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Anti-Ballistic Missile Tracking Based On Relative Localization by Li-Dar Sensor Fusion

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Abstract – The Anti-Ballistic Missile is an embedded system to perform control, guidance, target data inference, destruction of an attacking missile and various other control operations. It also describes vision based relative localization approach for a target based on Li-DAR and high speed camera and embedded processing technique running at extremely low power. Higher velocities of moving target and the interceptor missile demands higher data update rates from the sensors processing elements and control system.

Index Terms – Anti-Ballistic Missile, Li-Dar Sensor Fusion.

1. INTRODUCTION

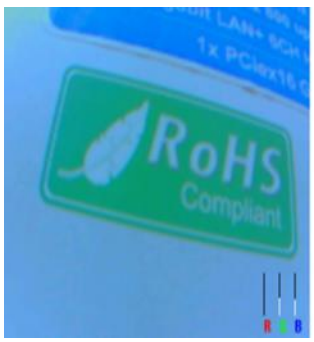
Designing and Developing a very low power embedded system for tracking and shooting a moving missile using a high speed video camera integrated with a high performance microcontroller. The microcontroller does the heavy task of embedded vision processing at very low power consumption. Localization by artificial key issue by targets particular in environments where accurate global positioning system and inertial sensor are not available. in this environment accurate and efficient robot localization is not a trivial task, increased accuracy usually leads to decrease efficiency and vice versa[1]. The relative navigation system is defined as one that process the difference of measurements pair of sensors mounted on to missile to provide relative position and velocity estimate. This system is based on Li-DAR (light detection and ranging) and inertial navigation system already installed on many missile[3]. In the framework of intelligent missile, multisensory system are used for developing complete preventive architecture improve vulnerable systems[4]. Self localization is very important issues for autonomous targets particularly the service mobile target in dynamic environments. Visual positioning methods place an important role in self localization of autonomous service mobile targets working in indoor environments [2]. The color and the depth information to provide complimentary cues about a scene. Many application need to capture both simultaneously like seen reconstruction and image based rendering. A basic device for seen reconstruction is a depth and color camera pair which consist of a color camera rigidly attached to depth sensors[5].The microcontroller firmware is developed to handle the real-time needs of the embedded software for the onboard computer, which is designed to achieve deterministic response times for the accurate control and precise scheduling of firing mechanism.

2. RELATED WORK

The microcontroller does the heavy task of embedded vision processing at very low power consumption. The project uses an STM32F429 microcontroller to track an object, using the images it gets from an OV2640 camera sensor. The camera is configured to output pictures in RGB565 format at QVGA (320 x 240) resolution. Once the target is selected, its color defines the threshold of the pixels in the image that is processed further. This process of separating a region on interest in a digital image based on the given color is called image segmentation. After the image segmentation is done, an algorithm recognizes the contour of the image and its centre, once located a control system calculates the movement of 2 servos (pan, tilt) in order to target the object precisely and another servo to trigger the interceptor firing towards it using a special gun shooting mechanism. A standard approach is to calibrate the cameras independently and then calibrate only the relative pose between them [4]. This may not be the optimal solution as measurements from[5] one camera can improve the standardization of the other camera. Moreover, the independent standardization of a depth camera may require a high precision 3D standardization object that can be avoided using joint standardization. A Spacecraft rendezvous and formation light navigation architectures using optical sensors can be categorized based on the number of cameras used in the implementation. When two cameras are used, the system is called a Bi-vision (or stereo) architecture, while a single camera architecture is called Mono-vision. Bi-vision(stereo) cameras are a popular choice for relative navigation problems since they can directly provide 3Dfeature points on a target using geometry and a known baseline between the cameras [7,9]. In cooperative formation light scenarios, detected feature points are associated with points on a known stable-body model of the target, and the relative positioning of the target is estimated. The relative position accuracy of 3D features found using Bi-vision approaches degrades as the distance to features increases [6]. This degradation results from the reduced feature disparity between each camera, which is inversely proportional to target distance when the baseline distance is end. Cameras, however, require fewer system sources (space/weight/power) and standardization sort than Bi-vision camera systems [8].The microcontroller firmware is developed to handle the real-time needs of the embedded software for the onboard computer, which is designed to achieve deterministic response times for the accurate control and precise scheduling of firing mechanism.

A. Module 1: Image Segmentation:

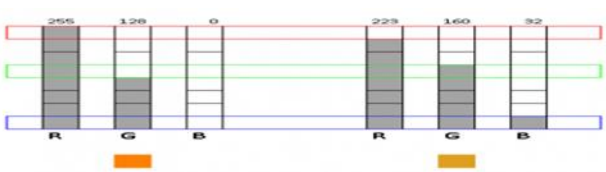
The segmentation in this case has the task of separating a region of interest in the image based on the color you choose. As each pixel is obtained from the camera, is compared with the threshold values, and the result is stored in the binary image. In the same pixels that are within the threshold will be represented as "logic one", while those outside this threshold will be "logical zero". An example of the binary image being the color green searched:



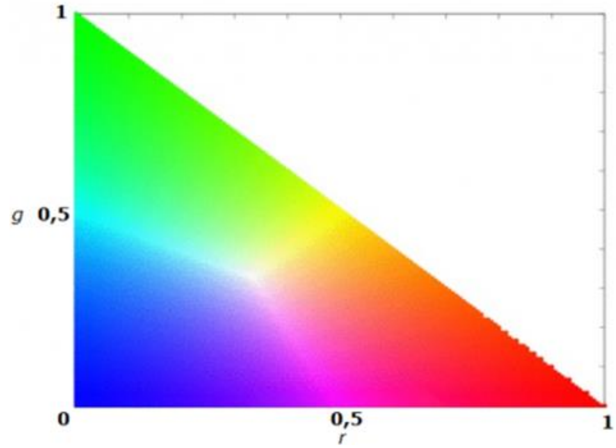
Captured image Segmented image

B. Module2: **Threshold in the RGB color space:**

RGB565 color format has the red component corresponding to take values between 0 and 32, green between 0 and 64; finally blue can vary between 0 and 32. The separation of the three color components is performed by the help of three variables of 8 bits. Color is only admissible if it is within these 3 ranges, as an example in the following figure there are two variants of orange color, and a threshold whose value is 32, each of the three components are within acceptable values.



The selection of a threshold in the RGB color space presents a problem because they don't separate the hue and illumination data. Therefore normalized RGB space AKA RGB chromaticity space, is two-dimensional and does not contain information of light intensity. Instead of representing the intensity of each color component (RGB), the proportion of each (RGB) to the total light (I) is represented:

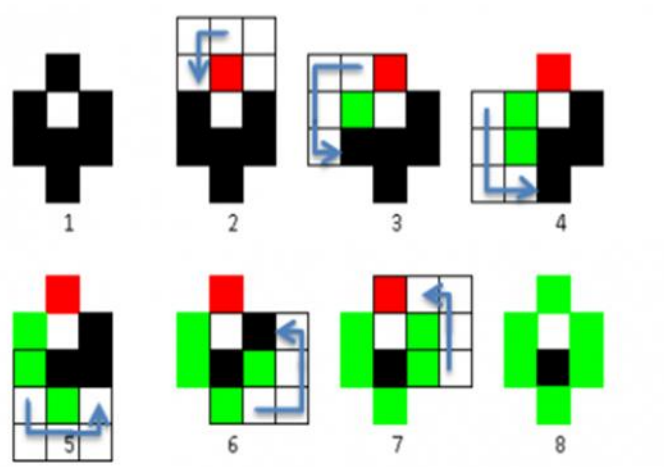


$$R + G + B = I$$

$$r = R/I, \quad g = G/I, \quad b = B/I$$

C. Module3: **Contour Detection Algorithm:**

To analyze the data from the image segmentation algorithm the binary image is used. For this it is assumed that the image consists of ones and zeros, where the pixels of color are of interest for logic one. The algorithm is developed to distinguish the region of interest by marking the outline of the present group of contiguous pixels in the binary image. Once this is done the result is delivered as upper limit, lower limit, right-side, left-side and both horizontal and vertical location of the centre of the object.

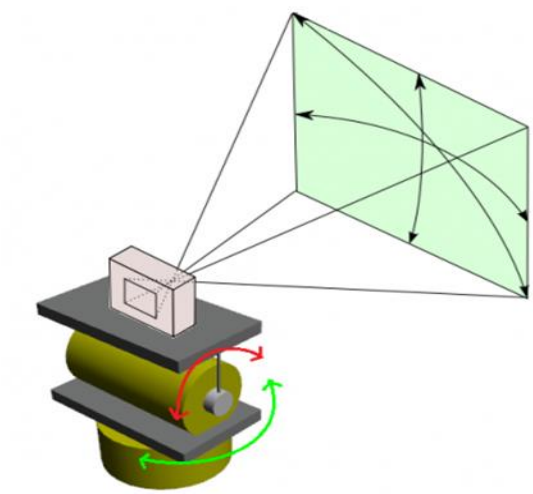


The algorithm inspects each of the rows of the binary image from left to right, starting from top to bottom. If the grouping of contiguous 1L pixels exceeds a preset width then starts to go through the outline from the first pixel of the line. The fig. shows how the algorithm runs on a sector of dark pixels detected, the process begins on the initial line (in this case the initial pixel is 1 and pixel width is detected, and the start is display in red). The contour integration algorithm is from here that the contour path begins, as a rule of the algorithm begins to search for the next valid anti-clockwise pixel in a 3×3 matrix, starting from an point inspection after last detected pixel step. To continue the contour detection, the centre of the next matrix is at pixel of the image is inspected and detected earlier.

Whenever a contour pixel of the image is detected and its position is evaluated, if it is less than the minima position, the minimum position value is updated, the same is done to the highest position. Thus at the end of the algorithm, the maxima and minima positions is obtained. The contour inspection stops once the pixel corresponding to the initial position is detected.

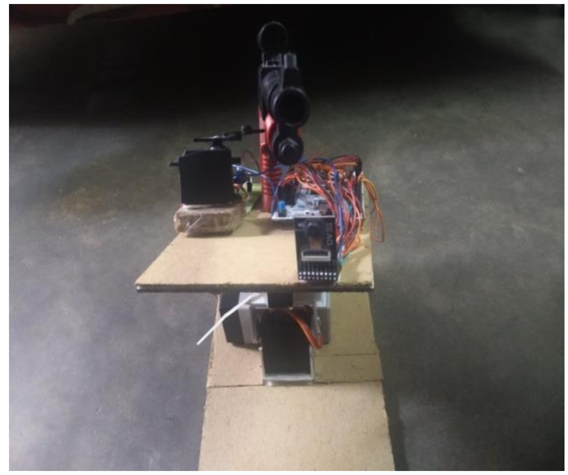
D. Module4: Pan-Tilt Servo Mechanism:

The platform where the camera is located to perform and the aiming is controlled by two pan-tilt servo motors. The Pan-Tilt type has two degrees of freedom. The control of each actuator is performed using pulse width modulation (PWM). For this, there are 2 outputs PWM are generated using Timer channels and oscillation frequency.



3. PROPOSED METHOD

Light Detection and Ranging mechanism which is used for detecting and localizing a target or an object which significantly identifies the object and collects the threshold value and color ranging value which is compared with the original image with the RGB depth camera through image processing. It also consist of estimating different poses of standardization object detected simultaneously by camera and multilayer Li-DAR sensor fusion. Each poses of the standardization target is parameters by the 3D coordinates of the circle center and normal of its plane. Servo motors are used for position control and to target on the moving object to calibrate the movement of the object.



4. CONCLUSION AND FUTURE WORK

In this paper we proposed a approach to localizing the position of a target based on the RGB5656 algorithm and depth camera with LiDAR sensor fusion. Track fusion with an algorithm using LiDAR using visual and depth trackers for 3d localization. The approach that we proposed were test under various scenarios. In future work 360 degree tilt camera can be used at a angle of 45 degree in a triangular pattern such that all the angles are covered to cover the range of the incident multiple target from all direction. we will develop a extended version of relative navigation algorithm by considering relative position and altitude control.

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