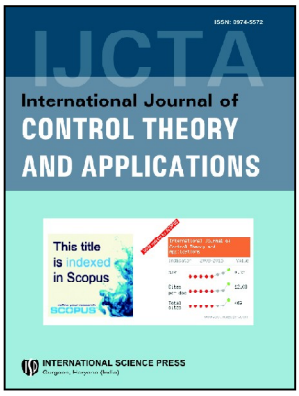

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Making Television More Power Efficient Using Pupil Detection Algorithm

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Abstract: Objectives: The power utilization for television is more now a days. On an average television utilization per day is around 5 hours and it almost costs around Rs. 50 per day. Sometimes the television will running idle without any viewer. The objective of this idea is to reduce this wastage of television power consumption.

Method: In this idea, we used face detection and eye ball detection using image processing for automatic television turn ON and turn OFF by using camera for detecting the viewer. The pupil detection in open CV software is used for our problem. The camera detects the face and then detects eye ball and continuously monitors the movement of eye ball. When the face and pupil is detected continuously for some time, by using a relay camera makes television unit ON and camera makes television unit OFF when pupil is not detected. This is developed for efficient utilization of television power.

Keywords: Eye Detection, Pupil Detection, face detection, power efficient TV, Television, Smart Television, Intelligent Television, Camera Television, Television Camera, Surveillance, Smart TV, Intelligent TV.

1. INTRODUCTION

Television is the medium for transmission of moving images in monochrome or color, in 2D or 3D with sound. In 1920s black & white televisions were started but were popular after the world war-II. In 1960s, color televisions has started and evolved to digital television in late 1990s. Now a days, high definition & smart TVs were emerging with advanced features.Many times power of a television is wasted when a viewer is sleeping without switching off the TV or forgets to switch off and left the room. This cannot be understood by a television to go into sleep mode, so the TV will be running and wasting the power of a television set.

The aim of this paper is to make television smart enough to understand whether the viewer is available and viewing or not. If no person is viewing the television and it is idle, the camera will identify and turn-off the television set. If viewer is available before TV, then it will be turned ON without any intervention of the viewer. By using face detection [1] & eye ball detection [1, 2, 3], the system identifies the viewer and his eye ball for some time interval and then takes a decision whether viewer is available.

(A) Hardware & Software

The system consists of raspberry - pi and web-camera connected to normal television. The raspberry-pi is brain of the system which controls the entire operations like processing and controlling etc. Raspberry pi is very efficient in processing the multiple images, frame by frame. For capturing video image High resolution camera or web camera can be used. But the memory size of the image should be minimum, which makes the normal camera preferable over HD camera by reducing the size in Megabytes. So the system can read and process the image more efficiently as per the requirements, and this will decrease its processing time. The Raspberry pi will give commands to the Relay circuit, which enables GPIO pins to perform operation like turning the television on/off. In the level we would like to perform the operation without relay. Instead of relay, by directly connecting the pi board to the power circuit we can do the same operation.

A real time video capturing and an advanced image processing are used. Raspberry - pi has its own operating system called as "Raspbian", which is Linux based Operating System and it is compatible with raspberry - pi3 board. Raspbian use PIXEL as main desktop environment and consist of precompiled programs. To detect exact location of eye pupil is more challenging. A new image processing technique has been used for detecting and tracking the eye pupil center, which works based on open computer vision (Open CV) library taking speed into consideration. Most of the coding is done with the help of Open CV library. There are several algorithms like Hough transform, Haar cascade [4], and edge detection are available for different applications. Python is a language used for coding, which is helpful to resolve the error efficiently and user friendly. Open CV 3.0.0 library with python has been used for this system.

Figure 1: Block diagram

(B) Raspberry-Pi

The Raspberry-Pi is a low power micro-computer designed for education purpose. It consists of Processor, RAM, Ethernet connector, HDMI port, Micro SD slot, Audio and USB ports for connecting pen drive, Keyboard, mouse etc., It has general purpose I/O pins (GPIO) to connect Raspberry - Pi to sensors, LEDs etc., to control with simple code. It runs with operating system which is based on LINUX Debian (also called as Raspbian). This can also be used with WINDOWS operating system. It operates at 5v powered by USB power supply. With this low power supply, it will work programming like a desktop but its performance is as good as desktop. Using

Raspberry - Pi is very easy, even a person with minimum knowledge on coding can write a code on python for Raspberry - pi. Here we used Raspberry - pi3 board. It has additional features Wi Fi, Bluetooth. Its performance is 50% faster than its previous version Raspberry - Pi2.

2. METHODOLOGY

Initially switch on the power on the television set. Then the camera will capture the video before the television and pass it to the Raspberry-pi. Raspberry-pi will check for the face, if face is not detected for certain time the Raspberry-pi will disable the relay through GPIO pins and make the television set OFF. If a face is detected, by using Haar-cascade technique it will check for the pupil and if the pupil is not detected it will make relay OFF, so the television set is also OFF. If the pupil is detected, the raspberry-pi will enable the GPIO pins, so the relay will be made ON so that the television will also be made ON. Continuously the raspberry-pi will check for the face as well as pupil in the video captured by the camera attached to the television. Based on the delay applied to the system, raspberry-pi will make television ON or OFF.

The main principle of our system is detecting the face and then the eye ball or pupil and making the television set to keep it in ON or OFF states. The first part of the operation is to detect the face by capturing the face and detects the eye by using Haar cascade algorithm [4, 5]. After detecting the eye, pupil will be detected by using the same algorithm. The USB camera was fixed to the television set, to capture the video images before television. When the system is initiated, it will start capturing all the faces available at the place. And if any face is detected it will look for the pupil to detect. If face and pupil is detected than the system will make the television set ON and keep on tracking the face and pupil.

There are three possible cases to make the television utilization.

Case 1: When the face and pupil are detected, our system will make the television set ON.

Case 2: When the face detected and pupil not detected for a considerable duration of time than it will make the television set OFF.

Case 3: When face is not detected then it will keep the television set OFF and keep on monitoring for the detection of faces.

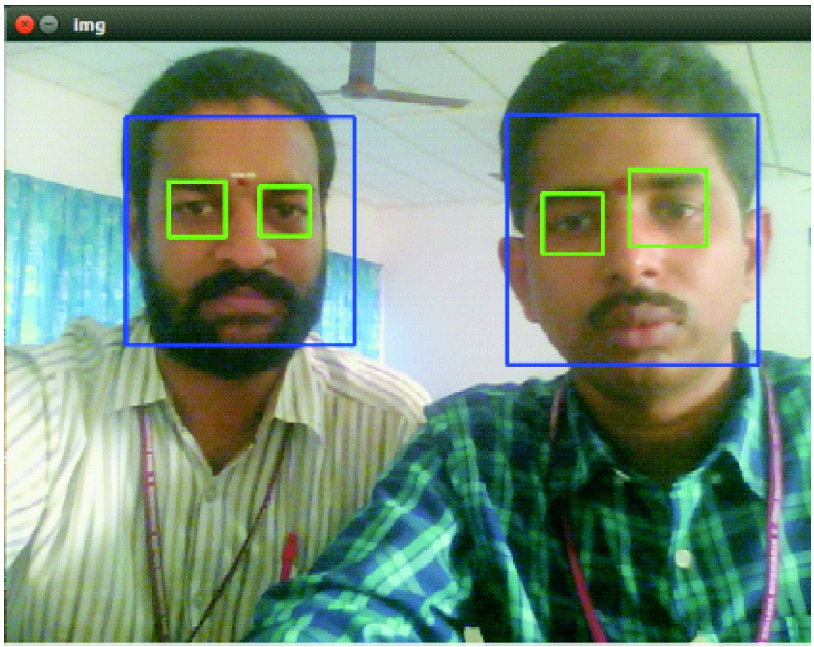

Figure 2: When Pupil is detected

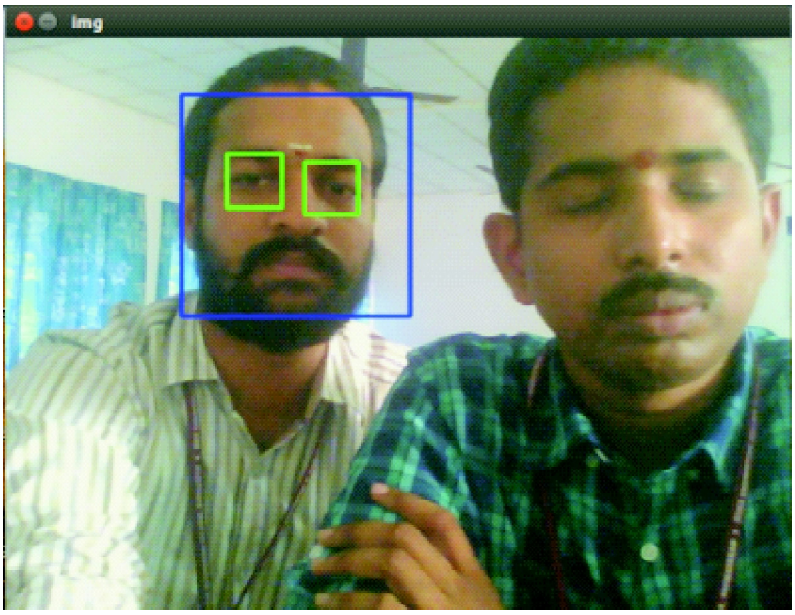

Figure 3: Difference between detected & Undetected Pupil

The system will continuously monitor the video images for face detection and eye pupil detection. It will check for the blinks, if the eye pupil is closed, then the time difference will be calculated between the present time and the previous time (i.e., eye pupil closing time). If the time is more than 60 seconds (we change this delay as per the user requirement) the system will understand as the pupil undetected and it will alert to make television unit OFF. If the pupil is detected when the television is OFF, it will wait for 60 seconds (we change this delay as per the user requirement) and alerts the television unit to make it ON. If there were more than one viewer and only viewer is active, then it will make the television set ON. The system will make the relay ON whenever there was at least one pupil is detected. If pupil of one eye is detected and the other eye pupil is not detected, it will take as the case face and eye pupil is detected.

In order to make the television ON/OFF based on the above cases we are using a Relay connected between Raspberry Pi and power unit of the television set. With the first caseraspberry pi makes GPIO of relay HIGH and thereby, the power of the television set is connected. With the next two cases Raspberry Pi makes the GPIO of the Relay LOW so, no power to the television set is allowed. In this way, the raspberry Pi with relay makes television set more power efficient. The television set will be ON if one pupil is detected. The Raspberry Pi will check frame by frame for detection of face and the eye ball or pupil. This is done with the help of Haar-cascade algorithm. If there was any drowsiness identified in the pupil, ie., pupil detected is less than 50%, it will take it as user is sleeping and then the relay is off, so the television unit will be OFF. There are limitations to the proposed model. The faces detection should be within the camera detection range. At least 50% of the pupil should be detected by the system. The major limitation this technique we observed is, the face detection and eye pupil detection is done only whenever there was a light falling on the face. If the light is not available in the room, we were having a limitation for identifying the pupil. This limitation can be avoided by using a HD night vision camera instead of normal web camera, to have better results.

(A) Haar-Cascade

Object detection is done by using Haar-cascade classifiers, which is an efficient method for detecting an object. This is done by training the machine by using a cascade function from a number of positive & negative images. This can be used for detecting the objects in any other images.

Here we used for face detection and eye pupil detection. Initially, the image captured by the camera connected to the television will be converted to gray scale image and the the algorithm will take number of positive images (i.e., images with faces) and negative images (i.e., images without faces) for training the classifier. From these images we extract features. They are like our convolutional kernel. Each feature is taken as single value obtained by substracting sum of pixels in black rectangle and sum of pixels in white rectangle. The haar features shown below are used for this.

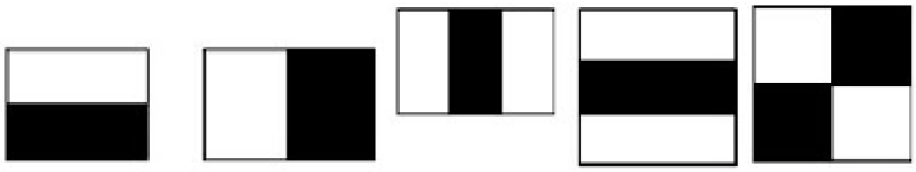

Figure 4: (a) Edge Features (b) Line Features (c) Four-Rectangle features

Now all the possible locations and sizes of every kernel should be used to calculate much number of its features. For calculating each feature, we should find the sum of pixels under the white rectangles and the black rectangles. To solve this complexity, they introduced the integral images. It will simplify the calculation for sum of pixels for large number of pixels also; it will be as simple as for an operation involving just four pixels.

For example, consider below figure. First row shows 2 good features.

1) It focuses on the region of eyes, which is darker than the region of the Cheeks and Nose.
2) It relies on the property that the eyes are darker than the nose. But the same windows applying on cheeks or any other places are irrelevant.

So by using **Adaboost**, we select the best features from 160000+ features.

For this, we need to see each and every feature on all the training images. For each feature, the best threshold is found, and this will classify the positive and negative images of faces. But, there will be errors or misclassifications. So, we need to select the features with a very low error rate, which means the features that best discriminates the images with face and without-faces. In this process, each image is assigned equal weightage at the beginning. After the classification, weights for misclassified images will be increased. The same procedure is repeated and new error rates & new weights are calculated. This process is repeated until the error rate required or accuracy is achieved or required number of features is found.

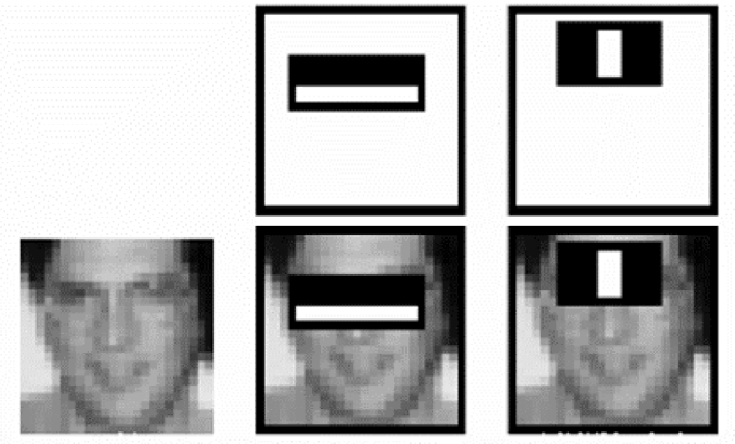

Figure 5: Selection of features

Final classifier is the weighted sum of weak classifiers. This is called as a weak classifier, because it alone cannot classify the image, but combining with others may form as strong classifier. So, let us now take an image with each 24x24 window. Apply 6000 features to it. Check if it is having a face or not. (Let total image features are 160000+). In an image, the majority region is non-face region. So, it is better to check if the window is a non-face region. If, it is non-face region, simply discard it. No need to process it. Instead of focusing on the region with face, better find the non-face region and discard it.

For this there was a concept calledCascade of Classifiers. Instead of applying 6000 features to the window, group all these features into different stages of classifiers and apply it one by one. If the window fails at the first stage, simply discard it. We need not consider the remaining features on it. If it passes, then do it for the second stage of features and so on continue the process. The window which will pass all the stages is a face region.

This haar cascade training can also be done for pupil detection as per the requirement. Based on the training the pupil will be detected.

3. FLOW CHART

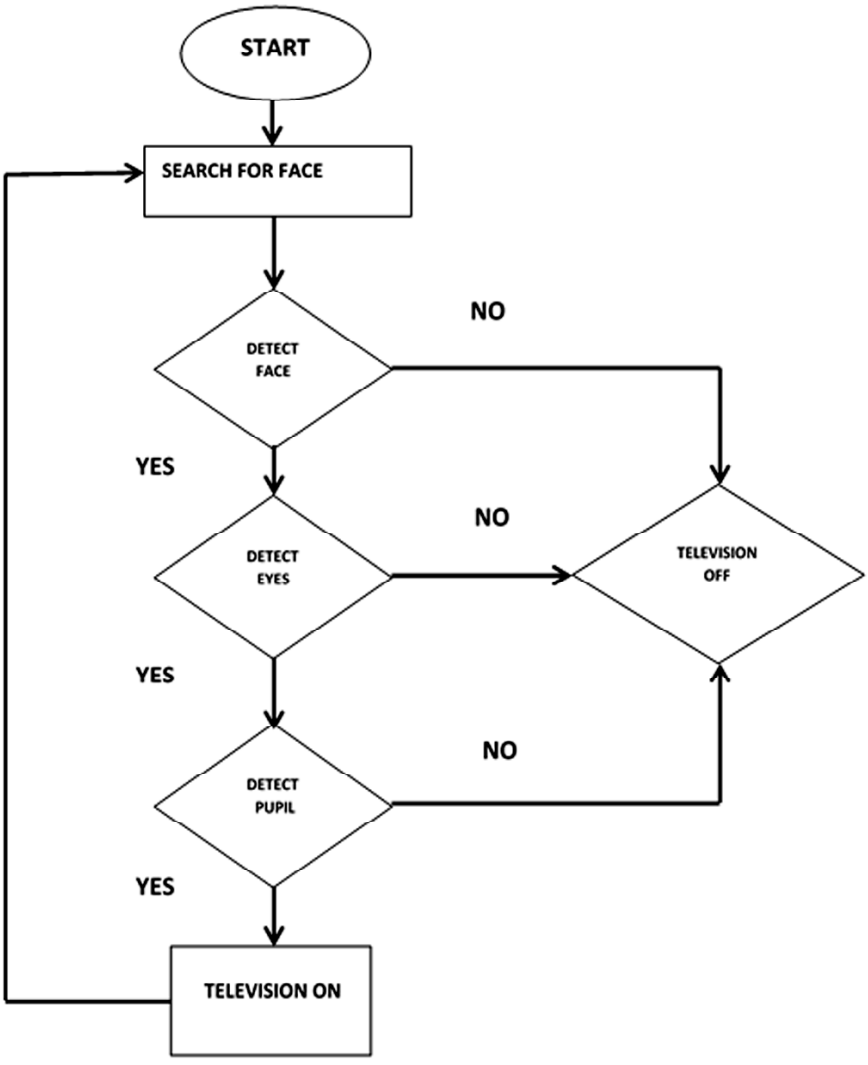

Figure 6: Flow chart

4. CONCLUSION & FUTURE SCOPE

We successfully implemented the proposed system using relay. By using the same system we may operate any appliances. But it is more suitable for television application, so we selected it. We can make this system by using IR sensing instead of using relay, by integrating the camera & Raspberry pi into the television set. We can use the same camera for the supervision of the room. And we can make the volume and channel controls based on the pupil motion. In future we can extend this model to the identification of users and their favorite list of channels according to the priority using Internet of Things. Using internet of things by integrating it to the television set we can take the information of channels viewed in the television and we can get the TRP rating for the channels.

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