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Object Motion Detecting Without Color and Object Tracking With Image Processing

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ABSTRACT
In this study, object detection and tracking application is aimed by using image processing techniques. To detecting the moving objects, pixel changes are used. It is aimed to keep the position of the object in front of the camera connected servo mechanism by using the color and shape properties of the desired object. Morphological processes were also used for image processing. The outputs were subjected to filtering processes during the movement and after the morphological treatment to remove the noise. By selecting the desired region or object and considering the detected pixel changes, the coordinates are determined and set to be in the image center. In case the object moves away from the center within the image taken from the camera, the biaxial pantilt positions the camera with the help of the servo motor to hold the object in the center of the image. All of these operations were done in a single program with the Raspberry Pi development card with ARM processor architecture. OpenCV library is used for image processing.
Keywords - Raspberry, Pi, Object, Tracking, Raspbi Cam, OpenCV

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I. INTRODUCTION

As technology progressed rapidly, the cost of video cameras and the costs of digital media storage fell. In recent years, there has been a large increase in the amount of video data uploaded in the world. In order to process all these video data, there is a growing demand for automatically analyzing and understanding video content. One of the most basic processes in understanding video content is visual object tracking, which is the process of locating one or more moving objects in each frame (image) of a video and its dynamic configuration[1].
Nowadays, image processing has started to show itself in the field of human life, especially with the development of digital technologies. For example, mobile phones which only have voice and text messages at very low times can be said to have recently been replaced by tiny computers with an integrated operating system with a compact camera.
Tracking the moving object has interested the attention of many researchers in the field of computer vision and image processing. Video surveillance is often the process of observing behaviors, events and other necessary evidence for the control, monitoring and protection of people. Image processing is mainly used by governments to gather information, identify criminals, prevent crime, make more effective analysis and follow up in military systems, and identify diseases in the health sector. Video analysis activity is divided into three. Manual video monitoring, semi-autonomous surveillance and full autonomous surveillance. In manual surveillance, one is responsible for analyzing the content of the video. Semi-autonomous systems include video inspection by the system with human interaction if necessary. Fully autonomous system, without human interaction, motion detection, monitoring and so on. performs every task[2].

Object tracking has many practical applications, such as video surveillance, human-computer interaction and robot navigation [3]. The purpose of object tracking in the video can be summed up as the task of finding the position of an object in each frame [4]. The ability to follow an object in a video depends on a number of factors, such as information about the target object, the type of parameters being tracked, and the type of video that displays the object [5].

Afef Salhi and Yengui Jammoussi[6],has implemented some tracking algorithms as known Meanshift, Camshift, Kalman Filter. The performance of algorithms has been studied under different video sequences.

System is described by Dedeoglu Yigithan[7],the system works on color and grayscale video frame from a stationary camera. It is adaptable under changing illumination conditions.

Yilmaz Alper[8], who proposed two different approaches for tracking objects which video acquire gets from mobile cameras. First of them tracks the centroids of the objects in Forward Looking Infrared Imagery. Second one tracks the complete contours of the objects.

II. SYSTEM ON CHIP AND SINGLE BOARD COMPUTERS

System on chip, the system is a microchip with all the necessary components to run a computer in a very basic way.

If a device fits in your hand and runs on battery, it's likely to be using SoC.

General SOC as shown Fig.1

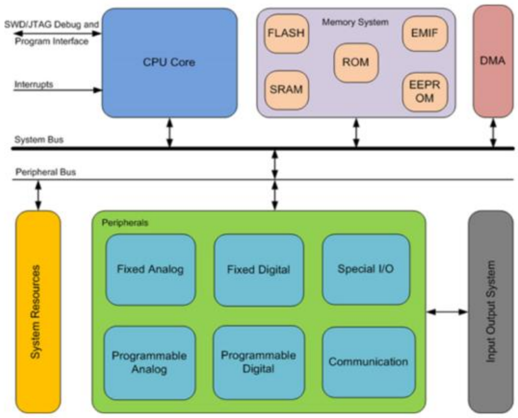

Fig. 1 General SoC Design

Single board computers can ensure all abilities of a normal computer with hardware that is smaller on a card Processor, graphics processor unit, ram, memory unit, input-output ports and other peripheral units are built on a single board. Single-card computers are intended for small production, so there are no external card slots (video card, sound card, etc.). System hardware (GPU, RAM, GPU, etc.) are designed to provide small size, low cost and low power consumption. These systems are generally preferred to develop prototypes for educational studies but have also been used for serious projects and industrial applications over time [9].

Its academic and industrial name is System On Chip. Even though there are embedded systems for

general use, these computers are also used for hobby and daily work. Single-board computers are documented in many studies, including on-site environmental applications [10-13], intelligent systems [14], smart cities and portable military systems, thanks to their low power consumption and small size.

The following Fig.2 shows single board computer.

Fig. 2 Single Board Computer

III. RASPBERRY PI 3 MODEL B

At first,the board was improved for children to learn computer skills.Then was developed with different generations and became a mini computer.

The board is slower than a laptop but can provide lots of expected abilities.

The third-generation Raspberry Pi was released with named Raspberry Pi 3 Model B in February 2016 which has lots of part as shown in Fig.3.

Board was produced with a 1.2 GHz quad core 64-bit BCM2837 processor with 1024 MB RAM.

Board has 10/100 Base-T Ethernet, Wifi and Bluetooth for communicating. 4 USB 2.0 ports for connecting with the outside world.

Board has CSI camera and DSI display port for connecting camera and touchscreen display.

Operating system is installed on the microsd card and raspberry pi has microsd card slot.

The raspberry pi has a HDMI to connect TV, monitor, LCD screen etc directly.

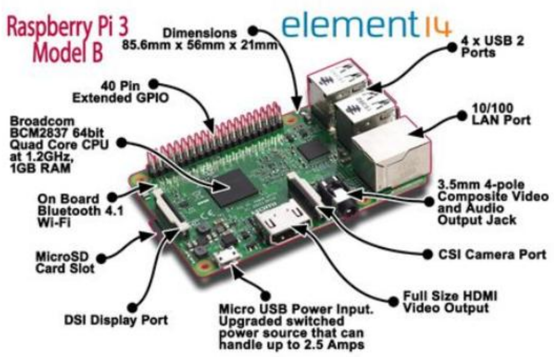

Fig. 3 Raspberry Pi 3 Model B

IV. PROCESS DIAGRAM

The codes of this study are written in C ++. The basic block diagram for detecting and tracking objects using motion detection and then the color feature is shown below (Figure 4):

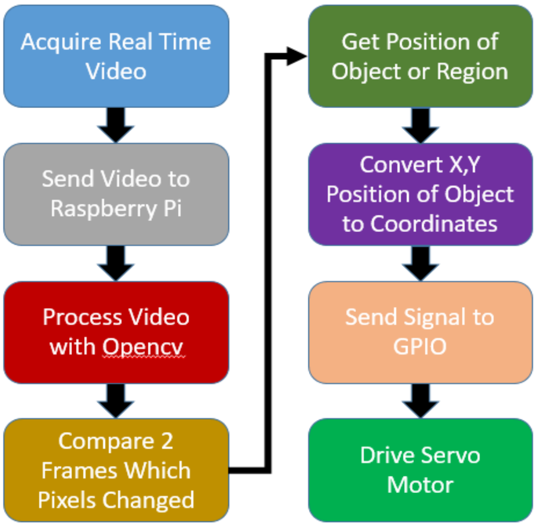

Fig. 4 Block Diagram of Entire System

The basic diagram consists of seven blocks called image acquisition, image transmission, preprocessing, motion detection, feature extraction, coordinate determination and tracking. The aim of these blocks is as follows:

Image Acquisition: Image retrieval is intended to acquire real-time video frames with the physical camera.

Image Transfer: Image transfer is provided to the raspberry pi of the imported video frames via the usb or CSI (Camera Serial Interface) connector.

Preprocessing: During the pre-processing, the first frame from the received video frames and the next frame are received. These frames are converted to gray beacuse it is easy to process in single shade. Processing gray images consume less time comparing to RGB. At this point, the median filter is applied to remove the noise from the images or frames taken from the video [15].

Motion Detection: The difference between the two frames is controlled by the function found in the OpenCV library. Regions that are different are filled with either 1 or 0, while the remaining regions are filled with the other value and distinction is achieved. The resulting difference indicates time dependent movement.

Feature Extraction: Choosing the right feature plays a big role in tracking the object. The different features required for monitoring are color, boundary, optical flow and surface or tissue. In the proposed approach, the target is monitored using the color property of the specified region. After following the target object using the color property, we will follow the object using the motion [15].

Monitoring: Tracking of target objects is accomplished under the leadership of the local characteristics of the object. For example; Bounding box, field etc. Here the bounding box feature is followed. The bounding box moves with it as the object moves.

V. DETECTING OBJECT WITH IMAGE PROCESSING

In the studies related to the target tracking systems in the literature, it is seen that t + 1 location is estimated according to the position of the target at the t moment and the target tracking is realized by performing the configurations in this estimated position.

The most basic method that can be used to detect possible movements in images with fixed background is to evaluate the absolute difference of sequential image frames[16]. In this method, the color image frames captured in succession with the camera are first converted to grayscale images in order to reduce the workload. The following equation (1) is used for this process. RGB to grayscale example shown in Fig.6

$$I=(R+G+B)/3 \quad (1)$$

In the equation (1) (R) the red component value of the pixel in the RGB image shows the green component value (G), the blue component value (B) and the gray component value (I). The next step is to determine whether the ratio of the absolute difference of the successive images to the total number of pixels forming the image exceeds a certain threshold. The change detection is mathematically provided by the equation (2). RGB definition and transform in Fig.5 and Fig.6

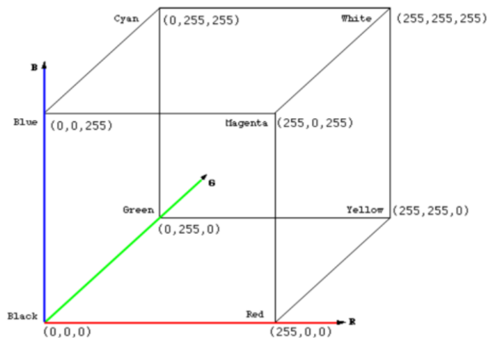

Fig. 5 General Definition of RGB

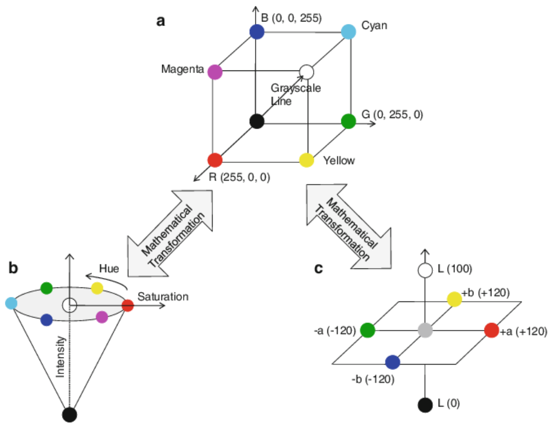

Fig. 6 General Transform RGB

$$AFD(T) = 1\frac{1}{wxh}\sum_{x=1}^{w}\sum_{y=1}^{h}|I_t(x,y) - I_{t-1}(x,y)| > E_1 \quad (2)$$

In the equation (2) the average frame difference(AFD) is (t) the current captured frame, (t-1) the previous frame, w the horizontal pixel size of the captured image, (h) the vertical pixel size, (x, y) the corresponding pixel (E1) indicates the threshold value. As seen in the equation, if the absolute value of the difference between the brightness values in the (t) and (t-1) images of the image element (x, y) at the position (x, y) is greater than the determined threshold value, the image element can be accepted as moving. Accordingly, the moving regions are derived from the difference between the estimated background and the current image. The threshold value is a value corresponding to a statistically significant brightness change. Predetermined value that determines whether the difference between the two pixels belongs to the motion [17].
By changing this value, increasing or decreasing motion detection sensitivity is provided.
Grayscale example as shown Fig.7.

Fig. 7 RGB to Grayscale

VI. SYSTEM COMPONENTS AND SOFTWARE

As part of this study, image processing and motion control are integrated on the Raspberry Pi board, which is installed on the Raspian operating system. In this context, C ++ is used extensively in embedded systems as software language. Opencv library was used for image processing functions. Raspi camera was used for image acquisition as shown in Fig.8.

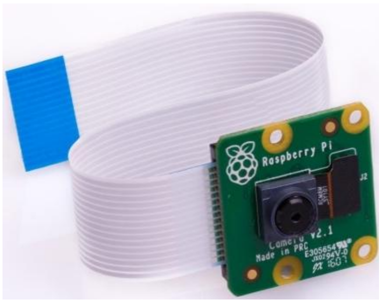

Fig. 8 Rasbpi Cam V2.1

The follow-up was carried out using two separate blocks. The first block; The second block enables the image of the camera to be processed and the second block starts the stepper motor with the camera placed on it according to the data from the computer.Pantilt servo motors as shown in Fig.9

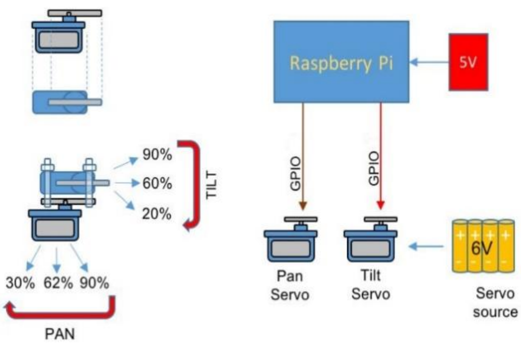

Fig. 9 Pantilt Servo Motor

Integrated system with camera coneccted to motors that can move on X and Y axis. General image of system as shown in Fig.10

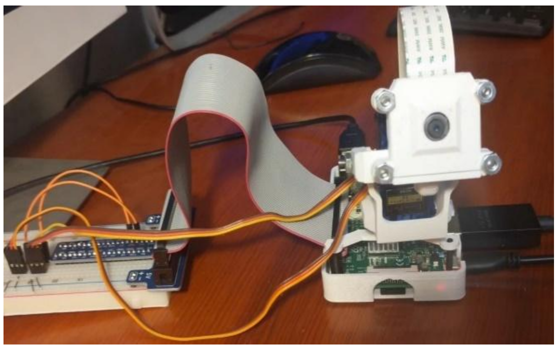

Fig. 10 System Setup

VII. ALGORITHM FLOWCHART OF SYSTEM

The image taken from the camera is processed in a continuous loop at raspberry pi. When motion is detected with Opencv, X and Y coordinates are determined. If the movement continues, the X and Y coordinates are sent to the GPIO for motor movement as a result of the mathematical calculations. One of the servos moves in the X plane and the other in the Y plane. Servos are moved according to the required coordinate information. General diagram of system shown in Fig.11

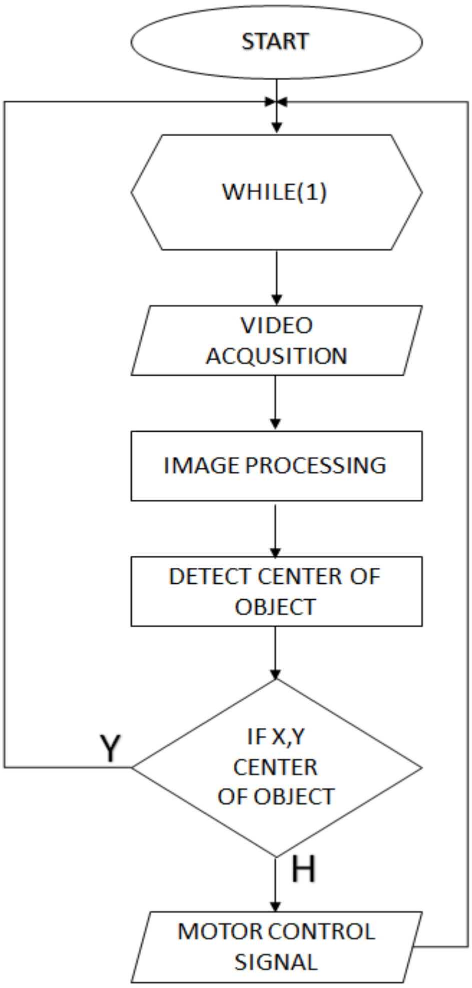

Fig. 11 Algorithm Chart

VIII. CONCLUSION

Object detection and tracking is an interesting duty in computer vision field. In object detection and tracking system consist of two essential processes, object tracking and object detecting. Object detection in real time video image acquired from single camera with static background. Which means camera frames is achieved by background subtraction approach. In this thesis, we tried motion based systems for detecting and tracking selected object.

In the literature, apart from the image processing techniques which are determined on a more determined color, a system that detects the difference between two consecutive frames is designed. It is aimed to follow the determined motion region or a selected object by using the color feature. When motion is detected, it is ensured by using servo motor movements by using coordinate information so that the image is not out of camera detection.

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