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DETECTION AND TRACKING OF MOVING OBJECT USING THERMAL THRESHOLD CLASSIFICATION (TTC) TECHNIQUE AND WORM TRACKER (WT) APPROACH

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Abstract:
In this huge pandemic era of COVID 19, the use of thermal scanner and related data is in more demanding situation. Thermal Scanning and Infrared thermography offers significant advantages in monitoring the temperature of objects in dynamic environment. The main focus of this work is detection and tracking of objects in dynamic environment using Visible Spectrum and Thermal Imaging. This paper proposes an initial approach to perform target detection of moving objects in thermal video sequences. Thermal imaging has capability to detect object in low light or dark conditions by detecting the infrared radiation of an object and creating an image which contains temperature information. The extracted regions are then used for performing the segmentation of targets in thermal videos. After segmentation of object, centroid based object tracking is performed to track the objects in thermal videos. For tracking of moving object in this paper we use worm tracker programming approach.

Key Words: Thermal Scanning, IR Thermography, Worm Tracker, Thermal Threshold Technique

A. Introduction:

Temperature distribution on the surface of an object can be determined using a method called thermal imaging, often also referenced as thermography. Infrared energy is emitted by all materials above 0 ºKelvin (-273 ºCelsius). IR radiation is part of the electromagnetic spectrum and occupies frequencies between visible light and radio waves. This energy is converted into electrical signals by the imaging sensor in the camera and displayed on a monitor as a colour or monochrome thermal image that represents the variations of the temperature values. **[1]**
The main advantages of thermography are that it is noncontact and not dangerous. Modern thermal imaging cameras provide high speed and high resolution. Furthermore, the stability of the earlier cameras has improved dramatically and calibration of the image against a stable temperature reference can be achieved to ensure reliability. This is of particular importance when repeated acquisitions are made with this technique. **[2][3]**
In public places such as hospitals and airports, objects pass through a specified direction past the temperature reference source, while an operator monitors the display. The thermal imager is adjusted for taking images on specified regions. The CPU processes radiation energy and the processor uses a color scale to map the temperature. The exposed colors represent the relative increase of temperature. The operator observes the display carefully and then decides if the subject needs extra check-up according the percentage and size of the red areas on the specified regions. **[11]**
In thermography processing analysis we first define target region of different objects taken under tracking and detection. Present software uses regular prismatic shapes for the definition of these regions, such as, rectangles, squares, circles and ellipse that poorly identified certain anatomical regions. These regular geometric shapes present limitations when they do not fit with the anatomical shape of the area that is to be characterized, either by the exclusion of relevant data or the inclusion of irrelevant data in the evaluation of the thermal images. This can lead to the errors into the analysis of a certain thermal image.

In order to overcome the geometric limitations of inclusion of irrelevant data in the evaluation, image segmentation algorithms may be applied to the selected target region. **[4][5]**

Segmentation is performed by demarcating an object on an image using pixel-level or object-level properties of the object. These properties can be edges, texture, pixel intensity variation inside the object, shape, size and orientation. The segmentation has two goals. The first is to decompose an image into regions for further analysis and the second is to perform a change of the representation of an image for faster analysis. Based on the application, a single or a combination of segmentation techniques can be applied to solve the problem effectively. **[8]**

The three types of segmentation techniques which is used for segmentation of image are Threshold based segmentation, Edge Detection segmentation and Region-based segmentation.

B. Material and Methods

Thresholding Algorithm [9][15][16][17][19]

Thresholding segmentation algorithms define the boundaries of the images that contain target objects on a contrast background. This technique gives a binary output from a gray scale image. This method of segmentation applies a single fixed criterion to all pixels in the image simultaneously. In this method we set an appropriate threshold value of temperature T, which is a converted binary image from a gray level image. The advantage of getting a binary image is that it simplifies both the complexity of the data and the process of recognition and classification.

In view of gray level (The **gray level** or **gray** value indicates the brightness of a pixel. The minimum **gray level** is 0. The maximum **gray level** depends on the digitisation depth of the image. For an 8-bit-deep image it is 255. ... In contrast, in a grayscale or colour image a pixel can take on any value between 0 and 255.) distribution in any image, we select the function of decision making which relies on pixel gray level.

We define two classes: first contain all pixels which are having gray levels 0 to T and similar to that and second comprise all pixels having gray level T+1 to N, where T is the threshold gray level and N is for the total number of gray levels in the image,

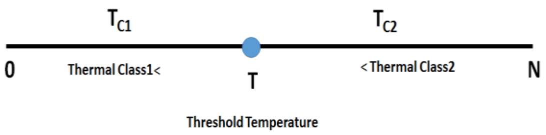

figure-1: threshold temperature

A hypothetical threshold gray level T is the set between the fixed threshold level T and T+1, so that for pixel description we use membership coefficient ½ of belonging to either class.

Grey level set to a class must imply the membership coefficient belonging to that class is greater than and equal to 1/2.

For thermal class 1 (T_{C1}) the linear relationship for assigning membership of the threshold is

$P_1(T) = 1/2 + a\,P(T).$ (1)

Where P_1 is the probability of pixels of the thermal grey level T of thermal class 1

P(T) is the probability of pixels of the grey level T

The probability of pixels of the grey level T-1 is defined as

$P_1(T-1) = ½ + a \sum_0^T P(T-i)$

$= ½ + a\,P(T_{C1})$ (2)

Where $P(T_{C1}) = P(0) + P(1)$ -------$+P(T)$

For Maximum probability $P_1 = 1$

Then from equation (2) we get

$1 = ½ + a\,P(T_{C1})$

Or, $a = (½) / P(T_{C1})$ (3)

For thermal class 2 (T_{C2}) the linear relationship for assigning membership of the threshold is

$P_2(T) = 1/2 + a\,P(T).$ (4)

Where P_2 is the probability of pixels of the thermal grey level T of thermal class 2

P(T) is the probability of pixels of the grey level T

The probability of pixels of the grey level T+1 is defined as

$P_2(T+1) = ½ + a \sum_0^N P(T+i)$

$= ½ + a\,P(T_{C2})$ (5)

Where $P(T_{C1}) = P(T) + P(T+1)$ -------$+P(N)$

After applying thermal threshold algorithm, we find the image classify the certain objects with higher temperature. In figure-2 object detected with high temperature.

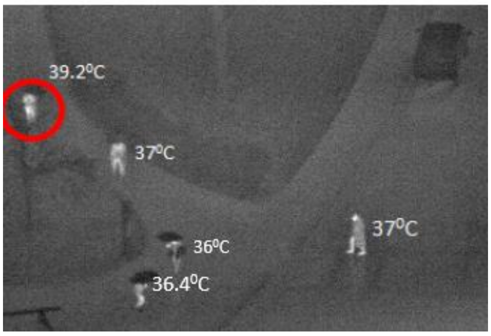

Figure-2: Object detected with high temperature

Tracking of object: Worm tracking [6][7]

First of all, a moving object should be maintained in the field of scanning camera. Second, the object outline and head direction should be determined. Third, a spline entitles the midline of the object at every frame should be gathered, and at last, parameters associated to object locomotion and its shape should be counted.

The captured images are processed through some steps to make a spline, and for the pixels in the original video frames are in greyscale having brightness values between 0 (black) and 255 (white), which the object will come in solid black color (Figure 3).

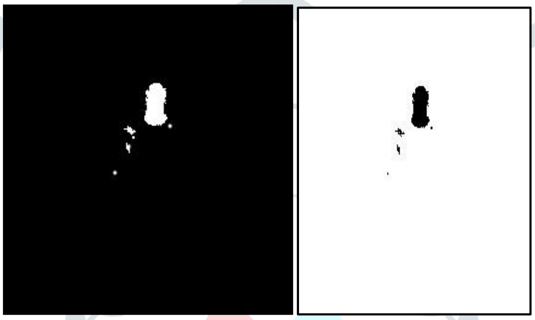

Figure 3: Spline selection with midline

The spline will make along the midline of the object shape by performing a cubic interpolation of midpoints. After that, it will divide into N segments by putting N+1 symbols at equal intervals, resulting in N-1 consecutive angles Figure 3, which can be numbered individually to measure bending belongings. For centroid, it will be set as the averaged position of the N+1 symbols

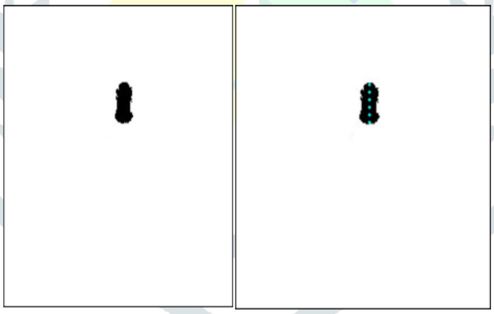

Figure-4: Segmentation of image using spline

Track-An Object could be restored by the travel path of that object alongside to the positions of either the centroid or any of the N+1 symbols according to the spline by integrating the stage movement information besides following objects images **Speed, distance, and direction.** These metrics are normally relied on the positions of the centroid over continues images while any of the N+1 symbols among the spline will be used, but centroid can be average of them. The Distance and Speed functions evaluated the mean speed (mm/sec), the entire distance passed (both forward and backward) additionally the net distance passed by the object (straight-line distance between the first and last positions of the object) in the recording time. The entire distance passed can be measured relying on to the positions of either the centroid or any of the N+1 symbols among the spline because the net distance passed may be measured only by considering the centroid positions. Directionality will be measured by comparing a velocity vector made by linking the last and current centroids in two continues frames and a head vector shaped by clinking the current centroid, so in the case of the estimation of the head vector onto the velocity vector is positive, the object is considered to be moving forward. **[10][12]**

C. Result and Discussion

The thermal camera that has adjusted to set the normal temperature of body as reference temperature is connected to program start taking thermal images of objects walking through the path. First taking continuous image of moving object as shown below in figure -5

Figure-5: Thermal image of moving object

By applying the first step of image Thresholding, result will be the first black and white version of thermal images which will be processed by thresholding algorithm in next step.

Figure6: Applying image Thresholding method

The last part of image Thresholding will applied which turn all the images to last binary version with higher temperature of normal human body left

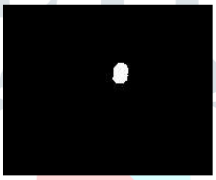

Figure7: Hot spot with high temperature

After applying the image thermal thresholding there will be remained only the spots with higher temperature rather than a normal body. As it is seen the fig there some spots left, some has high temperature. Algorithm will find pixel area of all them including their coordinates.

These objects with their pixel area value and coordinates were identified:

Grain Areas: 236pxl, 78pxl, 3pxl.

The object with 236pxl is detected as target.

Tracking the path [6][7]

In this step we track the movement of the only object in video which is the detected face. Minimum and maximum pixel area for the object is defined for algorithm so it will only track the detected face. Maximum and minimum velocity of the objects will be defined too so if there is a mistake in order of the images or a gap, it will be automatically corrected.

Worm Tracking [14][18]

Worm Tracking compares positions of the worm over successive images, and uses this information to correct the stage position. All stage movements are automatically recorded in a *stage* file, which is used in combination with worm image files in subsequent analyses. Stage positions are corrected between intervals of image acquisitions. Recorded images are processed through several steps to produce a spline. The spline is created along the midline of the worm profile by performing a cubic interpolation of midpoints. It is then divided into n segments by placing n+1 markers at equal intervals, resulting in n-1 consecutive angles which may be measured separately to determine bending properties. The centroid position is defined as the averaged position of the n+1 markers. Worm Tracking includes different modules, including Calibrate, Record, Playback, Spline, Analyze, *and* Batch Analyze.

The algorithm of Worm-Tracking analyses has two graphic interfaces: Analyze and Batch Analyze. For both the methods, the spline data and equating stage data would be used as the input so it will generate quantitative data. Equating stage data will have appointed automatically in the time that exact spline data are chosen. Then the quantitative parameters will be categorized in two groups: Movement Analysis and the Bend Analysis. The Bend Analysis comprised plotting the bend trace and bend frequency spectrum, numbering the enormity and frequency of the maximum bends, enormity the sum of every bends averaged in the time, and capturing the bending activities like RMS and maximum bend for every chosen bend (1 to N+1). The algorithms of Movement Analysis involved recreating the object travel path, capturing the object amplitude, scheming the speed and space of movements, and calculating the distance and duration of forward and backward movements. Every of these parameters but not the object amplitude and directionality can be calculated by considering the positions of either the centroid or any of the N symbols.

D. Conclusion

An algorithm, first to automatically identify the target regions with higher temperatures among all other faces and objects from infrared images has been proposed. Also this work proposes an approach for improving automatic object detection in a dynamic environment. This paper represents a method which can detect object with high temperature among other objects (having any temperature). Comparing to methods which are using now, this method is faster and more accurate and also does not need human labor. Methods which are currently used for detection needs a lot amount of time. In some cases, we put object one by one in front of thermal camera to check their temperature. All the methods would take lots of time because it should apply on object one by one. Method presented in his paper is able to do automatic detection of object with temperature in a very short time. Thermal images would be taken from the moving object and after analysis, we detect out target. It will take very short amount of time. Also, presented algorithm is able to track objects of interests and draw their movement path. It will allow us to find location of the object of interest at any time. The proposed approach includes image Thresholding using template matching and moving objects tracking.

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