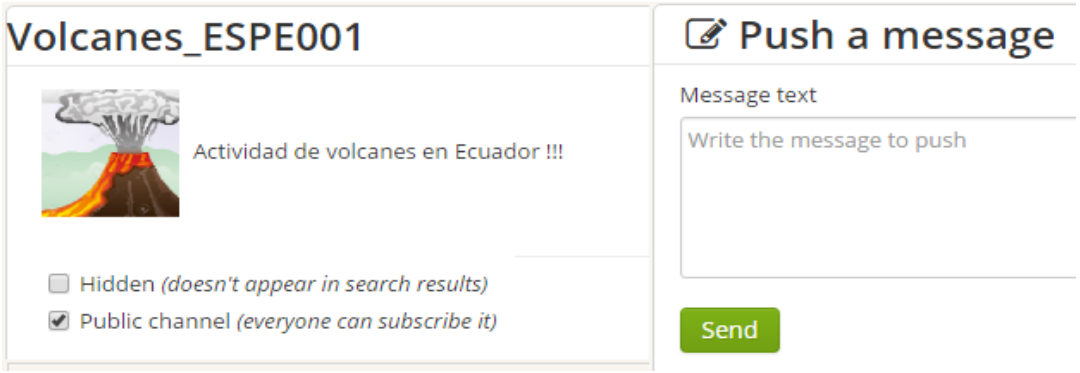


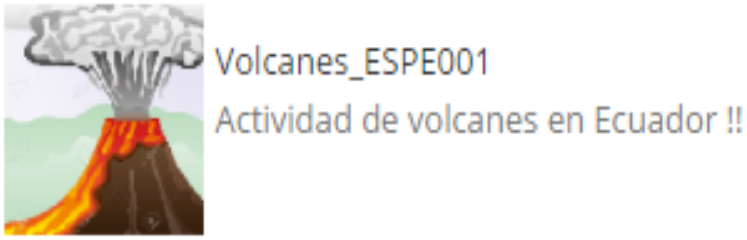
Alarm and communication systems (ELECTRONIC)





Alarm and communication systems (NOTIFICATION)

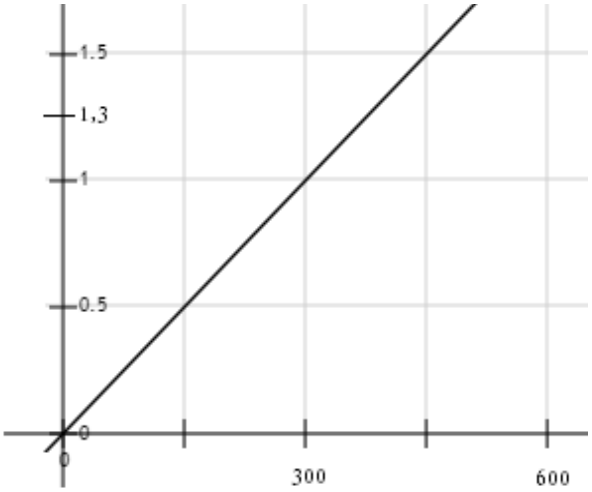




Communication Systems

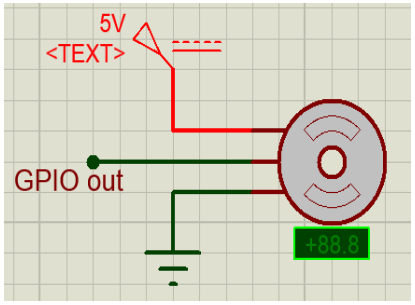
The types of communication that can be used for data transmission, applicable to the project are: Bluetooth, Ethernet (html) through Wi-Fi, LAN, 3GSM and 4G LTE networks allowing interaction with the external environment.

Centralization of the area of interest

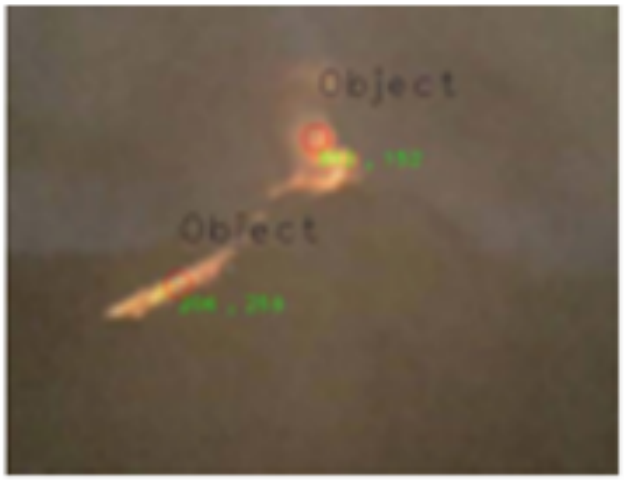


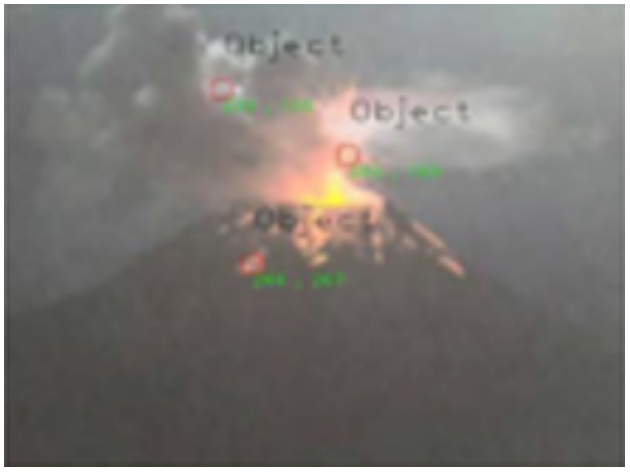
$$y - y1 = m(x - x1)$$
$$y - 1{,}3 = 0{,}0021(x - 600)$$
$$y = 1{,}3 + 0.0021x - 1{,}3$$
$$y = 0{,}0021x$$

```
if (error > 200):
    sol=sol-pul
    p.ChangeDutyCycle (sol)
else:
    sol=sol+pul
    p.ChangeDutyCycle (sol)
```

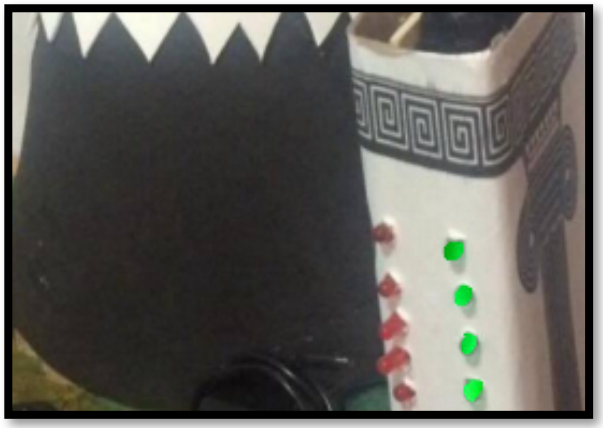


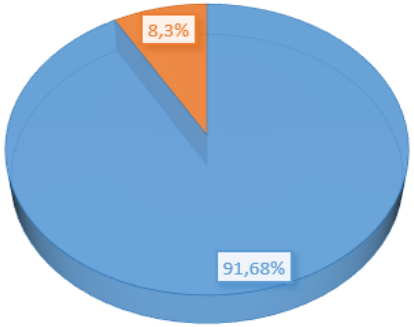
Trackbar aplication





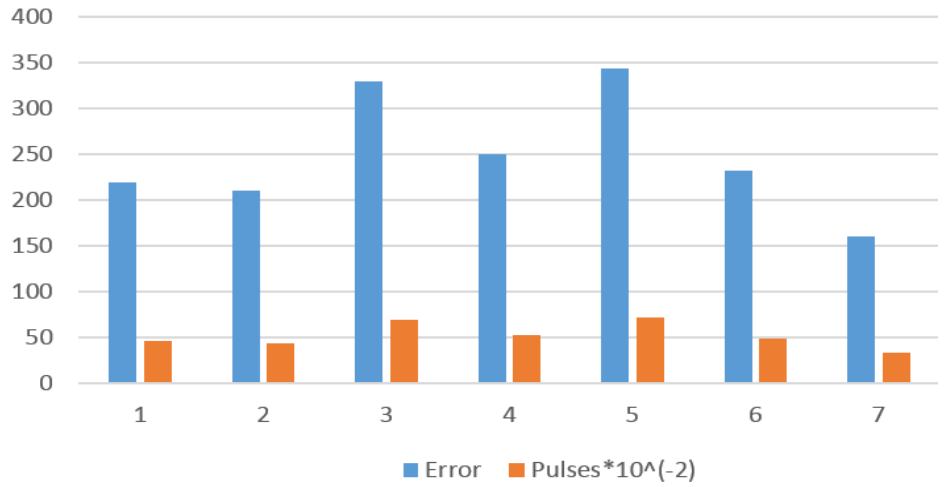
Activation of the sound and light sistems



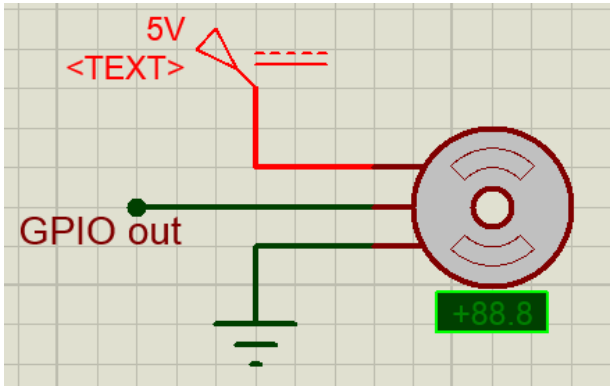


Test	Time- turn on lights	Time - get notification	System Efficiency
Effective time / # test	0.5 s	12 seconds	100%
1	0.601 s	12.3 s	96.8%
2	0.700 s	12.6 s	93.9%
3	0.721 s	14.1 s	84.4%
4	0.650 s	12.5 s	95.05%
5	0.553 s	12.9 s	92.93%
6	0.768 s	13.3 s	88.9%
7	0.750 s	12.9 s	92.04%
8	0.767 s	13.5 s	87.6%
9	0.733 s	12.8 s	92.2%
10	0.690 s	12.6 s	93.0%

Centralization of the area of interes



Error	Pulses*10^(-2)
220	46,2
210	44,1
330	69,3
250	52,5
344	72,24
232	48,72
160	33,6



- For monitoring made towards the center of the detected objects, compensation is employed by pulses sent to the anchored servomotor to a camera, using equation shown.

- The warning systems such as light alarms, sirens, messages on mobile applications, which are transmitted in real time to vulnerable populations time, they can be vital to forewarn and especially save lives, because of the short time that used to be activated.

- HSV values are (H min = 0, S min = 158 min = 108 V) and (H max = 256, S max = 188, V max = 256).
- Leaving only blank area of interest, which the area is calculated, and is considered significant if it is greater than 1000 pixels, because of the scaling 1-10000 for the mirror screen

Future works

- We could implement a board with more RAM and with a better processor, also use an energy autonomy system for a continuous monitoring.

THANK YOU FOR YOUR ATTENTION

Questions and coments :
cmcruz1@espe.edu.ec