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Autonomous Targeting System using Open CV

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Abstract: ***Border security is a major concern to countries all over the world. Hostiles trying to trespass borders comprises the security and poses an immediate threat on human life. The armed forces do man the borders and keep a firm watch over the line of control fences. However manning the borders is not sufficient and cannot be done with full efficiency by human forces alone. Continuous accurate surveillance is also not possible with human forces. The armed forces are also at risk of losing their lives in attempt to stop the terror inflicting intruders. Creation of an autonomous system that monitors the border area and prevents intruders from entering the fences in absence of human supervision will increase the security to ultra-modern standards. Thus the project aims at creating an Autonomous Targeting System using OpenCV that detects human hostile intruders and takes capable measures to prevent them from compromising homeland security. The system is based on Raspberry pi 3 model b, pi camera and uses OpenCV. The autonomous targeting system detects and points a laser towards a human inside its visual range. The existing technologies utilize high end machinery, optoelectric technology and radar to target hostile. This increases the maintenance frequency and overall cost of the existing systems. By blending improved CAMshift (Continuously Adaptive Mean Shift) algorithm and we can considerably reduce the time complexity and resources consumed by the system. The raspberry pi based system focuses on reducing the complexity and the cost while improving the accuracy. These low end systems can be used in border surveillance and domestic security.***

Index Terms*: *ATS, Target Tracking, OpenCV, CAM shift Algorithm

I. INTRODUCTION

THERE has always been need for proper security measures throughout the world. Proper protection of not only ones personal belongings and valuable objects, but proper manning of civil area which then includes country's national border is equally essential. In the recent years, there has been increased tension between warring nations regarding the proper protection of national borders. There is a continuous presence of threat due to extremist groups trying to inflict trepidation in minds of the people. A system which aids security personnel and border security forces to skillfully and safely patrol disputed regions is well in need.

Autonomous weapons systems are set to revolutionize how wars are fought. As things stand, there are still no completely autonomous weapons systems. But a trend towards more and more autonomy in military (weapons) systems is clearly discernible. Conventional drone technology has already changed the traditional understanding of the conduct of war. The remote control of drones makes deployment possible without direct personal risk from a distant control centre, on a computer screen. Experts, however, regard the development of autonomous systems as genuinely revolutionary and as a veritable paradigm shift in military technology. In the scientific literature and official government documents there are a number of approaches to defining autonomous weapons systems. At present, there is no universally accepted definition. Common to all the different approaches, however, is that the level of capability with regard to decision-making by means of algorithms alone, without human intervention, is stressed as the decisive criterion for autonomy. Autonomy should therefore not be understood in the moral philosophical sense as the free will of an individual. Even an autonomous robot can operate only within the limits of the possibilities programmed into it by means of algorithms. However, to conclude from this that no really autonomous system can exist, because at a certain point a human being is always involved in the decision-making matrix; is an unjustified simplification of the problems arising.

The proposed system is a low budget and low maintenance system. It uses computer vision which is important when it comes to detection of humans. Computer vision has also been successfully used to distinguish humans from animals and other stationary objects. The detection of a human in a live video stream is a particularly difficult job. As the speed of the moving object increases, the accuracy of detection decreases. Even so, the improved CAMshift algorithm is used to increase the accuracy. The improved CAMshift algorithm has been known to show better and accurate results than the traditional CAMshift algorithm or the Meanshift algorithm. The system is designed for places where sufficient brightness is present. The input video stream is in grayscale so as to increase the speed of the system. Furthermore, the complete system is based on open source platform using easily available hardware such as RaspberryPi and OpenCV and Python.

We have tried to overcome the limitations of the currently available systems which are costly and need constant maintenance. Our system is low maintenance, affordable and open source while also optimized and accurate.

II. RELATED WORK

Different methods for human detection in video and image streams have been used. HOG feature extraction has been exclusively part of most of the detecting algorithms. The improved CAMshift algorithm has also shown promising results. Various other methods include using multi-dimensional camera models and depth vision. Humans can also be tracked using their body heat which is usually more than that of the surrounding temperature. The use of ultrasonic transmitters and receivers can also help in determining the distance of the human from the system. Detection of humans is possible using the Radar technologyand is used in many implemented practical applications to efficiently identify and confirm presence of human.

There are various methods of detecting and tracking moving objects and humans. Deep learning and Artificial Intelligence based models which are far superior have also been developed. The scope of this paper is limited to detection of humans using HOG and improved CAMshift algorithms.

III. PHYSICAL SETUP

The system is based on an open source platform. Keeping that in mind, all the software requirements for the system are freely available online and can be downloaded and used. The hardware of the ATS is a RaspberryPi 3B system. The RaspberryPi running on Raspbian Jessie, acts as the CPU of the system. The Arduino Uno system is the core of the motor control unit. The RaspberryPi and the Arduino system are connected to each other. The camera input is mounted on the CPU while the pointing device is with the pan tilt assembly.

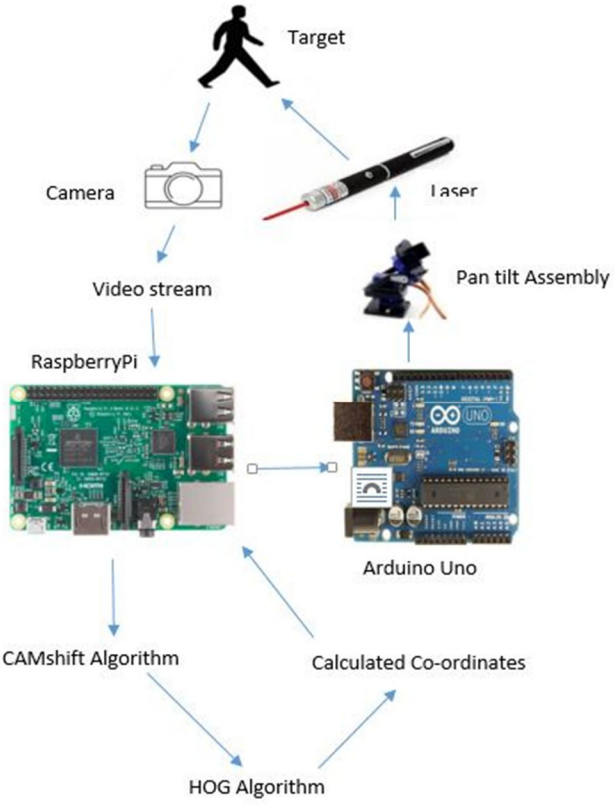

Figure 1: Block diagram of the ATS

The system is always stationary with only the pan-tilt assembly moving to point at the detected human. The pan titl assembly has a laser mounted on it to point at the target and it rotates in both x axis and y axis. The servo responsible to move assembly on x axis holds the weight of the servo responsible to handle the movement of y axis. The servo of y axis has the laser pointer that points at the target. The assembly requires a voltage of five volts which is provided through computer connected raspberry pi or the ac to dc step down transformer charger connected directly to main power supply. There is also a requirement of bread board to make the necessary connections from servo motors to raspberry pi. The pi camera used has a five megapixel native resolution and video modes like 1080p30, 720p60, 480p60. The pi camera is interfaced with the raspberry pi using the Camera Serial Interface port. The

raspberry pi has a 40 pins architecture from which some pins are used to connect the servo motors and also to the laser pointer that aims at detected target. To serve the purpose of the Read only memory ROM there is an SD card attached to the raspberry pi whose purpose is to save the processed data produce by the algorithms. Raspberry pi 3 model b already has an antenna soldered to the board and hence it is good at picking signals of Bluetooth and wireless LAN.

The pi 3 used is logically powered by the Broadcom BCM2837 system-on-chip having four high-performance ARM Cortex-A53 processing cores running at 1.2GHz with 32kB Level 1 and 512kB Level 2 cache memory, a VideoCore IV graphics processor, and is linked to a 1GB LPDDR2 memory module on the rear of the board. The Raspberry Pi 3 shares the same SMSC LAN9514 chip as its predecessor, the Raspberry Pi 2, adding 10/100 Ethernet connectivity and four USB channels to the board. As before, the SMSC chip connects to the System on Chip via a single USB channel, acting as a USB-to-Ethernet adaptor and USB hub.

The ATS system could be mounted on a mobile vehicle or caterpillar wheeled remote controlled or autonomous drone. By doing this the accuracy of the system might reduce but with further down development in the system the accuracy can be regained.

IV. HUMAN DETECTION USING CAMSHIFT ALGORITHM

The paper proposes a new take on the CAM shift algorithm. By combining the frame difference and background subtraction methods, better 'moving target detection' algorithm is produced. For human body detection, the tracking region is set automatically. Then based on least square method, the motion parameter estimation algorithm was also put forward using the information of detection and tracking.

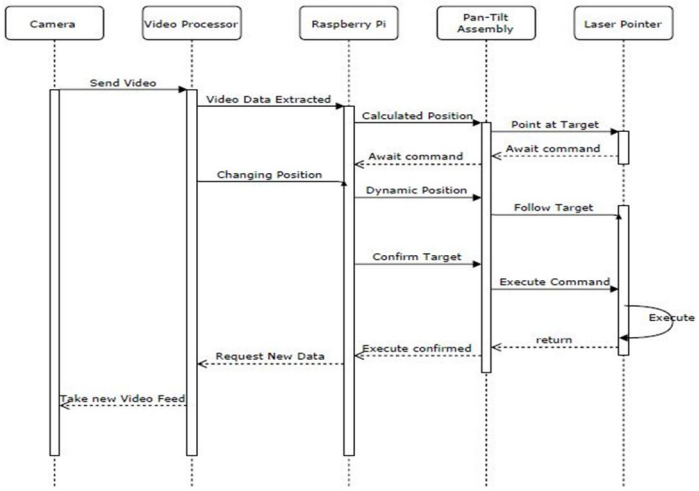

Figure 2: Sequence Diagram For ATS

The video stream is first accepted from the input device i.e. Pi camera. The Pi camera is recommended for systems based on RaspberryPi. The images are then extracted from the video stream at certain intervals. The images are then converted to grayscale HSV images. The same method can also be applied to the initial video stream. For the background subtraction method, and initial image is set as the background. The consecutive image is then subtracted from the current image and the difference of the histogram levels using histogram subtraction is used to locate the moving object. Unlike the Meanshift Algorithm which detects a moving object and forms a window around it but does not change the size of the window, the CAMshift algorithm adjusts the frame around the object according to the size of the object. As the frame is formed, a center point is calculated which is used to point the laser towards the target. This center point is also use to track the moving object. Once the Baycenter of the target is beyond the threshold value, the direction of the target is found and a new window is initialized. The new window hence formed is around the image with the value of Baycenter below the threshold value. The computation time is to be kept at a minimum so as to make the system useful in for real time use.

V. IMPLEMENTATION

The process of improving the detection and tracking of humans through a simple pi camera begins with optimization. The camera needs to be placed where its visual range is brightly lit. The target, when enters the visual range of the system need to be properly distinguished from its background. The first stage of the implementation process is detection.

It deals with the detection of the target in the visual field of the ATS system. The Pi camera grabs the video feed of the visual field and sends it to the RaspberryPi to process. The video feed is then converted into frames so as to ease the task of processing. The background subtraction algorithm is then applied on the incoming frames. The background subtraction algorithm grabs the first frame and considers it against the next incoming frame. When an object enters the picture, the intensity values of the object and the background are subtracted and when the difference is found, the object is detected. If the new object which entered the picture stays still for some time, the background subtraction algorithm considers it as a part of the background and detects it only when it moves. To overcome this problem, the improved CAMshift algorithm is used. It detects the object and forms a frame around it. This frame moves with the object and adjusts to its size. This provides a better way of tracking objects. Another problem arises when we have to differentiate between humans and other non-living objects.

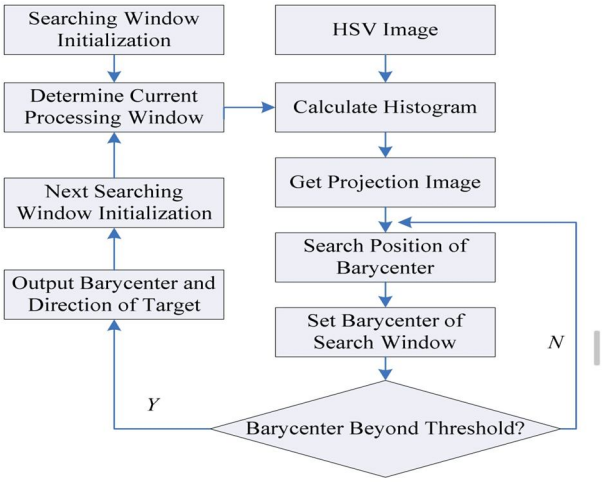

Figure 3: CAMshift Algorithm Flowchart

The HOG transform method identifies the new object in the frame and compares it with existing samples to categorize the object into human or non-human. The sample space consists of general body structures of a human. The frame of detection is formed only if the object is more than 30% similar to the sample figures. This guarantees more accuracy. Once the hostile target is detected, the second part of the implementation process begins i.e. tracking.

In tracking the output generated by the HOG transform becomes the input for further processing. The coordinates are extracted from the frame generated by the detection program. Using one corner point of the frame the system can easily calculate the coordinates by also using the height and breadth of the frame. The frame of the detection is used to interpret the target area frame and this frame is then taken ratio of to set various duty cycles of the servo motors. There is a range of duty cycles to be programmed on the x axis servo and the y axis servo. Based on the value provided by detection algorithm the servo motor on x axis will traverse to x coordinate which are as per calculated duty cycle. Similarly on the value provided by detection algorithm the servo motor on y axis will traverse to y coordinate.

By doing this the laser pointer is perfectly pointed at the detected. Further on the laser can be replaced by a light non lethal projectile launcher or an electric taser which only stuns the target and does not cause any loss of life.

The system carries on the work of detection immediately after the previous target is done executing and actively searches for new targets. Once new target is found again the whole process of detection algorithms and tracking algorithms and programs is executed.

VI. CONCLUSION

It was found that the detection of humans and their tracking using a basic Open CV based system is satisfyingly accurate. The Autonomous Targeting System, on further developments will be helpful in bringing down the cost of the current systems in action. It can also be used for home surveillance and in the private sector.

VII. ACKNOWLEDGMENT

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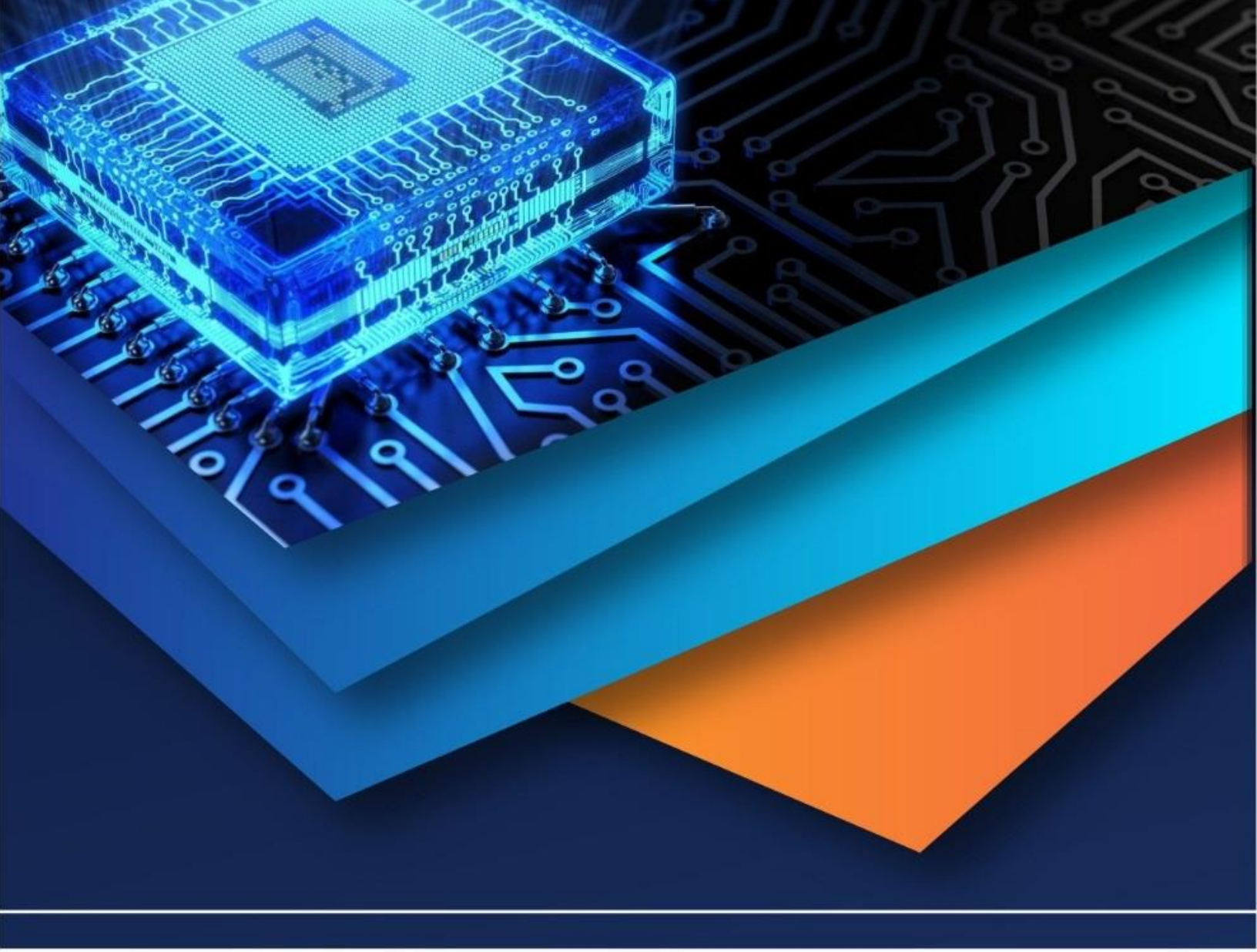

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