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PEDESTRIAN DETECTION IN INFRARED IMAGES: INTERVAL VALUED REPRESENTATION BASED APPROACH

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ABSTRACT
The evaluation in the cost of infrared cameras opens a new platform for attacking many untouched vision problems. This article proposes a novel method of representing infrared images by the use of edgelet features for object recognition application. The proposed technique makes use of interval valued representation for edgelet features of the infrared images. A scheme of identification of the objects based on the proposed features extraction and representation model is also designed. Hence the features are transformed in interval valued representation, the proposed model drastically reduces the dimension of the feature space which in turn reduces the computational time for object recognition in the infrared images. Further an extensive experimentation is conducted on publically available datasets. The result of the experiments tells us that the proposed algorithm outperforms for the state of the art technique. However, the main advantage of the proposed technique is that it takes relatively a less time for identification as it depends on a simple matching strategy.

Keywords: Object recognition, infrared images, interval valued representation**.**

1. INTRODUCTION

Pedestrian detection is one of the most important applications of computer vision which has several applications like Advanced Driver Assistance Systems (ADAS). In recent year there are plenty of algorithms were developed for efficient detection of pedestrians using image processing algorithms. Pedestrian detection is considered as one of the real time problem which requires efficient algorithms to solve these issues in uncontrolled environments like day time, evening time and in limited sun light. To tackle this, common cameras are not compatible because of the lack of capacity to capture the images in the night time. This article addresses the problem of detecting pedestrians in dull sun light or in night time using infrared camera. Detection of pedestrians in night time will open up new application for addressing security issues in the absence of sun light. In most of the applications we expect that security cameras or surveillance camera systems should work on an around the clock basis. Normal cameras which produce images in visible spectrum are not effective in the absence of natural light. Even though some solutions are there for such problems like morning time natural illumination and night time artificial illumination arrangement for the camera, but these solutions are not practically advisable. Also these solutions have limitations like shadow in the morning or day time. As a result, system may fail in capturing and identifying objects in the dark areas of the current environment. One of the solutions for such problems is usage of Infrared IR cameras instead of visible spectrum cameras.Infrared (IR) cameras are ideally suited to applications which require functioning at the night time and also in the dark light. [25-26]

This research article presents a method for detecting pedestrian in the dark sun light or dull light using infrared camera. The proposed approach consists of different stages like feature extraction, knowledge base construction stage and pedestrian detection stage. The details of the proposed algorithm are present in the respective section of the paper.

The rest of the paper is organized as follows. In section 2 a brief literature survey is presented. In section 3 we present the proposed model for object recognition in infrared images. Section 4 discusses about experimentation and comparative analysis performed on the proposed models. Paper will be concluded in section 5.

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2. LITERATURE SURVEY

This section presents adetailedliteraturesurvey of the feature extraction techniques for object recognition. Since this article focuses on the object recognition in the infrared images, we restrict our study tofeature extraction of conventional object recognition approaches and few works on infrared images. The main aim of object recognition is to locate and identify instances of an object from an image with the help of features extracted from the images.

In literature most of the works on feature extraction techniques are classified into two categories like edge-based type and patch based feature types.From the survey it is clear that some approaches use combination of edge-based type and patch based feature type [1-5].

Edge Based Approaches
This method uses the edge map of the image and identifies the objects in the image in terms of edges [1, 2, 6-7].Considering edges as features is advantageous because of many reasons, as they are largely invariant to illumination conditions and variations in objects' colors and textures. They also represent boundaries of the object well and represent the data efficiently in the large spatial extent of the images [6].The main two deviations in these techniques are s: use of the complete contour (shape) of the objectas the feature [8-13] and use of collection of contour fragments as the feature of theobject [1, 2, 6, 14-20]. Figure 2 shows an example of complete contour and collection ofcontours for an image.

Hamsici [8] the whole shape of the contour of the edges to get a foothold in the recognition of a set of points of contact between them. Schindler [12] considered the super-pixels, such as segmentation based approaches.They are considered to be close to the contours of the surrounding areas from the very beginning to get the contours of the closure. Ferrari[17] at the edges of the object detection offers the best of contemporary methods used in the most advanced edge detection method. After the closure of the contours of the edges to form a network connected across the small gap between them. [15] Ren is significantly more difficult becauseof the presence of background information in the natural images; the contours of the objects are used to complete a triangulation. All of these techniques require additional computation intensive treatment and are often sensitive to the choice of a variety of practical outlining parameters of note. The other problem with such a feature for testing and validation of images, is available to match the contours of even an incomplete image and therefore the entire contour of the degree is generally low [11].

Patch Based Approach
The patch based feature extraction approach has been in use since more than two decades [21], and edge-based featuresare relatively new in comparedpatch based technique. Moravec [21] considered local maxima of minimum intensitygradients, he called it as corners and selected a patch around these corners. This work isenhanced by Harris [22], which made the new detector less sensitive to noise, edges, andanisotropic nature of the corners proposed in [21].In its regular form, such as the features of the object templates [23] in order to use the same size of a rectangular or square in local areas. Such features are effective for multi-scaling (the appearance of a variety of material) . The following may not be suitable due to the size of the fixed patch. The size of the patch is small, it is big but may not cover the most important local feature. Such a feature is a short list of information may be lost. The size of the patch is large on the other hand, it may not be present simultaneously with other images or more than one separate covers. Another shortcoming of many small rectangular patches needs to be overcome in order to assess the attributes and the material. Both of these are computationally expensive and memory intensive. The images have a variety of features such as robustness, use of smaller or larger features, better and faster learning capabilities, and requiring less storage [24].

3. PROPOSED METHODOLOGY

This section presents the details of the proposed model for Pedestrian detection using supervised learning algorithm. The proposed model can be seen as different modules like interval valued representation stage and pedestrian detection stage.

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Interval valued Representation of Features

The proposed interval valued representationmodelis based on representinganobject's descriptionbyedgelet features of the infrared images of a class in the form of symbolic data.Anedgeletis a feature which is a short line segment or a curve present in the image which identifies the positions and normal vectors of the points in an edge by $\{U_i\}_{i=1}{}^{k}$ and $\{n_i{}^{E}\}_{i=1}{}^{k}$, k is the length of the edgelet. Given an input image I, denoted by $M^I(p)$ and $n^I(p)$ are the intensities of edge at position P of input image$I$. In practice,edge orientations are quantized and represented by $\{V_i{}^{E}\}_{i=1}{}^{k}$ and $V^I(p)$ of the input image I respectively. A features sample of an object of a particular class suffersfromintraclassvariations.An effective feature representation for capturingthevariations of features samples through their assimilation by the use of interval valuedrepresentationcalled as symbolic feature vector is proposed.

Let [$Sp_1, Sp_2, Sp_3 . . . , Sp_n$] be the set of n samples of class D_j, $j = 1, 2, 3, . . ., N$ (N denotes the number of classes(domains)) and let $Fpi = [fp_{i1}, fp_{i2}, fp_{i3}, . . ., fp_{im}]$ be the m edgelet features of $Sp_i$of classCd_j.The μjk, k = 1,2,…,m be the mean of k^{th}featuresand can be obtained from the following equation

$$\mu_{jk} = \frac{1}{n}\sum_{i=1}^{n} fp_{ik}$$

Standard deviation of the k^{th} feature and it is calculated using the following equation.

$$\sigma_{jk} = \left[\frac{1}{n}\sum_{i}^{n}(f_{ik} - \mu_{jk})^2\right]^{\frac{1}{2}}$$

Now standard and meandeviation are considered in the identification of theintraclass variations in k^{th} feature space of the j^{th} class and it is represented by interval valued feature representation as $[f_{jk}^{-}, f_{jk}^{+}]$where

$$f_{jk}^{-} = \mu_{jk} - \sigma_{jk} \text{ and } f_{jk}^{+} = \mu_{jk} + \sigma_{jk}$$

Now, these interval valued representation of the reference image of class Cd_j will be created by representing each in feature ($k=1,2,3,. . . ,m$)

$$\{[f_{j1}^{-}, f_{j1}^{+}], [f_{j2}^{-}, f_{j2}^{+}], [f_{j3}^{-}, f_{j3}^{+}], \ldots, [f_{jm}^{-}, f_{jm}^{+}]\}$$

Pedestrian Detection Stage

Pedestriandetectionin infrared images presented in this work considers a query image which is described by the set of m crisp features, as they are the features of one sample of test image and are compared with the symbolic feature of the respective classes presented in the knowledgebase.Since the features are transformed into interval valued representation, the proposed model drastically reduces the dimension of the feature space which inturnminimizes the computational time for object recognition in the infrared images.So from this we can notice that the proposed edgelet features with interval valued out performs the state art techniques.

Let $F_{test}=[f_{t1}, f_{t2}, f_{t3}, ... , f_{tm}]$ be the m-dimensional crisp features corresponding to a query image. During the object recognition, each kth feature value of the test image will be compared with the corresponding interval valued feature and examined whether the feature value of the test image lies within the corresponding interval. The number of features of a test image which fall inside the corresponding interval of the respective class will give the degree of similarity.

$$Similarity\ (Test, Training) = \sum_{k=1}^{m} Sim(f_{tk}, [f_{jk}^{-}, f_{jk}^{+}]$$

Here $[f_{jk}^{-}, f_{jk}^{+}]$ represents the kth feature interval of the jth class and it is defined as

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$$Similarity\ (Test, Training) = f(x) = \begin{cases} 1, & if\,(f_{tk} \geq f_{jk}^{-}\ and\ f_{tk} \leq f_{jk}^{+}) \\ 0, & otherwise \end{cases}$$

1) Given a query image Sd_q, the class representative can be formed as explained in the previous sections which requires computation of O(k.t+k). After creating the representative vector of a query image, we need to find out whether each representative value lies within the class interval or not. To compare with class it requires $O(2k)$ where k is the length of the representative vector. Therefore, to compare with all k classes it requires $k \times 2k$ computations and hence it is of $O(k.t+k+k^2)$

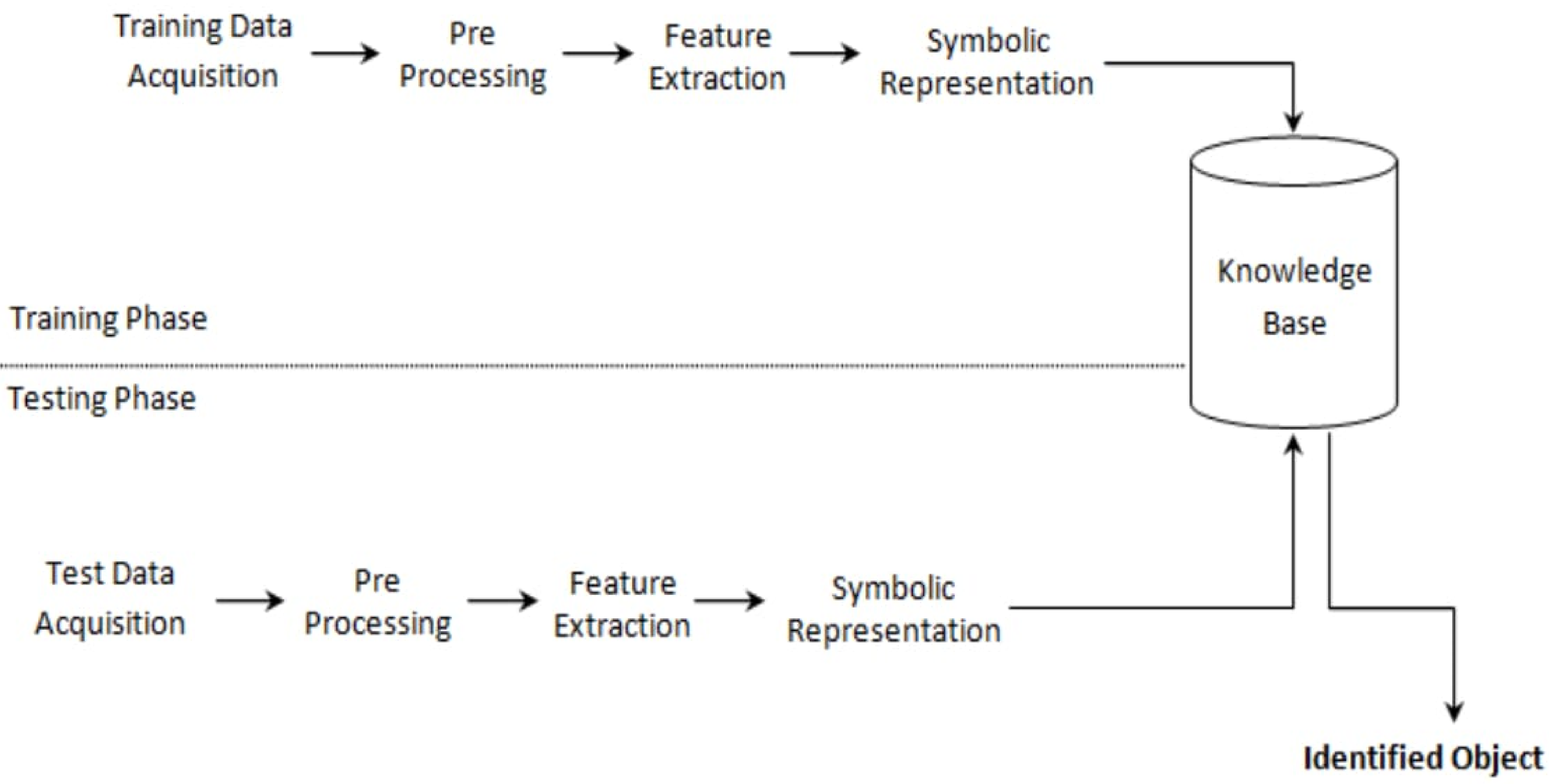

Figure 1 block diagram of the proposed approach

4. EXPERIMENTAL SETUP

This section presents the details of the experiments conducted to represent the effectiveness of the proposed method on publically available IR corpuses like OSU Thermal Pedestrian Database[28]. Two sets of experimentations are conducted where each set contains three different trails. In the first set of experiments, we have used 40% of the database for training and remaining 60 % is used for testing. In second set of experiments, we have used 60 % training and 40 % for testing [27]. In each trail we have randomly selected training and testing samples. For the purpose of evaluation of the results, we have calculated precision, recall and f-measure for each trail. The details of the experiments are shown in the following table1.

Table 1 : Result of the proposed method

Datasets	40% : 60%			60% : 40%		
	Precision	Recall	*f* Measure	Precision	Recall	*f* Measure
OSU Pedestrian Database	0.8421	0.8638	0.8528	0.8865	0.8921	0.8893

5. CONCLUSION

This article presents a novel method of representing infrared images by the use of edgelet features for object recognition applications. The proposed technique makes use of interval valued representation for edgelet features for identification of the objects in the infrared images. A method of identification of the objects based on the proposed edgelet features and interval valued representation model is also proposed. Since the features are transformed into interval valued representation, the proposed model drastically reduces the dimension of the

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feature space which intern reduces the computational time for object recognition in the infrared images. The proposed algorithm is critically analyzed on three publically available corpuses. Further an extensive experimentation is conducted on publically available datasets. Even though the proposed method requires minimum time for identification of objects in infrared images, result of the experiments tells us that the proposed algorithm outperforms the state of the art technique. However, the main advantage of the proposed technique is that it takes relatively a less time for identification as it depends on a simple matching strategy.

REFERENCES

1. *Opelt, A. Pinz, and A. Zisserman, "Learning an alphabet of shape and appearance for multi-class object detection," International Journal of Computer Vision, vol. 80, pp. 16-44, 2008.*
2. *Z. Si, H. Gong, Y. N. Wu, and S. C. Zhu, "Learning mixed templates for object recognition," in Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, 2009, pp. 272-279.*
3. *R. Fergus, P. Perona, and A. Zisserman, "A sparse object category model for efficient learning and exhaustive recognition," in Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, 2005, pp. 380-387.*
4. *Y. Chen, L. Zhu, A. Yuille, and H. J. Zhang, "Unsupervised learning of probabilistic object models (POMs) for object classification, segmentation, and recognition using knowledge propagation," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 31, pp. 1747-1774, 2009.*
5. *J. Shotton, "Contour and texture for visual recognition of object categories," Doctoral of Philosphy, Queen's College, University of Cambridge, Cambridge, 2007.*
6. *J. Shotton, A. Blake, and R. Cipolla, "Multiscale categorical object recognition using contour fragments," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol.30, pp. 1270-1281, 2008.*
7. *I. A. Rizvi and B. K. Mohan, "Improving the Accuracy of Object Based Supervised Image Classification using Cloud Basis Function Neural Network for High Resolution Satellite Images," International Journal of Image Processing (IJIP), vol. 4, pp. 342-353, 2010.*
8. *O. C. Hamsici and A. M. Martinez, "Rotation invariant kernels and their application to shape analysis," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 31, pp. 1985-1999, 2009.*
9. *L. Szumilas and H. Wildenauer, "Spatial configuration of local shape features for discriminative object detection," in Lecture Notes in Computer Science vol. 5875, ed, 2009, pp. 22-33.*
10. *L. Szumilas, H. Wildenauer, and A. Hanbury, "Invariant shape matching for detection ofsemi-local image structures," in Lecture Notes in Computer Science vol. 5627, ed, 2009, pp. 551-562.*
11. *M. P. Kumar, P. H. S. Torr, and A. Zisserman, "OBJCUT: Efficient Segmentation Using Top-Down and Bottom-Up Cues," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 32, pp. 530-545, 2009.*
12. *K. Schindler and D. Suter, "Object detection by global contour shape," Pattern Recognition, vol. 41, pp. 3736-3748, 2008.*
13. *N. Alajlan, M. S. Kamel, and G. H. Freeman, "Geometry-based image retrieval in binary image databases," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 30, pp. 1003-1013, 2008.*
14. *Y. N. Wu, Z. Si, H. Gong, and S. C. Zhu, "Learning Active Basis Model for Object Detection and Recognition," International Journal of Computer Vision, pp. 1-38, 2009.*
15. *X. Ren, C. C. Fowlkes, and J. Malik, "Learning probabilistic models for contour completion in natural images," International Journal of Computer Vision, vol. 77, pp. 47-63, 2008.*
16. *A. Y. S. Chia, S. Rahardja, D. Rajan, and M. K. H. Leung, "Structural descriptors for category level object detection," IEEE Transactions on Multimedia, vol. 11, pp. 1407-1421, 2009.*
17. *J. Winn and J. Shotton, "The layout consistent random field for recognizing and segmenting partially occluded objects," in Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, 2006, pp. 37-44.*
18. *V. Ferrari, T. Tuytelaars, and L. Van Gool, "Object detection by contour segment networks," in Lecture Notes in Computer Science vol. 3953, ed, 2006, pp. 14-28.*
19. *K. Mikolajczyk, B. Leibe, and B. Schiele, "Multiple object class detection with a generative model," in Proceedings of the IEEE Conference on Computer Vision and Pattern Recognition, 2006, pp. 26-33.*

International Journal of Engineering Researches and Management Studies

20. *R. C. Nelson and A. Selinger, "Cubist approach to object recognition," in Proceedings of the IEEE International Conference on Computer Vision, 1998, pp. 614-621.*
21. *H. P. Moravec, "Rover visual obstacle avoidance," in Proceedings of the International Joint Conference on Artificial Intelligence, Vancouver, CANADA, 1981, pp. 785-790.*
22. *C. Harris and M. Stephens, "A combined corner and edge detector," presented at the Alvey Vision Conference, 1988.*
23. *M. Varma and A. Zisserman, "A statistical approach to material classification using image patch exemplars," IEEE Transactions on Pattern Analysis and Machine Intelligence, vol. 31, pp. 2032-2047, 2009.*
24. *P. M. Roth, S. Sternig, H. Grabner, and H. Bischof, "Classifier grids for robust adaptive object detection," in Proceedings of the IEEE Computer Vision and Pattern Recognition, Miami, FL, 2009, pp. 2727-2734.*
25. *Kwong Wing Au, Saad J. Bedros, Keith L. Curtner, "Object classification in video images", US7646922 B2, 2010.*
26. *Charles A. Myers, Alex Shah,"Image classification and information retrieval over wireless digital networks and the internet",US8311294 B2.*
27. *S.N.Bharath, Rakshith.K.M, RaghavendraU.Karunakar, RajendraNayak, Deepashri. Image Encryption Based Approach to Address Privacy and Security Issues in RFID Tags. IJCSMC, Vol. 4, Issue. 5, May 2015, pg.416 – 423.*
28. *Geronimo, D.; Lopez, A.M.; Sappa, A.D.; Graf, T. "Survey of Pedestrian Detection for Advanced Driver Assistance Systems", Pattern Analysis and Machine Intelligence, IEEE Transactions on, Vol. 32, Issue: 7, July 2010, pp. 1239 – 1258.*

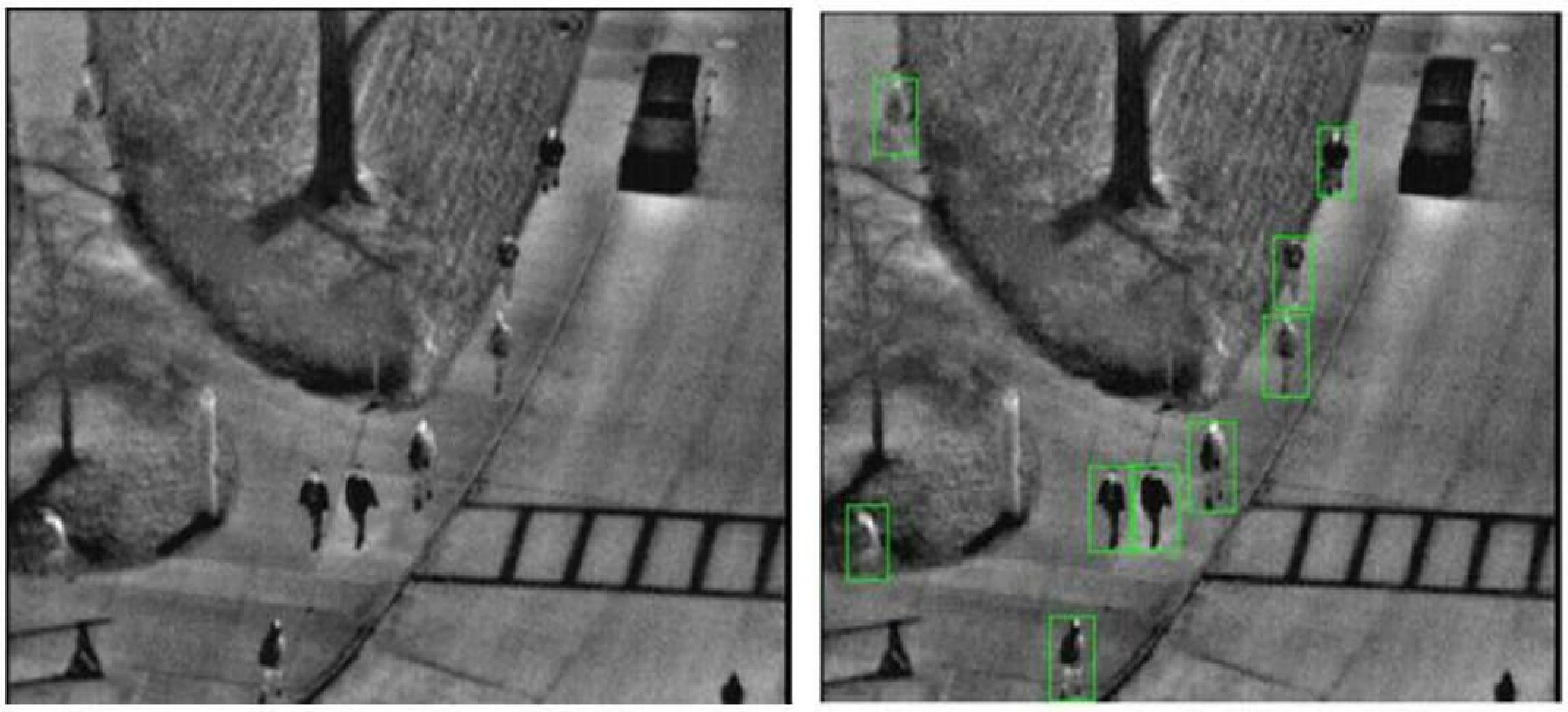

Figure 2: Output of the proposed approach