Indian Journal of Engineering

ANALYSIS

ISSN 2319 – 7757 EISSN 2319 –7765

A comparative study of elephant identification using Euclidean, Manhattan and Chebyshev distance metrics

Publication History
Received: 26 July 2016
Accepted: 20 August 2016
Published: October-December 2016

Citation
Fathima G, Arivazhagan B, Basavaraj N, Jeyanth C. A comparative study of elephant identification using Euclidean, Manhattan and Chebyshev distance metrics. *Indian Journal of Engineering*, 2016, 13(34), 646-654

A COMPARATIVE STUDY OF ELEPHANT IDENTIFICATION USING EUCLIDEAN, MANHATTAN AND CHEBYSHEV DISTANCE METRICS

G. FATHIMA
Professor,
Department of Information Technology, Adhiyamaan College of Engineering, Hosur, Tamil Nadu, India
hod_it@adhiyamaan.ac.in

B. ARIVAZHAGAN
UG Scholar
Department of Information Technology, Adhiyamaan College of Engineering,
Hosur, Tamil Nadu, India
arivusaran5@gmail.com

N. BASAVARAJ
UG Scholar
Department of Information Technology, Adhiyamaan College of Engineering,
Hosur, Tamil Nadu, India
basava2425raj@gmail.com

C. JEYANTH
UG Scholar
Department of Information Technology, Adhiyamaan College of Engineering,
Hosur, Tamil Nadu, India
jeyanth.c2008@gmail.com

ABSTRACT

The Elephant Identification System (EIS) is used to identify the elephants that roam around the villages near Forest region. The main aim of the Elephant Identification System is to reduce the Human Elephant Conflict (HEC) that occur major in the forest border areas and to identify the intrusion of the elephant into the villages. This system identifies the elephants among the presence of various species such as Bison, Rhinoceros and Hippopotamus. This system uses Euclidean distance, Manhattan distance and Chebyshev distance to compare images of same dimensions and to find threshold values to set in Elephant Identification System. A threshold value is necessary to separate the distance of elephant and other species. The comparative study based on the results of Euclidean Distance, Manhattan Distance and Chebyshev Distance for various parameters are done. By the results of this system, the intrusion of elephant are informed to the authorities through alert messages.

General Terms

Euclidean Distance, Manhattan Distance, Chebyshev Distance

Keywords

Elephant Identification System, Human Elephant Conflict, Threshold

1. INTRODUCTION

The Asian elephant (Elephas maximus) is affected by habitat fragmentation, and human-elephant conflict. Out of all the elephant population, India has about 60% of the elephant population. Most of the elephants are located in and around the forest areas near villages. The southern part of India has half of India's total elephant population consisting of about 6300 elephants. The population growth in India has resulted in the improvement of agricultural and industrial sectors causing the conversion of forest lands into human settlements. The elephants and other animals face a drought situation due to urbanization of forest areas. It causes the elephant to move into villages in search of food and water. Hence, there has been severe human-elephant conflict. The surveillance and tracking of these elephants are difficult due to their huge size and slow movement. The elephants move in herds and the time to recover from their attack is negligible; hence, the loss due to destruction in the farms is more. The elephants are attacked by the humans causing death to the elephants. The elephants are not only attacked for the Human-Elephant conflict, but also for the ivory in their tusks. Human-elephant conflict (HEC) is a key example of the conflict between people and wildlife for space and resources throughout Africa and Asia. This study explores the correlation of reported HEC incidents within 58 villages between 150 km from the boundary of Krishnagiri, Dharmapuri, Karnataka, India. Habitat loss and fragmentation is the biggest threat to the continuing survival of Asian elephants in this region. In addition to food crops, forests are being logged for their timber or cleared to make space for cash crop plantations such as rubber, tea, and palm. Due to the population explosion in the forest border areas, the elephant's habitat are decreasing vigorously. Human-elephant conflict is on the rise and it is a battle that the elephant is losing. As elephant habitat diminishes, the elephants are pushed into smaller areas. This increases the population density to beyond sustainable levels and food availability grows short. The shortage of fodder has a negative impact on rates of reproduction; hence, normal birth rates begin to decrease. The serious consequence of the shortage of wild food leads to a corresponding increase of crop raiding and incidents of human-elephant conflict.

2. OBJECTIVES

- To identify the animal is elephant using image processing by Euclidean Distance, Manhattan Distance and Chebyshev Distance.
- To create dataset consisting of maximum possibility of elephant images containing 360 degree view of the elephant.
- Detecting and locating the frequent Human Elephant Conflict areas and to install this system to provide early warning to people about the intrusion of the elephants and to alert the authorities.

3. RELATED WORKS

Many methods are followed to avoid HEC. Construction of elephant proof trenches is being done all over the world. Figure 1 shows the Elephant Proof Trench.

Fig 1: Elephant Proof Trench

In [1], Fernando et al. discussed solar fencing to avoid elephant human conflict. Figure 2 shows the Solar Fencing.

Fig 2: Solar Fence

In [2], King et al. presented the concept of using beehives to mitigate elephant crop depredation. Figure 3 shows the beehive fencing. In [3], Loarie et al. discussed about the role of the artificial water sources which allow elephants to reside in forests during dry seasons.

Fig 3: Beehive Fence

In [4], the authors discussed the potential use of satellite technology for conflict mitigation. The elephants tagged with radio collars react violently and damage it and even the elephants die. In [5], Venter and Hanekom proposed the possibility of using the elephant-elephant communication (elephant rumbles) to detect the presence of a herd of elephants in close proximity, In this work, the authors have recorded the low frequency infrasound pattern, but they do not compare with that of other animals to confirm an elephant occurrence.In [6], Vermeulen et al. proposed unmanned aircraft system to survey elephants shown in Figure 4, in which the elephant images are acquired at a height of 100m but the small flight time and being expensive do not make it viable.

Fig 4: Unmanned Aircraft

In [7], Dabarera and Rodrigo proposed appearance based recognition algorithms for identification of elephants. Given the frontal face image of an elephant, the system searches the individual elephant using vision algorithms and gives the result as, already identified elephant, or as a new identification. In [8], Ardovini et al. present an elephant photo identification system based on the shape comparison of the nicks characterizing the elephant's ears. In [9], Goswami et al. addressed identifying elephants from photographs, and comparing resultant capture recapture-based population parameter estimates using supervised visual identification of individual variations in tusk, ear fold and lobe shape. The authors show that this is a reliable technique for individual identification and subsequent estimation of population parameters. But in real time, the capture of elephant's front image is not possible. It is easier to chase elephants before they enter fields and therefore most damage can be averted [10].

4. PROPOSED SYSTEM WITH DESIGN

Guarding from watch towers, patrolling, and trip wire alarms provide farmers with advance warning of approaching elephants. Once the animals are detected, active crop guarding devices using light and noise are deployed to chase them away. An early warning system to minimize the human-elephant conflict in the forest border areas is proposed in this paper.

Our system is an early warning system which alerts the user before the intrusion of elephant. The camera used in the system has the ability to cover 200 m and 360 degree view. The image from the camera is taken and are used for detection of elephants.

This system uses Euclidean distance, Manhattan Distance and Chebyshev Distance for comparison. The threshold values are fixed for each distance mechanism separately. The distance value lying in the threshold range are identified as Elephants. After the elephant is detected, an alert system alerts the user about the intrusion of elephants. Figure 5 shows the workflow of the system.

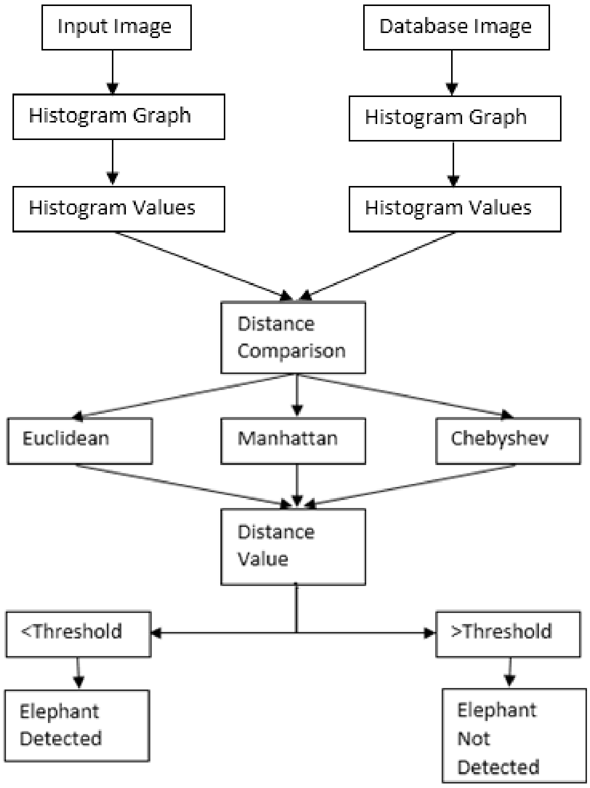


Fig 5: Workflow of the System

5. METHODOLOGIES

The Methods such as Euclidean Distance, Manhattan Distance and Chebyshev Distance are used in the system. The Distance Comparison are based on the histogram generated for each image. A set of points are obtained from each image to generate the histogram. Each method is described as follows.

5.1 Histogram

A histogram is a graph that shows the frequency and intensity of an object. Usually histogram have bars that represent frequency of occurring of data in the whole data set.

A Histogram has two axis the x axis and the y axis. Histogram of an image, like other histograms also shows frequency. But an image histogram, shows frequency of pixels intensity values. In an image histogram, the x axis shows the gray level intensities and the y axis shows the frequency of these intensities. The histogram of the object in Figure 6 is shown in Figure 7.

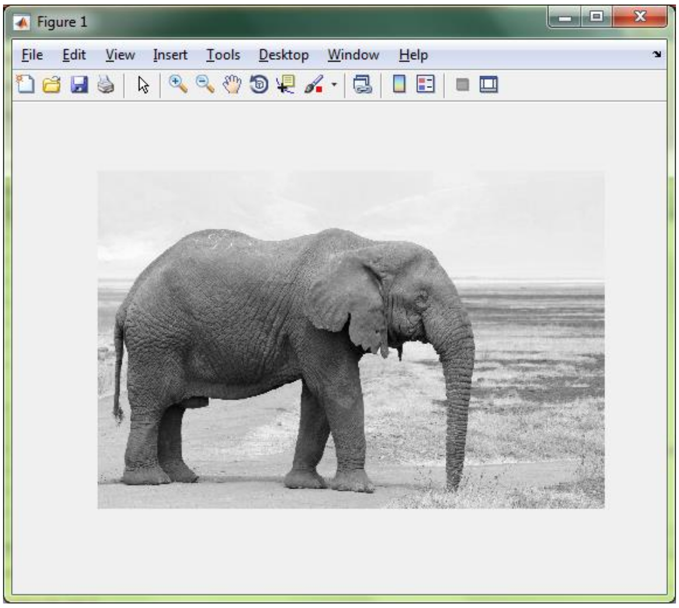


Fig 6: Sample Image

The x axis of the histogram shows the range of pixel values. Since its an 8 bpp image, that means it has 256 levels of gray or shades of gray in it. Thats why the range of x axis starts from 0 and end at 255 with a gap of 50. Whereas on the y axis, is the count of these intensities.

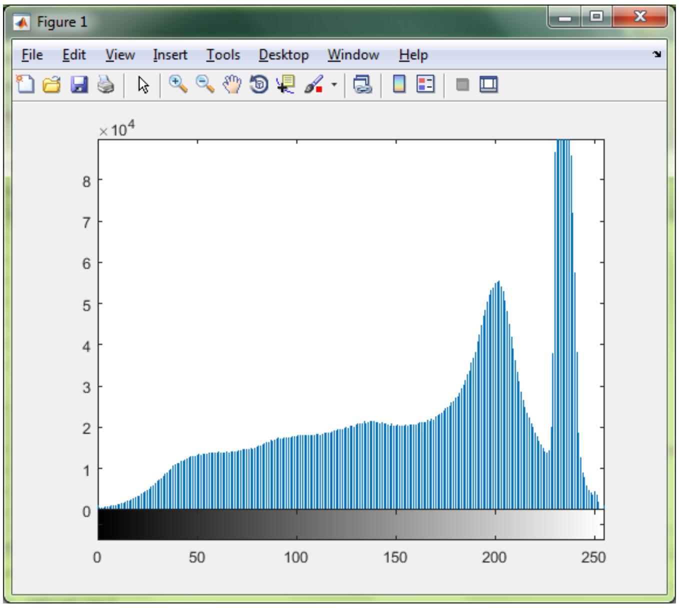


Fig 7: Histogram of the image

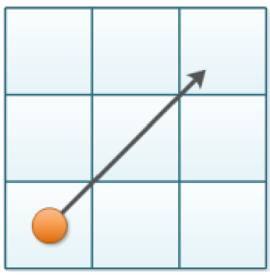
As observed from the graph, that most of the bars that have high frequency lies in the first half portion which is the darker portion. That means that the image has got darker portion and it can be proved from the image too.

5.2 Euclidean Distance

Distance transform (DT) is the transformation that converts a digital binary image to another gray scale image in which the value of each pixel in the object is the minimum distance from the background to that pixel by a predefined distance function. Three distance functions are often used in practice, which are City-block distance, Chessboard distance and Euclidean distance. The Euclidean Distance Transform (EDT) is used in the paper. The signed Euclidean distance transform which represented the displacement of a pixel from the nearest background point, was defined in [11], and exploited in applications like curve smoothing, detecting dominant points in digital curves, finding convex hulls etc. Mitchell et al used a gray scale mathematical morphology approach for Euclidean distance transform [12], [13]. Morphological erosion is an operation which selects the minimum value from the combination of an image and the predefined weighted structure element within a window, so it is appropriate for EDT. And they applied decomposition properties of mathematical morphology for parallel computing. Shih et al achieved correct and efficient EDT by size-invariant four-scan algorithm in [14] and two-scan based algorithm in [15].Vincent [16] encoded the objects boundaries as chains and propagated these structures in the image using rewriting rules. Euclidean Distance is shown in Figure 8.

The distance transform (DT) is the transformation that generates a map D whose value in each pixel p is the smallest distance from this pixel to Oc, Where Oc is the point at which the distance must be calculated.

D(p) := min{d(p, q) | q ∈ Oc} = min{d(p, q) | I (q) = 0}. (1)The image D is called the distance map of I (or of O, in case I is tacitly understood).



$$\sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2}$$

Fig 8: Euclidean Distance representation with formula

D itself can also be called a distance transform, if there is no ambiguity between the image D and the transformation (DT) that generated it. The term DT may also refer to a DT algorithm, depending on the context.

It is assumed that Oc contains at least one pixel, as in Rosenfeld and Pfaltz [1966], otherwise the output of the DT is undefined. Moreover, D(P,Q) is generally taken as the Euclidean distance, given by:

$$D(P,Q) = \sqrt{(PX - QX)^2 + (PY - QY)^2}$$

5.2.1 Setting up the threshold for Euclidean Distance

The database consists of 50 Elephant images. The input images are varied and different inputs are given to the system. The input images are Elephant, Hippopotamus, Bison and Rhinoceros. For each of the inputs the values are noted down.

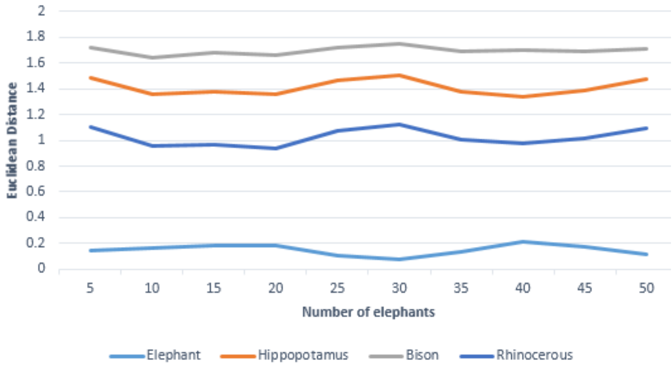


Fig 9: Euclidean Distance Values of Elephants vs Others Species

The Elephant input image have an average value 0.1519 for 50 database images. The Hippopotamus input image have an average value of 1.4119. The Bison input image have an average value of 1.6955. The Rhinoceros input image have an average value of 1.0255. All the distance values of the negative images are found to be above 1. The average value of the positive image is found to be 0.1519. Hence to find an exact match of the elephant image, the threshold value can be fixed to 0.75 for Euclidean distance. The graph generated for the values of all the database images compared with elephant and other species is shown in the Figure 9.

5.3 Manhattan Distance

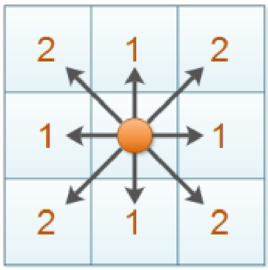
Manhattan distance is also called city block distance. It computes the distance that would be travelled to get from one data point to the other, if a grid-like path is followed. The Manhattan distance computes the sum of difference in each dimension of two vectors in n dimensional vector space. It is the sum of the absolute differences of their corresponding components. The distance between two points in a grid is based on a strictly horizontal and/or vertical path as opposed to the diagonal. The manhattan distance is the simple sum of the horizontal and vertical components, whereas the diagonal distance might be computed by applying the Pythagorean Theorem. Manhattan distance is also called the 1 L distance. The Manhattan distance is shown in the Figure 8.

If $u = (x_1, x_2, x_3 .... x_n)$ and $v = (y_1, y_2, y_3 .... y_n)$ are two vectors in n dimensional hyper plane, then the Manhattan Distance MD(u,v) between two vectors u, v is given by the

$$MD(u,v) = |x_1 - y_1| + |x_2 - y_2| + ... + |x_n - y_n|$$

$$MD(u,v) = \sum_{i=1}^{n} |x_i - y_1|$$

Where n is the number of variables and xi and yi are the values of the ith variable at the point x and y respectively. The Manhattan distance is shown in the Figure 10.



$$|x_1 - x_2| + |y_1 - y_2|$$

Fig 10: Manhattan Distance representation with formula

5.3.1 Setting up the Threshold for Manhattan Distance

The database consists of 50 Elephant images. The input images are varied and different inputs are given to the system. The input images are Elephant, Hippopotamus, Bison and Rhinoceros. For each of the inputs the values are noted down. The Elephant input image have an average value 1.0759. The Hippopotamus input image have an average value of 1.6944. The Bison input image have an average value of 1.8649. The Bull input image have an average value of 1.7694. The Rhinoceros input image have an average value of 1.5123 for database images. All the distance values of the negative images are found to be above 1.65. The average value of the positive image is found to be 1.0759. Hence the threshold value can be fixed to 1.65 for Manhattan distance. The graph generated for the values of all the database images compared with elephant and other species is shown in the Figure 11.

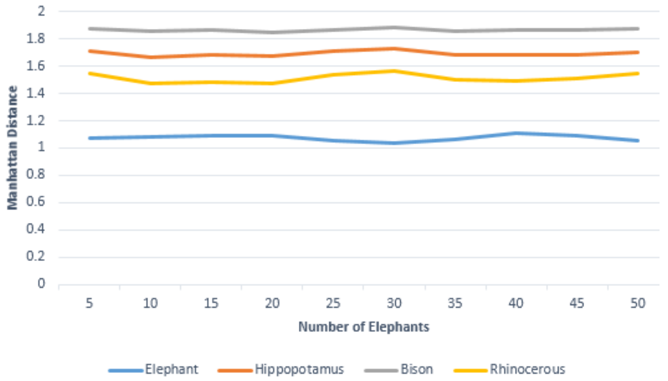


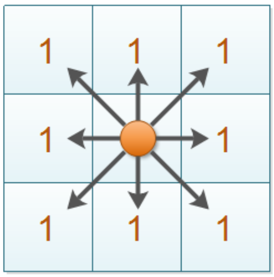
Fig 11: Manhattan Distance Values of Elephants vs Other Species

5.4 Chebyshev Distance

Chebyshev is also called the maximum value distance or chessboard distance. It computes the absolute magnitude of the difference between the variable values. It is calculated by the following formula:

$$D(P,Q) = \max_{i=1,2,..n} |Pi - Qi|$$

Where P represents the point of comparison in the first image and Q represents the point of comparison in the second image. The Chebyshev Distance is shown in the Figure 12.



$$\max(|x_1 - x_2|, |y_1 - y_2|)$$

Fig 12: Chebyshev Distance representation with formula

The chessboard distance is a metric defined on a vector space where the distance between two vectors is the greatest of their along any coordinate dimension.

5.4.1 Setting up the Threshold for Chebyshev Distance

The database consists of 50 Elephant images. The input images are varied and different inputs are given to the system. The input images are Elephant, Hippopotamus, Bison and Rhinoceros. For each of the inputs the values are noted down. The Elephant input image have an average value 0.0461. The Hippopotamus input image have an average value of 0.3631. The Bison input image have an average value of 0.2457. The Rhinoceros input image have an average value of 0.4250. All the distance values of the negative images are found to be above 0.24. The average value of the positive image is found to be 0.0461. By the Figure 13, the threshold value can be fixed to 0.20 for Chebyshev distance. The graph generated for the values of all the database images compared with elephant and other species is shown in the Figure 13.

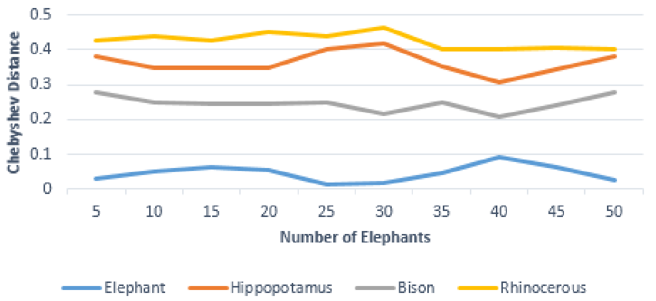


Fig 13: Chebyshev Distance Values of Elephants vs Other Species

6. WORKING OF THE SYSTEM

The first and the important part of the project is the creation of database images. The image of a graphical elephant acts as the database. The different posture of the elephant are taken and it is shown in the Figure 14.

Fig 14: Database Images

6.1 Case 1:Positive Input Image

The input is given into the system by selecting an image. The system then processes the input and compares with the images in the database and the result is displayed with an alert message. The input image is displayed with the best matches in separate windows. 6 images are retrieved for the given input image based on the best match. The input image is shown in the Figure 15. The Best matches are shown in the Figure 16. The Alert message is shown in the Figure 17. The average distance value for the given input image is shown in the Figure 18. As it is explained earlier, if the distance value is less than the threshold value the alert message is displayed as “Elephant Detected”.

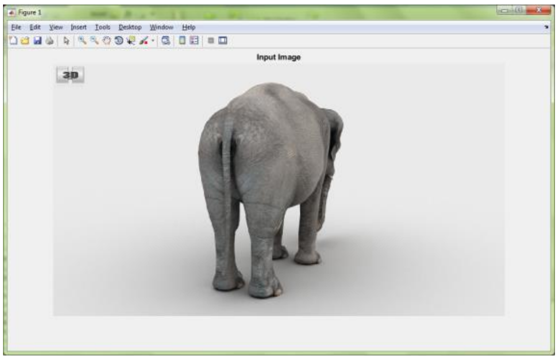


Fig 15: Input Image

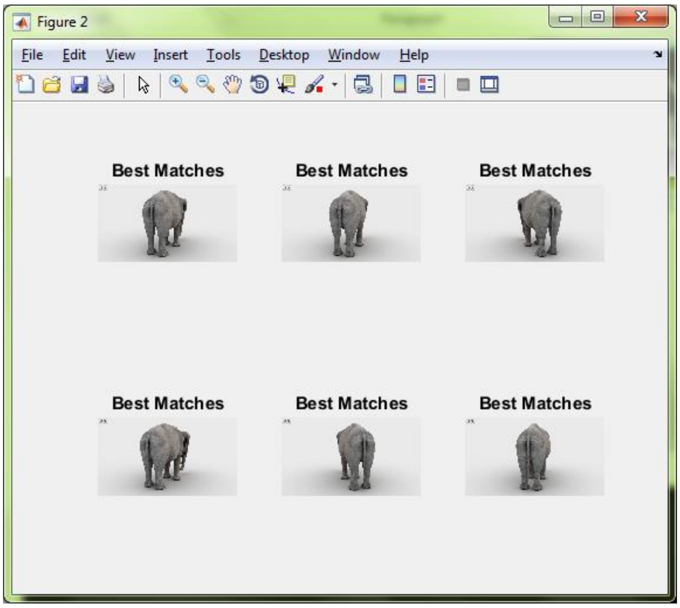


Fig 16: Best Matches

Fig 17: Alert Message

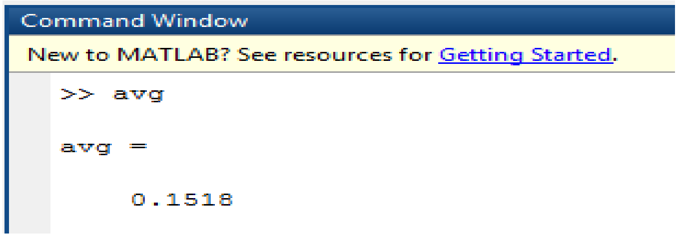


Fig 18: Average Distance Value

6.2 Case 2:Negative Input Image

The bison image is given as the input to the system. The input image is shown in the Figure 19.

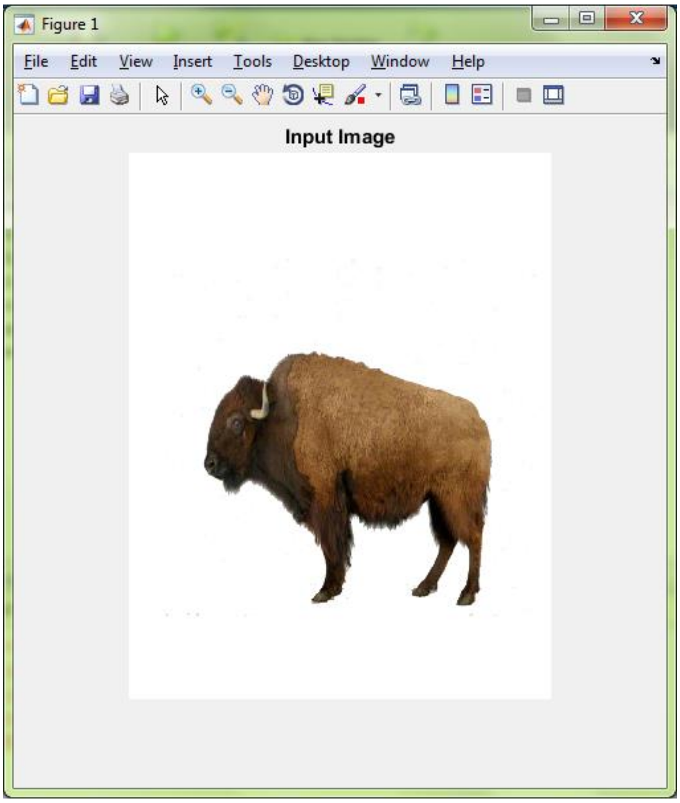


Fig 19: Input Image

The processing is done for the input image and the input image is compared with the database images. The average distance value for the bison image is shown in the Figure 20.

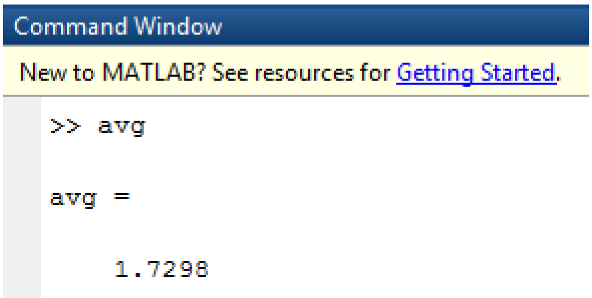


Figure 20: Distance Value

As the Average distance value exceeds the threshold value, the input image is not an elephant. The alert message is shown in the Figure 21.

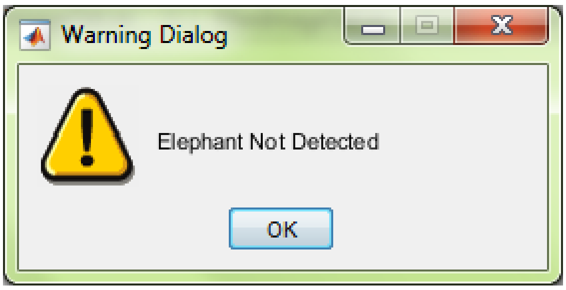


Fig 21: Alert Message

7. RESULTS AND DISCUSSIONS

Thus, the Euclidean, Manhattan and Chebyshev distances are used for identification of elephants. The Comparison between the Euclidean, Manhattan and the Chebyshev distances is made with two categories. The Distance values and the Retrieval time are the two different phenomenon that categorize the best distance.

7.1 Distance Values

A graph is plotted using the difference distances for the same set of database image and the same input image. The graph is shown in the Figure 22. It can be inferred from the graph that the Euclidean distance values for elephants lies in the range of 0.15 and for the other species it lies above 1. Hence it is easy to fix up the threshold value to the maximum of about 0.75.

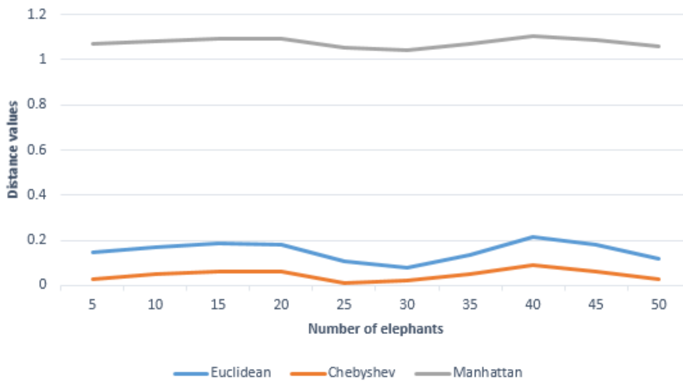


Figure 22: Distance comparison graph

For the Manhattan and the Chebyshev Distances, the difference between the distance values for elephant and other species is considerably less as compared with the Euclidean distance values. Hence, the Euclidean distance is suitable for the system. Also, the Chebyshev and the Manhattan distances can be used for supportive results.

7.2 Retrieval Time

A graph is plotted for retrieval time of the elephant images. The graph is shown in the Figure 23. For the first 5 images, the retrieval time is found to be high, but as the datasets are processed the time becomes less. The retrieval time for Euclidean distance, Manhattan Distance and Chebyshev Distance differ by milliseconds. The graph started at different time intervals but as the system processes the dataset, the time is more or less same for Chebyshev and Euclidean distances. As of Manhattan distance, the retrieval time is less between 10 and 45 images. As the dataset is increased the retrieval time is also increased.

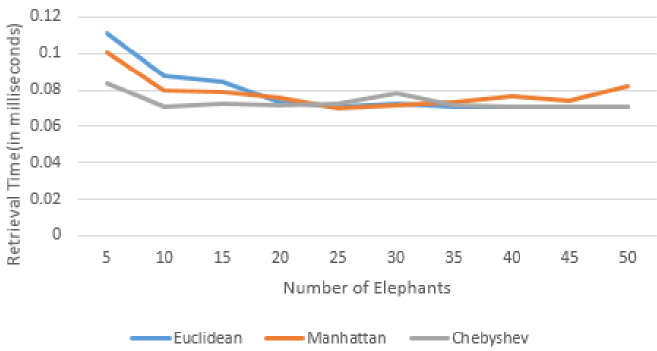


Fig 23: Retrieval Time per image for 50 images

8. CONCLUSION

The Alert system is proposed in this paper. The Alarm is activated if the elephant is detected by the system. The Alarm is used to alert the users about the intrusion of the elephant. Thus, the system works mainly based on the Euclidean distance and for supportive results, it uses Chebyshev and Manhattan distances. The histogram is generated for the input image and the database images. Based on the histogram values the threshold values were fixed for an exact identification of elephant. The threshold values for Euclidean, Manhattan and Chebyshev distance values are 0.75, 1.65 and 0.20 respectively. Though we have found the threshold values, the threshold values of Chebyshev and Manhattan distances be in a collision range with the other species. The retrieval time for the Euclidean, Manhattan and Chebyshev distance methods were found to be more or less similar to one another. But, as the database size increases the manhattan distance metrics is found to have some delay in producing the result. Hence, it is suitable to use Euclidean distance to identify the elephant and reduce the false identification.

9. ACKNOWLEDGEMENT

The authors would like to thank UGC, New Delhi, India for sponsoring this research project. The authors also acknowledge the academic support from the college.

10. REFERENCES

[1] P. Fernando, M. A. Kumar, A. C.Williams, E.Wikramanayake, T. Aziz, and S. M. Singh, "Review of human-elephant conflict mitigation measures practiced in SouthAsia," AREAS Technical Support Document Submitted to World Bank, WWF-World Wide Fund for Nature, Vaud, Switzerland, 2008.

[2] L. E. King, A. Lawrence, I. Douglas-Hamilton, and F. Vollrath, "Beehive fence deters crop-raiding elephants," African Journal of Ecology, vol. 47, no. 2, pp. 131–137, 2009.

[3] S. R. Loarie, R. J. V. Aarde, and S. L. Pimm, "Fences and artificial water affect African savannah elephant movement patterns," Biological Conservation, vol. 142, no. 12, pp. 3086–3098, 2009.

[4] [8] A. B.Venkataraman, R.Saandeep, N. Baskaran, M.Roy, A.Madhivanan, and R. Sukumar, "Using satellite telemetry to mitigate elephant-human conflict: an experiment in northern West Bengal, India," Current Science, vol. 88, no. 11, pp. 1827–1831, 2005.

[5] [9] P. J. Venter and J. J. Hanekom, "Automatic detection of African elephant (Loxodonta africana) infrasonic vocalisations from recordings," Biosystems Engineering, vol. 106, no. 3,pp. 286–294, 2010.

[6] [10] C. Vermeulen, P. Lejeune, J. Lisein, P. Sawadogo, and P. Bouche, "Unmanned aerial survey of elephants," PLoS ONE, vol. 8, no. 2, pp. 1–7, 2013.

[7] [11] R.Dabarera and R. Rodrigo, "Vision based elephant recognition for management and conservation," in Proceedings of the 5th International Conference on Information and Automation for Sustainability (ICIAfs '10), pp. 163–166, December 2010.

[8] [12] A. Ardovini, L. Cinque, and E. Sangineto, "Identifying elephant photos by multi-curve matching," Pattern Recognition, vol. 41, no. 6, pp. 1867–1877, 2008.

[9] [13] V. R. Goswami, M. V. Lauretta, M. D. Madhusudan, and K. U. Karanth, "Optimizing individual identification and survey effort for photographic capture-recapture sampling of species with temporally variable morphological traits," Animal Conservation, vol. 15, no. 2, pp. 174–183, 2012.

[10] J. Lenin and R. Sukumar, "Action plan for the Mitigation of Elepant-Human conflict in India," Final Report to the U.S. Fish and Wildlife Service, Asian Nature Conservation Foundation, Bangalore, India, 201

[11] Ye Q. Z.: The Signed Euclidean Distance Transform and Its Applications. Proc. ninth Int. Conf. Pattern Recognition. (1988) 495-499

[12] Huang C. T., Mitchell O. R.: A Euclidean Distance Transform Using Grayscale Morphology Decomposition. IEEE Trans. Pattern Analysis and Machine Intelligence. 16 (1994) 443-448

[13] Shih F. Y., Mitchell O. R.: A Mathematical Morphology Approach to Euclidean Distance Transformation. IEEE Trans. Image Processing. 1 (1992) 197-204

[14] Shih F. Y., Liu J. J.: Size-invariant Four-scan Euclidean Distance Transformation. Pattern Recognition. 31 (1998) 1761-1766

[15] Shih F. Y., Wu Y. T.: The Efficient Algorithms for Achieving Euclidean Distance Transformation. IEEE Trans. Image Processing. 13 (2004) 1078-1091

[16] Vincent L.: Exact Euclidean Distance Function by Chain Propagations. IEEE Proc. Computer Vision and Pattern Recognition. (1991) 520-525