Journal of Data Acquisition and Processing
ISSN: 1004-9037
https://sjcjycl.cn/
DOI: 10.5281/zenodo.7766353

A RANDOM FOREST ALGORITHM BASED DARK OBJECTS VISUALIZATION

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Abstract

Object detection on targets in dark scenario are identified using external illuminated light sources or using thermal scanning of the target, where the existing work produces less precision, low quality, or taking more time for detection of targets in dark scenario. In order to get around these problems, an Infrared light source is used to find targets in the dark scenario. The random forest machine learning algorithm is implemented using the visual studio code programming tool, which relies on the principle of decision trees. Multiple trees are constructed by the random forest algorithm, with each tree based on a subset of features from the same training data source. The infrared light sources with webcam interfaced in the model obtained an accuracy level of 96.3795, error rate precision as 72.56 and error rate falseness as 29.1675. Thus, this paper is proposed for Object detection to find effective targets in an anonymous way under dark scenario.

Keywords: Infrared, Random Forest, Object detection, Dark scenario

Introduction

In the field of object detection, the task of recognizing is of great significance to discover potential objects in the environment in time. Some scholars use excellent algorithms to reduce the negative effects of weak light on the judgment of fore-ground objects, and some of the models have been applied in daily life and military use.

Object detection is for identifying and localizing the objects in the environment using monitoring devices. Various algorithms and techniques are used for improving the detection accuracy and capturing the images.

The detection and visualization of objects under low light and dark environment become a challenge in existing method. Edge Smoothing is one of the major issues, needs adjustments over the contrast and brightness of the images captured. Further in the Related work dark scenario-based object detection works are discussed.

Related work

Machine learning algorithm, thermal imaging and low light illuminators used in (Yuxuan Xiao et al. 2020) was proposed that mainly used to increase the precision of obstacle detection and categorization in nighttime traffic.

Edge Smoothing is one of the major issues, needs adjustments over the contrast and brightness of the images captured as done in (Guo Chen et al. 2021). The result in which object is obtained will have many irregular edges. This results in false object detection. It is manually noticed and adjustments are done manually according to the needs which is a highly time-consuming process. Thus, these techniques are not suitable for viewing the objects under dark condition.

Another technique is Pixel Level Fusion method. It has two types in it, they are the transfer domain fusion method and the edge preservation method. The transfer domain fusion level includes many transforms technique such as Stationary Wavelet Transform (SWT), Curvelet Transform (CVT), Dual Tree-Complex Wavelet Transform (DTCWT),

Author suggested is the R-CNN in (Kun Wang et al. 2020) and it stands for Region based Convolutional Neural Network. The R-CNN is used for object detection like the following. The R-CNN first localize the object in a n image, then no. of objects are localized. Then, using the CNN technology, the object is detected and output is obtained in such a way.

ADAS is Advanced Driver Assistance Systems which is discussed by the author in (Adam Nowosielski et al.

2021) is used to prevent deaths and injuries by reducing the number of car accidents. This technique established with the help of communication between SoCs and ECUs fixed on the vehicle. Night vision system in this vehicle uses two type of techniques, they are Low light illuminated imaging and Thermal imaging System for parking assistance. The below shown Fig. 1 describes the output level of above discussed techniques.

Author has introduced the frame differentiation method in (Manoj Purohit et al. 2021) where the images which are captured are taken as frames, the frames are compared with each other. The frames which are different from each other indicating there has been an object movement is detected. Also low light sensors are used here. These Sensors make use of available visible light and will be producing the result (image/video).

This technique in (Sonu Kumar et al. 2017) uses hot- spot and background subtraction algorithms for detecting the objects. The term hot-spot refers to the region of the image frame whose the pixel intensity corresponds to the thermal spectrum of a normal human being. In background subtraction algorithm, the background image is generated by analyzing the

absolute pixel differences between the object and background regions. The various objects are differentiated by determining the height to width ratio.

Author discussed the Night Vision method in (Heena Patel et al. 2020) which is made using the thermal imaging camera. Radiation released by the objects exceeds radiation released by the surroundings. The surrounds will be depicted as blue, while the objects will be shown as red (heat). It also functions without illumination from visible light.

Technique which is used in (Zhang Yanlin et al. 2010) is the laser light vision. As the name indicates, the light source is the laser here, the technique here is mainly used to detect the license plate of vehicles. Since the laser is used, the range might be high but there will be no multipath effect and techniques like Piecewise linear transformation are used to improve the visibility by adjusting the contrast and brightness of image.

Fig.1 Thermal , Laser light and Low illuminated light images (referred from Zhang Yanlin et al. 2010; Heena Patel et al. 2020; Yuxuan Xiao et al, 2020)

In this paper, the IR light spectrum used for detection ranges from 700nm to 1mm which lies beyond the visible light spectrum. The modified camera is used for capturing images. Then the captured images classified using the random forest algorithm.

Further in this paper section III discuss about Object detection using random forest, section IV discusses about Results and section V discuss about Conclusion.

Object Visualization and Detection by Random Forest

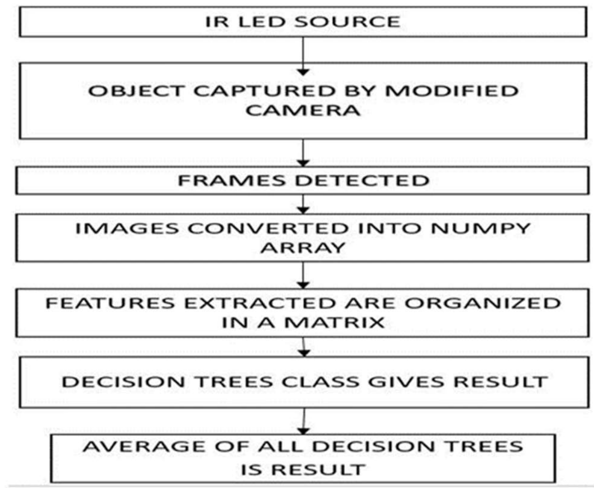
The major contribution in this project is getting around the above discussed drawbacks in the existing methods has been discussed in this paper. The objects could be

viewed under complete darkness using the infrared source. The algorithm used for the prediction of the objects in a dark environment is the Random Forest machine learning algorithm. The work flow for the mentioned is given in the Fig. 2. The Mathematical representation of algorithm is given below

$$\sum_{n=1}^{\infty} Nn$$

Infrared Led source is a solid state of a lighting device. It emits light in range of electro-magnetic radiation wave spectrum. This IR spectrum ranges from 700nm to 1mm. It lies beyond the visible light spectrum. Since the wavelength of infrared is more than that of the visible light, humans could not see the infrared radiation with naked eyes. The Infrared LEDs have been used in this approach in order to view the image of an object.

Fig. 2 Model flow of this paper



The camera which is used here is a webcam. Every camera will have an infrared filter in them. That filter must be removed from the camera. The filter will be present inside the camera module which comprises of lenses. The filter must be removed with immense care without damaging the lens and the camera must be restored again as before without

the infrared filter. Hence, the camera can now be able to receive the infrared radiation and form the images even under extremely dark environment. The visibility for the camera is mainly depend upon the intensity of the IR radiation present in that environment. The image will be in greyscale as the spectrum has only grey shades and the entire ray spectrum is discussed in a table format as shown in Table 1.

Table 1 Comparison of Spectrum Visibility and Wavelength

Type of Rays	Wavelength Emission		Spectrum Wavelength
	Color	Visibility	
UV: Ultrav ioletRadiation	UV-C	In-visible	100-280 nm
	UV-B	In-visible	280-315nm
	UV-A	In-visible	315-400nm
VIS: Visible RadiationLight	Violet	Visible	400-450nm
	Blue	Visible	450-470nm
	Bluegreen	Visible	470-495nm
	Green	Visible	495-530nm
	Yellowgreen	Visible	530-570nm
	Yellow	Visible	570-590nm
	Orange	Visible	590-620nm
	Red	Visible	620-800nm
IR: Infrared Radiation	IR-A	In-visible	800-1400nm
	IR-B	In-visible	1400-3000nm
	IR-C	In-visible	3-1000µm

Frames detection is the recognizing of the captured picture, where the captured frames of the picture is further analyzed with the random forest algorithm for detection.

Table 2 Frame detection Pseudo code

Code	Usage
ret, image = cap.read() cv2.imwrite('image.jpg', image)	ret --> used to see the Boolean values. If frames present, the value is true Or else false.

Representation of images in a grid of numerical values is essential for manipulation and analysis using NumPy array operations. Each pixel of image is represented as a single element of the NumPy array. This representation of images as NumPy arrays is very useful as it allows us to easily apply various operations to images such as cropping resizing, filtering and transformations as well as to feed the images into machine learning models as input data.

The decision trees and their subsets are stored and analyzed in the matrix format, say that S is a decision tree consisting of S1, S2, S3…SM. Which consists of features on basis of samples trained.

$fA11 \quad fB11 \quad fC11 \quad C1$

S1= $fA12 \quad fB12 \quad fC12 \quad C2$

$\ldots \quad \ldots \quad \ldots \quad \ldots$

$fA135 \quad fB135 \quad fC135 \quad Cn$

$fA21 \quad fB21 \quad fC21 \quad C1$

$fA22 \quad fB22 \quad fC22 \quad C2$

The main principle of Random Forest algorithm is based on "Decision trees". It builds different trees with n number of subsets for each type of sample with features. Each created decision tree are with a different, randomly chosen subset of training data and with the randomly chosen subset of features at every node.

Final prediction for the detection of image using random forest algorithm is based on the average of all the decision trees (i.e.) DT1, DT2, DT3, ... DTn. Captured image with the prediction based on decision tree features of samples is shown in the below fig. 5, 6 and 7, 8. The Mathematical representation can be given as:

Results and Discussion

The results and discussion part consist of the setup and the output of the project. The prototype setup for this paper is shown in the below Fig. 3. The various parameters such as

$\ldots \quad \ldots \quad \ldots \quad \ldots$

$fA212 \quad fB212 \quad fC212 \quad Cn$

extracted features, software, image sized are used for analysis has been mentioned in the Table 3. The Infrared LED light sources are turned on under the extreme dark

S3=[
SM=[

$fA31$
$fA32$
…
$fA312$
$fA14$
$fA32$
…
$fA125$

$C1$	$fB31$	$fC31$
$C2$]	$fB32$	$fC32$
…	…	…
Cn	$fB313$	$fC313$

$C1$	$fB34$	$fC24$
$C2$]	$fB22$	$fC12$
…	…	…
Cn	$fB115$	$fC105$

environments. The Webcam is interfaced with the system and it has positioned in such a way that it utilizes the Infrared rays from the light source and the object which is positioned in front of the camera is captured.

Fig. 3 Prototype of proposed model

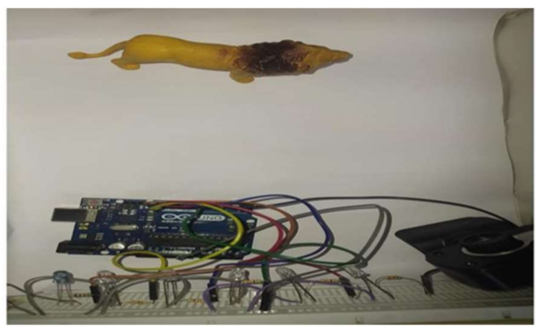


Table 3 Simulation Parameters

Parameters	**Values**
Software	Visual Studio Code
Python Version	3.7.1
Image Size	224x224
Features Extracted	Tusks, Dots, Stripes
Background	0
Stripes	1
Dots	3
Tusks	4

The images were fed to the model and the frame presence would be checked initially in order to locate the object in the streaming. In the case of Fig.5, the object is the cheetah. The object presence is found by returning a Boolean true value.

The output is obtained by compiling and running the code and making the prediction based on decision tree features of samples in the Visual Studio Code software. The corresponding GUI for the respective capture image is shown in the below Fig. 5 – 8.

Fig. 5 Captured Image

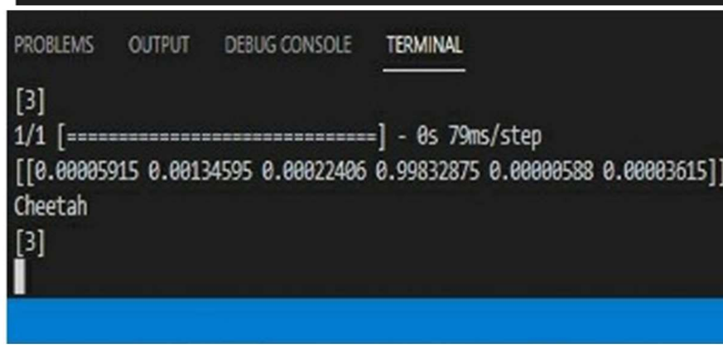


Fig. 4 Display GUI

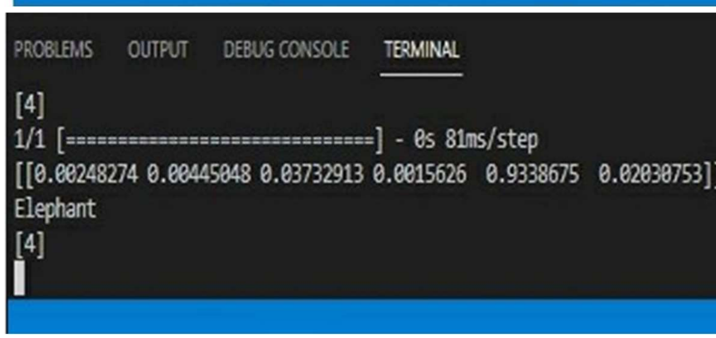


Fig. 6 Display GUI

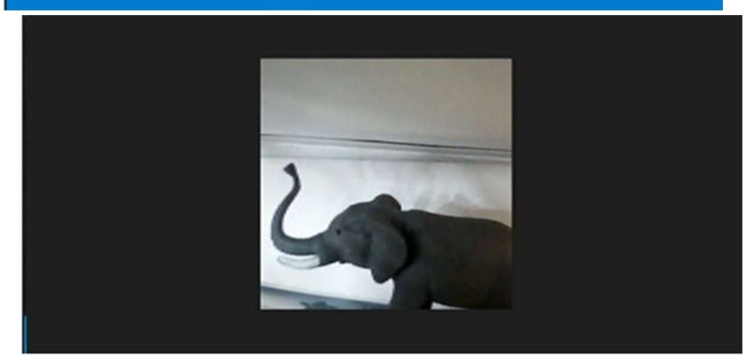


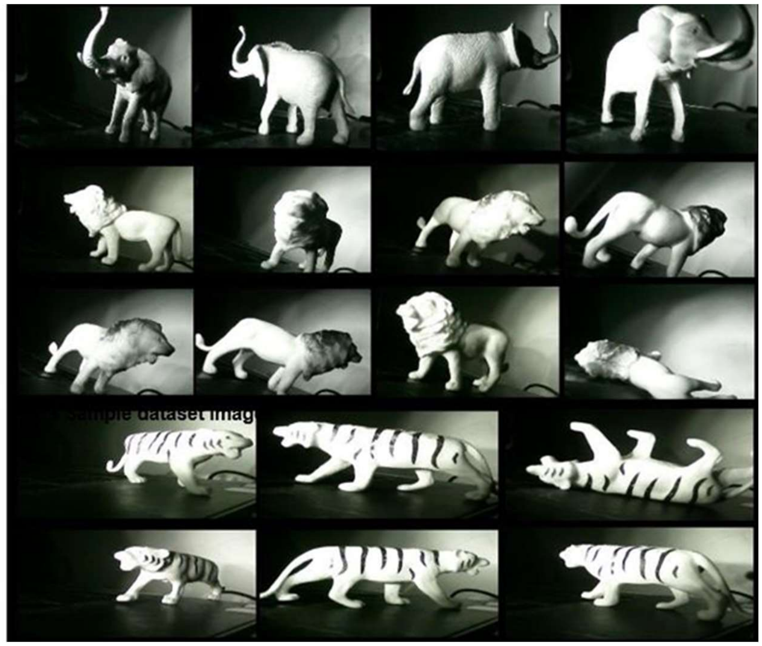
Fig. 7 Captured Image

The image is then subjected to extraction of the features which would be found in the dataset. In the case of Fig. 6 the dots over the object would get considered as a feature. These features of the datasetsample1 will get stored as feature f11 which
would be called as feature number 1 of the sample 1. The features of the further samples and their feature

values would be stored in the form of matrix. The captured images used for training the webcam is shown in the Fig. 8.

The below are the few datasets which were used for the training of the machine learning model. Then, the image of the object would get converted into a NumPy array values to make the computation of the pixel values in an earlier way.

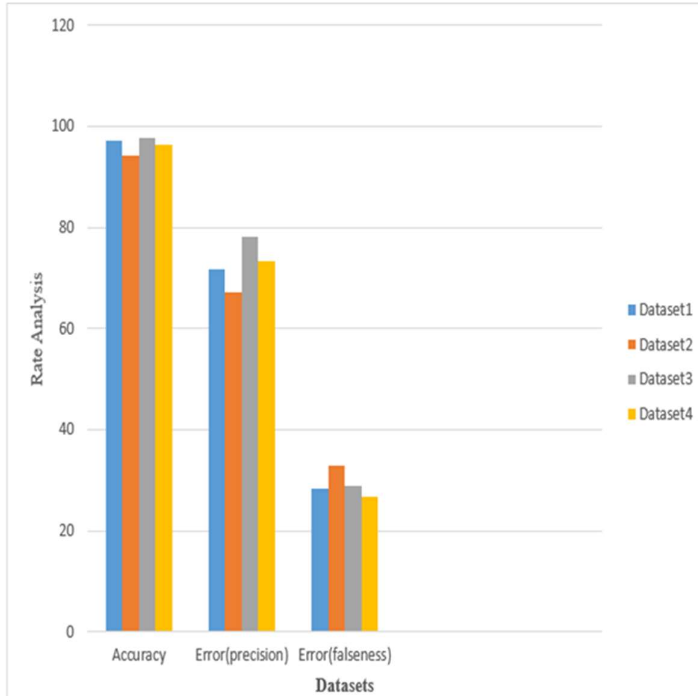
Fig. 8 Sample Dataset Images



The matrix mainly used here to represent the values in the form of the matrix under the class of decision trees. Each sample's features were stored under a corresponding class which could be represented as Cn where, n=1, 2, 3, 4, 5, etc.

The classes of the features were responsible for building the decision trees. Each decision trees will derive the final result. The accuracy level and error rate precision and falseness has been analyzed and reported in graphical format as shown in the Fig. 9.

Fig. 9 Prediction Accuracy Graph



The above graph is plotted between the rate analysis and datasets. The following three parameters would get discussed in this graphical representation which could be the accuracy, error precision and error falseness. In the case of the Fig. 5, the accuracy is 99.83 as shown in

Fig.4. For Fig. 8, the accuracy is around 93.38 as shown in Fig. 7. In the case of error precision, it is 78.13 for Fig. 4 whereas for Fig. 7 this is around 73.35 Fig. 6. In the case of Error falseness, the value is 28.7 for Fig. 4 whereas for Fig. 7, the value is around 26.66.

Conclusion

The above discussed issues should be overcome in the future in order to increase the accuracy of object detection and the visualization at the dark environment without any type of visible or low illuminated light source. This paper is able to produce accuracy rate of 96.7395, error precision rate of 72.56 and error falseness rate of 29.1675. That will make objects to be viewed in extreme dark and will be making a revolution.

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