INTRUSION DETECTION BY UTILIZING MULTIMODE OPTICAL FIBER BASED ON SPECKLE IMPRESSIONS

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ABSTRACT

This paper introduces the system that is able to identify the disturbances that occurs on a fiber when buried across the protected parameters or boundaries. The overall detection system comprises of video camera, a coherent laser device from which the light is sent through the optical fiber, and then the distributed pattern called as speckle pattern can be seen on a screen which changes as soon as the disturbance on a fiber varies. Now this pattern is captured by the video camera and can be investigated on computer screen. For analyzing and evaluating, the differences in speckle impressions image processing algorithms are used followed by soft estimating skills; therefore, the system is capable of detecting different intrusions in the intricate conditions or surroundings with an economized cost and reduced arithmetic calculations.

Keywords*-Artificial neural network, Intrusion detection, laser source, multimode optical fiber, Perturbations, Speckle impressions.*

1. Introduction

When the fiber sensor is used as sensing device followed by a camera which can act as a detector and laser, then the frames from video sequence are acquired on a screen. In further image processing, the varying properties of speckle impressions like contrast, intensity or speckle content or magnitude are analyzed. With the help of determination of these parameters, different disruptions such as fluctuations, physical force or any kind of emphasis can be inspected [1]. Different scientific techniques of detecting intrusions have also been used in previous years like POTDR (polarization optical time domain reflector) system. During the launch of pulse, it is propagated through the fiber. As the perturbation occurs, there are sudden changes in POTDR traces. These traces are taken every 5 seconds. The principle is based on the difference between two consecutive images [2]. While detecting the real intrusions due to human, there are also probability of false alarms that may arise resulting due to moving animals like dogs or cats, therefore, careful judgment to

such distractions is essential [3]. As the multimode optical fiber has its larger core, multiple modes can travel together through the optical fiber, when speckle impression is obtained on a screen, it consists of a dissimilar concentration of light whereas its complete intensity remains same as shown in fig. [1]. Optical fiber finds its application in other fields also like detecting the pipeline leakages in which the optical fiber is buries under the soil along with pipeline. The intrusion and leakages can be inspected by analyzing the characteristics of the light power [5].
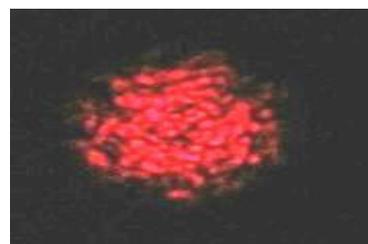

Fig.1 Speckle Impression

Recent growth in electronics science and technology have provided the intelligent algorithms and software through which the analyzing and determining the images in real time can be done in a very efficient way. The widely used technique for observing and estimating the images is the Artificial Neural Network. The processing in this network is self learned [6]. The structure of neural network is shown in fig.2.
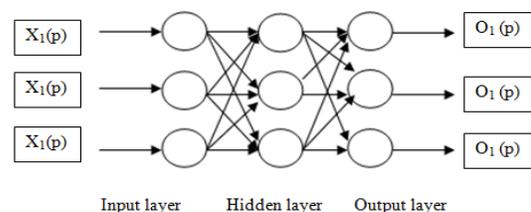

Fig.2 Neural Network Structure

By employing this technique, the detection and classification of any kind of perturbation like real or non

real events can be done easily. This event classification technique basically involves the pre processing stage that selects the exclusive characteristics from the event and a classifier that appoints the characteristics to the appropriate class of perturbation [7]. The application of artificial neural network can broadly advance the recognition correctness. Whereas, when the results deviate, the system can adapt by itself according to the desired result and can certainly re-train. After training, the system detects different disturbances with the new weights.
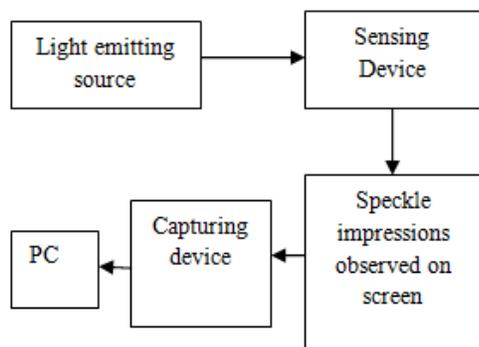
2. Architecture of Perturbation Detection

Fig.3 Architecture of Detecting Perturbation

The setup is shown in fig.3. While the ray of light comes from the laser source that generates the orderly illumination through multimode optical fiber, then the output can be acquired on other end of fiber whereas speckle impression can be noticed on a screen which is in addition, pick up by the camera and seen in pc.

3. Principle

When the camera captures the video consisting of series of image frames, the consecutive frames are taken in MATLAB in which the net consecutive frame difference is carried out to detect the motion. After some period of time, again succeeding frames are taken and associated with preceding frames. The final alteration is obtained in matrix form where each contiguous co-ordinate indicates the intensity sharpness value.

Many functions are carried out in MATLAB that involves the tasks of loading patterns in memory, computing difference between consecutive frames and calculating total intenseness.

4. Formation of speckle impressions from different perturbations

3 different cases of intrusions are acquired in MATLAB, that is, human, vehicle and animal. Various activities are performed under each case that are totally based on different kinds of forces or pressure on fiber.

5. Artificial Neural Network

Training and classification part is performed in ANN before testing. In this, 3 dissimilar sections of human, vehicle and animal intrusions are distinguished. ANN is a series of actions that performs and gives the desired result. It comprises of large number of interconnected constituents known as neurons. These neurons are responsible for overall computation in neural network. The network has input layer, hidden layer and output layer called as multilayer feedforward network as shown in fig. 4.
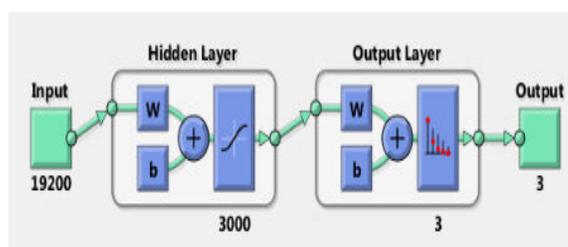

Fig. 4 Multilayer Feedforward Network

5.1 Testing phase in ANN

Now testing is performed after the training and classification is done in which different sections of human, vehicle and car intrusions are classified. Testing phase includes practicing various intrusions on fiber. Firstly human disturbances are applied and then examined with the trained image data developed in ANN classification. Likewise, testing is performed with other intrusions also. While doing the human intrusion activities on fiber, the output value will be high and ultimately 'human intrusion' is displayed on a screen.

6. Results and Discussions

While doing the human intrusion activities on fiber, the output value will be high and ultimately 'human intrusion' is displayed on a screen. Fig.5 shows the results after human intrusion is tested. Higher value indicates the human intrusion.
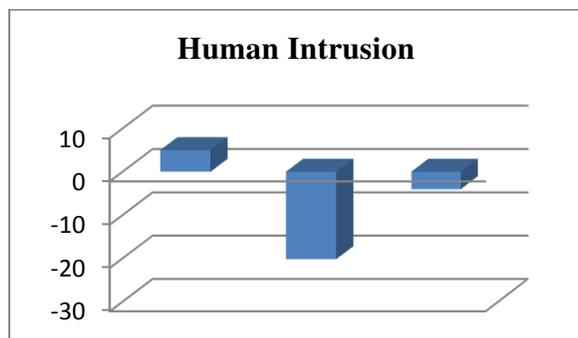
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523

Fig. 5 Human intrusion testing result

7. Conclusion

5 trials of human physical disturbances have been conducted. Out of which 1 trial is misclassified as wrong intrusion that provides 80% accuracy. Therefore, human intrusion can be detected by using the very simple detection system based on observing the speckle patterns. This system provides sufficient accuracy in real time with reduced cost and computation.

Future Scope

Due to the advancement in fiber optic sensor technology based on speckle impression analysis, the identification of real and non real intrusion has become much easier. Due to its low cost and faster computation, it can be applicable in multiple fields. To get precise measurement, larger number of intrusion samples can be taken. Multiple activities can be performed under human; vehicle and animal intrusion in testing phase and observe the results.

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