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VISUAL MONITORING AND ALERTING SYSTEM FOR ARC TYPE METERS

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Abstract

In the fast industrial growth, it is necessary to avoid unexpected interruption of electrical machines. In this paper, Visual Monitoring and Alerting System have been developed to monitor the electrical parameters such as voltage, current and temperature. The new Algorithm is used to identify the angle of the pointer's image obtained from the ARC type meters. The obtained angle value is compared with the specified limit. If the angle exceeds the limit then the alarm will be turn on to alert people. The proposed system can be operated in all environmental condition because it utilizes non-invasive technique.

Keywords: Visual Monitoring and Alerting System (VMAS), Angular Detection Algorithm (ADA), Region of Interest (ROI).

1. Introduction

In industries, it has become necessary to incessant monitor the stipulation of the electrical machines and systems to avoid any unscheduled breakdown during the production process. To protect plants, switchgear systems, and alternators, the non-invasive sensors and controllers plays important roles at the time of integrated faults or catastrophe. In recent years, more attention has been focused on the monitoring of various parameters such as voltage, current, and temperature of electrical systems from control room using remote sensing methods. As the electrical machines are critical components in industrial processes the machine failure may yield an unexpected interruption in the production process, with consequences in costs, product quality, and safety. The measuring instruments such as voltmeters, ammeters, and temperature gauges must be watched continuously and constantly to avoid any devastation in the process. In most of the industrial process, analog type meters and gauges are still being used because human inspectors are very prone to visualize deflection more easily than to recognize a digital display. Hence, to replace the human inspector for supervision and monitoring of electrical parameters, a visual monitoring system (VMS) having knowledge based artificial intelligence is essential. A novel architecture of Angular Detection Algorithm has been developed to identify the geometrical and statistical. features of the pointer's image position from the captured image of indicating type meters.

In our view, a real time visual monitoring system has the following stages: 1) image acquisition; 2) image pre-processing; 3) segmentation; 4) feature extraction; 5) feature comparison; and 6) display of result along with Alarm signal. The geometrical, statistical, and wavelet-based image features were used to recognize the indicated value using feature matching algorithm. Also, the algorithm compares the recognized value with the set value of parameters and if, it is found beyond the specified limit, it generates various alarms.

2. Background and related work

A literature survey is done for various papers which are essential to know the previously available techniques and their significance and limitations. It also includes the various supporting papers for the proposed technique and their advantages. There are many approaches available for monitoring system with less accuracy. The Dynamic Sliding Window Algorithm (DSWA) provides the visual monitoring system with high accuracy

R. Sablatnig et al proposed Increasing flexibility for automatic visual inspection: The general analysis graph [4]. it presented the automatic reading of dial type instruments based only on geometrical lay-out of the dial of meter or gauges. it provides the initial stage for non invasive technique.

S. G. Liu et al proposed Checking on the quality of gauge panel based on wavelet analysis [1]. The Wavelet analysis and Hough transform based inspection system created a room for application of soft computing techniques in the monitoring, calibration or inspection of gauges.

M. R. Mamat et al. proposed Fault detection of 3-phase VSI using wavelet-fuzzy algorithm [7]. This approach has been presented to detect the 3-phase VSI faults of closed loop fuzzy controlled induction motor. The features are directly extracted from the wavelet transform of the stator currents. The results clearly show that wavelet analysis together fuzzy logic, offers a great potential for monitoring and diagnosis of power electronic drives.

G. G. Acosta et al proposed A current monitoring system for diagnosing electrical failures in induction motors[8]. This paper used non invasive technique, such as Extended Park's Vector Approach. it is one of the complex computational based techniques being used to diagnose any electrical failures in induction motors.

R. L. Cárdenas et al proposed "Inter-turn short circuit and unbalanced voltage pattern recognition for three-phase induction motors"[9]. The main perspective is that the monitoring of voltage variation is also equally useful to detect any flaws either in the motor or in the connected systems

Z. A. Jaffery and A. K. Dubey proposed Real time visual inspection system (RTVIS) for calibration of mechanical gauges[10]. They have designed a real-time visual inspection system for the calibration of mechanical gauges using artificial intelligence

.J. Datt et al proposed remote monitoring of different electrical parameters of multi-machine system using PC. The basic idea is focused on the monitoring of various parameters such as voltage, current, and temperature of electrical systems from control room using remote sensing methods. The main drawback is the Throughput of the electrical parameters depends on the Internet bandwidth.

From the literature survey, it is evident that the existing techniques use only geometrical features of the image. Hence the Accuracy and Reliability are less. The proposed architecture of detection algorithm identifies the geometrical and statistical features of the pointer's image position from the captured image of indicating type meters. The development of visual monitoring system for automatic reading of analog type gauges or meters ensures robust, economic and user friendliness of the system.

The segmentation is a process in which features or regions having homogeneous characteristics are identified and grouped together. The image segmentation method involves edge detection, boundary detection, statistical classification, region detection, and thresholding or combination of these techniques. There are numerous image segmentation techniques available for the segmentation of desired portions or objects from colour, intensity, and black & white images.

It is expected that the main text will be divided into several sections and subsections as author wishes. Make sure your breakdown of the main body does not affect the coherence of the flow of arguments or the continuity of the presentation. It may be a good idea to use appendixes for describing lengthy expressions / proofs or anything that might influence the readability of the main text.

2.1 Boundary encoding method

To code windows from multiple regions in an image, one must know to which region each window belongs, so that each window can be decoded with respect to the correct codebook. For generic samples from multiple classes, one can estimate the distribution of each class label and then code the membership of the samples using a scheme that is asymptotically optimal for that class distribution. Such coding schemes are highly inefficient for natural image segmentation, as they do not leverage the spatial correlation of pixels in the same region.

In fact, for the proposed application, pixels from the same region form a connected component. Thus, the most efficient way of coding group membership for regions in images is to code the boundary of the region containing the pixels.

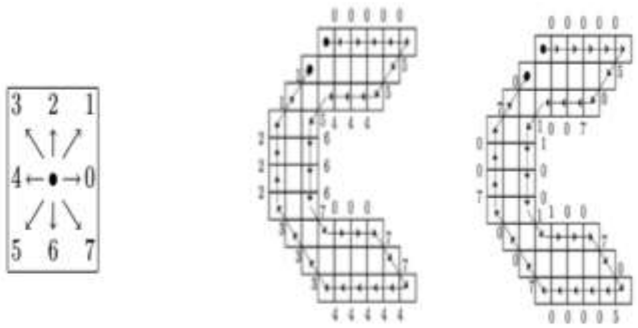

Figure 1 Left: The Freeman chain code of an edge orientation along 8 possible directions. Middle: Representation of the boundary of a region in an image with respect to the Freeman chain code. Right: Representation with respect to the difference chain code.

A well-known scheme for representing boundaries of image regions is the Freeman chain code. In this coding scheme, the orientation of an edge element is quantized along 8 discrete directions. Let {ot}T t=1 denote the orientations of the T boundary pixels of R. Since each chain code can be encoded using three bits, the coding length of the boundary of R is

$$B(R) = 3\sum_{i=0}^{7} \#(o_t = i). \qquad (1)$$

The coding length B(R) can be further improved by using an adaptive Huffman code that leverages the prior distribution of the chain codes.

Though the distribution of the chain codes is essentially uniform in most images, for regions with smooth boundaries, we expect that the orientations of consecutive edges are similar, and so consecutive chain codes will not differ by much. Given an initial orientation (expressed in chain code) ot, the difference chain code of the following orientation ot+1 is Δot . = mod (ot −ot+1,8). Figure 1 compares the original Freeman chain code with the difference chain code for representing the boundary of a region. Notice for this region, the difference encoding uses only half of the possible codes, with most being zeroes, while the Freeman encoding uses all eight chain codes. Given the prior distribution P[Δo] of difference chain codes, B(R) can be encoded more efficiently using a lossless Huffman coding scheme:

$$B(R) = -\sum_{i=0}^{7} \#(\Delta o_t = i) \log_2(P[\Delta o = i]). \tag{2}$$

For natural images, we estimate P[Δo] using images from the BSD that were manually segmented by humans. which used 1000 images of curves, contour patterns, and shapes obtained from the web. As the regions of natural images tend to have more smooth boundaries when segmented by humans

2.2 Dynamic region growth

The quality of region-growth techniques is highly dependent on the locations chosen to initialize the growth procedure. We propose an alternate process for region growth that does not depend exclusively on the initial assignment of clusters for the final segmentation. The procedure searches for regions where the gradient map displays no edges. The selected regions form the initial set of seeds to segment the image. The region growth procedure also accounts for regions, which display similar edge values throughout, by detecting unattached regions at various edge density levels.
Adaptive Threshold Generation: The GSEG algorithm is initiated with a colour space conversion of the input image from RGB to CIE . This step is vital, because the latter is a better model for the human visual perception justified by the fact that given two colours, the magnitude difference of the numerical values between them is proportional to the perceived difference as seen by the human eye, a property that cannot be associated with the RGB space. Using the acquired data, the magnitude of the gradient of the colour image field is calculated . The histogram of this gradient map is utilized to determine the seed addition levels employed for dynamic seed addition. Initially, the objective is to select a threshold for the initiation of the seed generation process. Ideally, a threshold value could be selected to provide the most edges, while ignoring the noise present in images. The flowchart of the region growth process is shown below.

The problem is that the nature of images does not allow for this disposition. A single threshold that may correctly delineate the boundary of a given region may allow other regions to merge incorrectly. Due to this factor, we propose choosing one of two empirically determined threshold values for initiating the seed generation process, by validating how far apart the low and high gradient content in the image are, in its corresponding histogram.

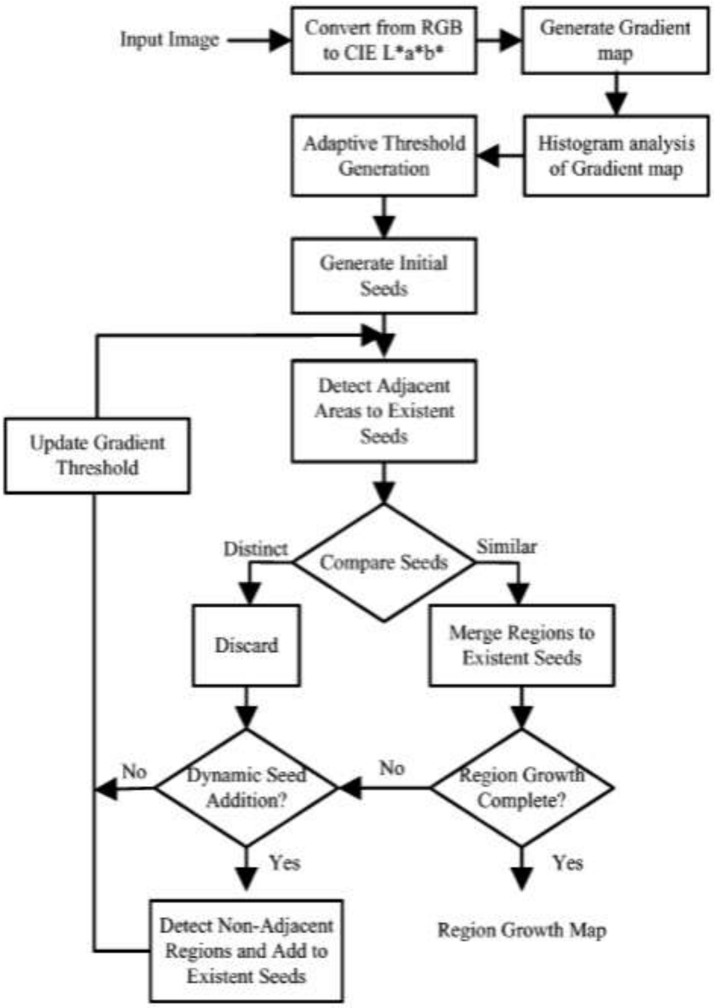

Figure 2: Flowchart of a region growth procedure

The idea is that a high initial threshold be used for images in which a large percentage of gradient values spread over a narrow range and a low initial threshold value be used for images in which a large percentage of gradient values spread over a wide range, in comparison to the span of the histogram.

2.3 Dynamic sliding window algorithm

The segmentation is a process in which features or regions having homogeneous characteristics are identified and grouped together. The image segmentation method involves edge detection, boundary detection, statistical classification, region detection, and thresholding or combination of these techniques. There are numerous image segmentation techniques available for the segmentation of desired portions or objects from coloured, intensity, and black & white images.

Dynamic Sliding Window Algorithm for Segmentation of Image: The Region Of Interest (ROI) based sliding window technique for the segmentation of a desired portion (a region having image of pointer of indicating type meter for RTVMS application) from the captured image is shown in Fig.3

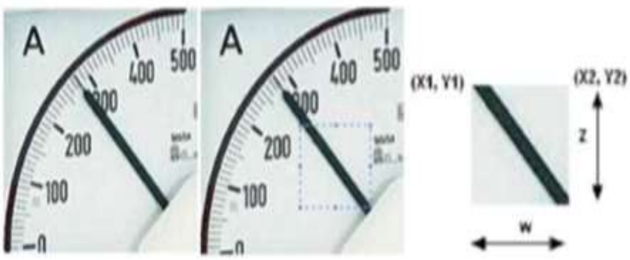

Figure 3: Selection of ROI

The sliding window algorithm involves some computational steps for the calculation of window size and number of sliding steps. It also includes the algorithm to detect solid line in the sliding window and if, in case, line is not detected in the window, the window shifts to the next higher location and so on till the detection of line .

The computations involved in the sliding window algorithm are as follows.

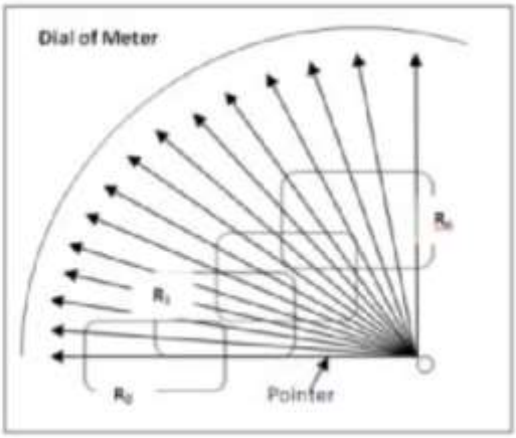

Figure 4: ROI Based Dynamic Sliding Window Technique

Calculation of size of sliding window: Let X1 = l; where l = 1 to i (i =Maximum value of x-coordinate of Image),Y1 = m; where m = 1 to j (j=Maximum value of y-coordinate of Image), X2 = X1+w; where w = Width of the sliding window, Y2 = Y1+ z; where z = Height of the sliding window. Therefore, the diagonal coordinates of ROI based rectangular sliding window are (X1,Y1) and (X2,Y 2). These coordinates define the size of the window.

Calculation of no of sliding steps: No of Sliding Steps n = x/w; where, x=Total Width of Resized Image, w = Width of the Sliding Window.

Locations of the pointer: Let L = Total number of steps in a defined range of the meter and Li =

Location of pointer at ith step, where i = {0, 1, 2–(L−1)}.

Development of ROI matrices: The ROI matrix defines the size of the window. The database of various window sizes has to be developed for one type of meter. The size of window and number of ROIs are the function of dial span and dial type, such as semi-circular, quarter circular and linear.

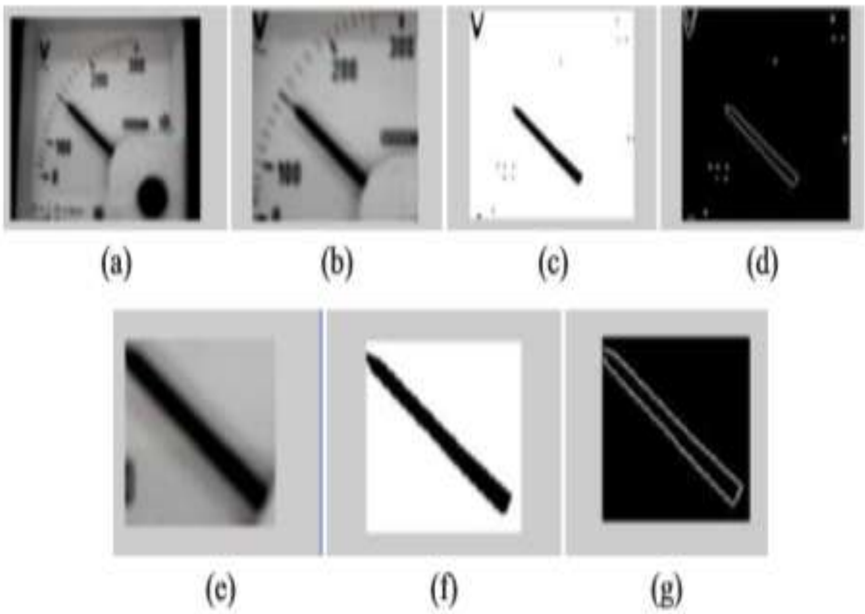
(a) (b) (c) (d) (e) (f) (g)

Figure 5: Effects of size of sliding window. (a) Original image. (b) Segmentation using larger window size. (c) Black and white image of segmented image (b) using threshold technique. (d) Edges of image objects appearing in (c). (e) Segmentation using smaller window size. (f) Black and white image of segmented image (e) using threshold technique. (g) Edges of image objects appearing in (f).

All above techniques have their own limitations for the real time application, where less computational power and execution time is a prime requisite. Therefore, a novel ROI based angular detection technique have been developed for the segmentation of desired portion from the captured image in real time applications

3. Proposed Technique

Effectiveness of the Real time applications mainly depends on execution time and reduced circuit complexity. In order to achieve these constraints, we have developed visual monitoring system with Angular Detection Algorithm (ADA). The algorithm detects the pointer's position and compares with the set value. If the pointer value exceeds the limit then the alarm will turn on.

3.1 Visual Monitoring and Alerting System

The system follows a non-invasive technique to protect the electrical plants. The non-invasive technique can be implemented in the places, where some sensors can't be used. Regardless of the environment condition VMAS can be implemented in all places. There is no physical touch and additional circuit is used in the case of VMAS. The flowchart of VMAS is shown in Fig.6

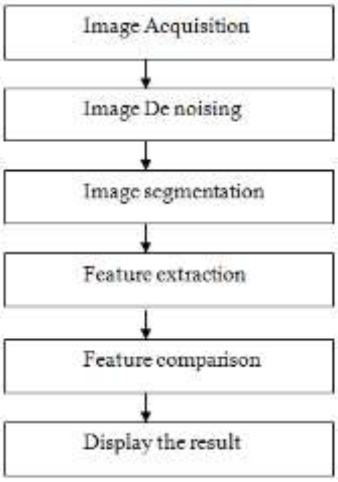

Figure 6: Flowchart of VMAS

3.1.1 Image Acquisition

Image acquisition techniques play an excellent role in the field of visual monitoring and alerting system (VMAS). The procedure and excellence of image acquisition enables RTVMS to work proficiently and precisely. The quality of image depends upon the type of camera, position of camera, number of cameras, and the illumination systems. The illumination techniques help in exploring the characteristics of images under test. In this approach, webcams with 12 mega pixel resolution and LED based illumination are used. Fig 7 is the input image for the system

.

Figure 7: Input Image

3.1.2 Image De-noising:

The wavelet transform (WT) is a prevailing tool for signal and image processing. It is being applied in many scientific and engineering fields such as signal pre-processing, image compression, image fusion, computer graphics, computer vision, feature calculation, image inspection, and pattern recognition. The fundamental concept involved in multi- resolution wavelet transform is to find average features and details of the image signal using scalar products with scaling signals and wavelets.

Usually, an image is sullied by various noisy factors during the acquisition and processing of it. This noisy effect decreases the performance of real time visual monitoring systems. Therefore, the de-noising process can be implicated as to remove the noise while retaining the quality of the processed image.

The three main steps involved in the de-noising process using wavelet approach are shown in Fig.8 This includes: wavelet transform, thresholding and inverse wavelet transform.

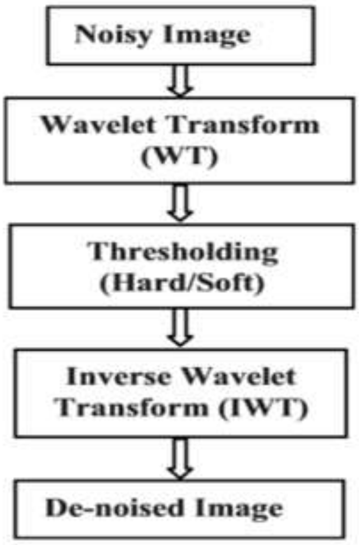

Figure 8:De noising steps

The type of wavelet and thresholding technique decides the efficiency of de-noising process. In this paper, the de-noising of captured images is done using Daubechies wavelet (db10). The following Fig 9 shows the De-noised image.

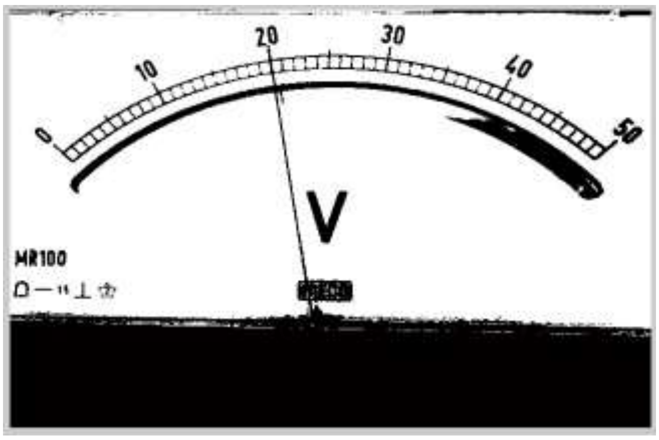

Figure 9: De-noised image

3.1.2 Image Segmentation:

The segmentation is a process in which features or regions having homogeneous characteristics are identified and grouped together. The image segmentation method involves edge detection, boundary detection, statistical classification, region detection, and thresholding or combination of these techniques. There are numerous image segmentation techniques available for the segmentation of desired portions or objects from colored, intensity, and black & white images. Our proposed method uses Angular Detection Algorithm (ADA), the steps involved in ADA is listed below. and Fig 10 and 11 includes the segmentation process.

1) The vertical growing lines in the image is found

2) Among the lines the longest one is chosen.

3) Mark the starting and end points of the line. Image is converted into matrix. The angle value is assigned to point based on the column and row value of the matrix.

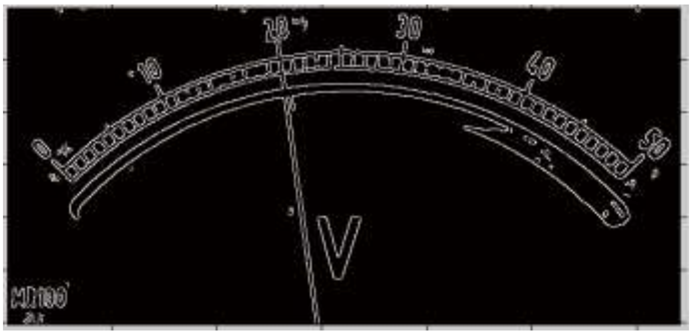

Figure 10: Edge Detection

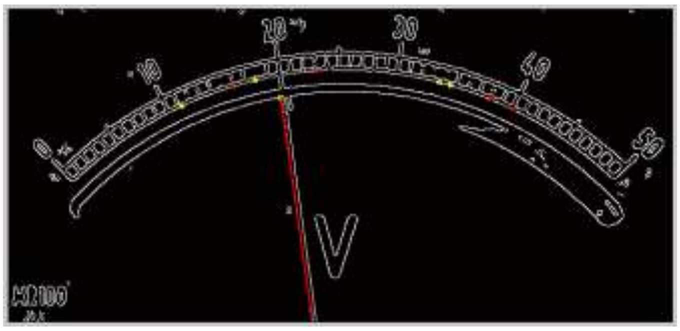

Figure 11: Feature Detection

3.1.3 Feature Extraction:

In this step required features are obtained from the segmented image. The pointer with starting and end point is our Region Of Interest (ROI). This is extracted from the previous stage. It is shown in Fig 12. The angle value to the pointer is assigned based on their co-ordinate position.

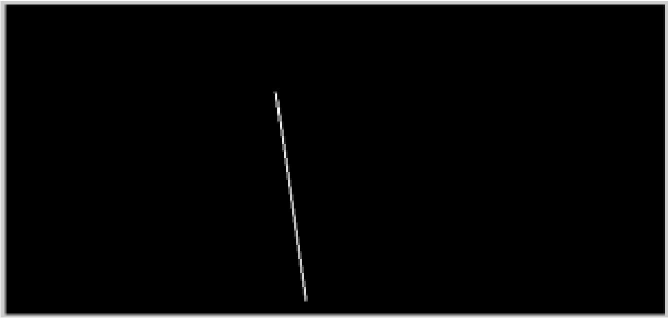

Figure 12: Feature extraction

3.1.4 Feature Comparison:

Once the required feature (pointer position) is extracted from the image then the respective angle value is assigned to the pointer. the present value of the pointer is compare with the set value. If the obtained pointer's value exceeds the limit then alarm will be turn on.

4. Implementation and Result

The Result shows the present angle value and measurement value of the meter. The threshold value is set as default . If the captured value exceeds the set limit then the Alarm will be Turn ON. The output for the different set value is shown below.

Fig 13 shows the output1, where angle is less than the set value hence there is no Alarm. In Fig 14, Angle is greater than the set value hence Alarm is turn ON.

IF SET VALUE IS 80:

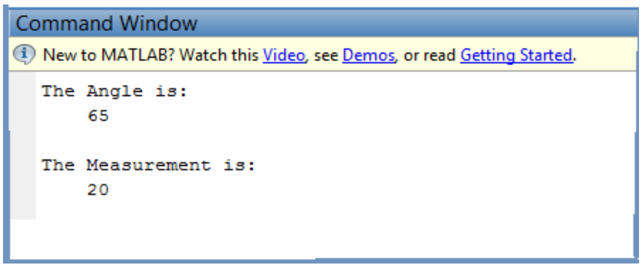

Figure 13: Output1

IF SET VALUE IS 50:

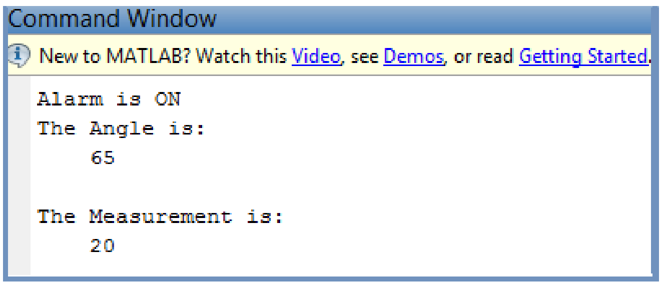

Figure 14: Output2

Table 1: Comparison between DSWA and ADA

Parameters	DSWA	ADA
Algorithm complexity	High	Less
Accuracy	Depends on window size	Stable and accurate output
Execution Speed	Less	High

The Table 1 shows the comparison between DSWA and ADA. The DSWA includes many processing steps hence complexity gets increased. Whereas in ADA less number of computational steps are involved. Because of the reduced steps execution speed is high in ADA , from the table it is clear that ADA has the better result than DSWA.

5. Conclusion

Angular Detection Algorithm has been developed for the segmentation of the captured pointer's image of the meter. The proposed algorithm gives very good result in real time mode and in robust conditions. The proposed method has less complexity and computational time compare to DSWA, which is illustrated in Table 4.1. The DSWA includes many processing steps hence complexity gets increased. Whereas in ADA less number of computational steps are involved. Because of the reduced steps execution speed is high in ADA , from the table it is clear that ADA has the better result than DSWA. wavelet transform is used for the image de-noising and the computation of the various image features. Canny edge detector is used for the detection of edges in the region of interest (ROI). The proposed VMAS is a non-destructive and a non-invasive technique for the real time monitoring of ARC type meters. All these implementations are done using MATLAB tool.

The proposed system may also be used as the third eye monitoring of speed, fuel, and temperature gauges of automobiles and aviations. An artificial intelligence based decision making algorithm may be added to further enhance the reliability and widens the application areas of RTVMS in the field of automations.

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A Brief Author Biography

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