IJCSE International Journal of Computer Sciences and Engineering Open Access
Research Paper Vol.-7, Issue-3, March 2019 E-ISSN: 2347-2693

Airport Runway Snow Fall Detection using Density Based Spatial Clustering Algorithm

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DOI: https://doi.org/10.26438/ijcse/v7i3.936941 | Available online at: www.ijcseonline.org

Accepted: 05/Mar/2019, Published: 31/Mar/2019

Abstract— In today's world, images have been generated from various sources like camera, Satellites, CCTV, and X-rays etc. The images which are collected shall provide lot of information if processed properly. It is the crucial task of segregating the data from an image, especially when working with large data sets. The image should be pre-processed and categorized through clustering algorithms. In image analysis, the clustering and classification are the two fundamental tasks. In this paper the DBSCAN algorithm has been applied on aerial digital images to categorize them accordingly for flight runway detection. Detection of snowfall in airport runway is the crucial task. The aerial images are gathered from various flight run way occurrence with snowfall as background situations.

Keywords— DBSCAN, Aerial image, Clustering, Machine Learning

I. INTRODUCTION

Contemporary methods for assessing the presentation of image mining algorithms are based on comparisons of one algorithm over the previous using the identical image datasets. This has led to diverse conclusions where now and again one of the algorithms is accessible as the best, while in other research works those equivalent algorithms performed in a different way. It is understood that some algorithms are finest to a particular type of image and that they will perform better when tested on these images. The projected study will be based on its evaluation with the use of diverse sets of images.

Image Mining can do on dissimilar type of images like real time image, satellite image, and medical images. The Image Processing involves an assortment of steps namely; Image preprocessing, Restoration, Analysis and Compression. Preprocessing includes numerical correlation and radiometric correlation. The associated image is then fed for re-establishment task.

In restoration process, effective noise removal is done. Followed by this, image examination is conducted. Here it includes the feature extraction, segmentation and classification steps for the additional analysis. Then the image is compacted to diminish the memory consumption which is experiential as output image. With the above mentioned steps, Image segmentation is one of the major key concepts in Image processing techniques. The images will be experienced and compared with each algorithm and these, in turn, will be tested in diverse image mining and clustering categories having as a final and principal goal the evaluation of the fundamental algorithm features that will make it fluctuate from another. The proposed methodology focuses on new method for comparing the performance of popular image mining and clustering algorithms is presented. The efficiency is measured in terms of converting the original image to binary image, the number of clusters found by the algorithm and the estimation of black and white pixel in the image.

The rest of the paper is organized as follows Section II deals with Literature Work. Proposed work is detailed in section III. Section IV provides Implementation. Results are depicted in the section IV and conclusion in section VI.

II. LITERATURE REVIEW

Celebi et. al. [1] used DBSCAN algorithm for mining biomedical images. In their work, they adapted a density-based clustering algorithm, DBSCAN, new problem domain: identification of homogenous color regions in biomedical images. Examples of specific problems of this nature include landscape segmentation of satellite imagery, object detection and, in this case, identification of significant color regions in images of skin lesions (tumors). Automated outer and inner boundary segmentation is a key step in segmentation of structures such as skin lesions, tumors of breast, bone, and brain. This step was important because the accuracy of the

subsequent steps (extraction of various features, post-processing) crucially depends on the accuracy of this very first step. The color regions identified by the algorithm are compared to those identified by the human subjects and the Kappa coefficient, a statistical indicator of computer-human agreement, is found to be significant.

Safaa O. Al-Mamory and Zahraa Mohammed Ali [2] used DBSCAN clustering algorithm in detecting Distributed denial of Service (DDoS) attack. They developed a method to detect DDoS attacks accurately and proactively using entropy concept to measure abnormal change in traffic according to the phases of the attack, and then these traffics are clustered using DBSCAN algorithm. The patterns for DDoS traffic was created based on extracted centroid points from each cluster, which were used in testing phase using Distances-based classification. This system is characterized processing and analyzing of high-speed network traffic (based on entropy approach), discovering and accurately identifying new types of DDoS attack to reduce the false alarms (FA), detecting this attack in real time and making use of pattern in the train stage to increase detection ratio.

Grace L. Samson, and Joan Lu [3] proposed a parallel algorithm for DBSCAN to optimize the information processing and retrieval. Also they proposed another algotithm to extend the X-tree spatial indexing structure for their work.

Abdellah IDRISSI and Altaf ALAOUI [4] in their work presents a solution based on the unsupervised classification for the multiple-criteria analysis problems of data, where the characteristics, the number of clusters are not predefined, the objects of data sets are described by several criteria, and the latter can be contradictory, of different nature and varied weights. Experimental results on different data sets were presented in order to show that clusters, formed using the improvement of the algorithm DBSCAN by incorporating a model of similarity, were intensive and accurate.

VDBSCAN, FDBSCAN, DD_DBSCAN, and IDBSCAN are the popular methodology compared and used [6]. These approaches were used to ignore the information regarding attributes of an objects. In [6] various clustering algorithms are compared and their attribute variations are listed.

III. PROPOSED WORK

Snow can cause issues through take-off, landings or even as in flight. Landing distances necessary in different for wet or dry runways, meaning some planes may not be able to land safely on their customary runway when snow is deposited in the runway.

Small snowstorms without much gathering aren't usually an alarm at airports that are equipped to detect snow as they have required snow-deduction utensils on hand. If there is heavy snowfall, on the other hand, make it hard to keep runways clear. Icing or turbulence may trouble during flights and landings. Snow on a runway is across the world bad. It isn't forever intolerable, but it is always bad. It reduces friction, reduces difference, obscures runway markings, and creates or obscures hazards.

From a risk organization position, snow on the runway is the foremost cause of snow-linked aircraft mishaps. Most mishaps occur throughout the landing phase, but snow in the runway gives trouble to pilots throughout takeoff and taxi operations. Earlier than taking the runway, it is forever best to remain for snow removal to occur, but not all little unattended airports have that ability.

A. Problem Statement

In this paper, the estimation of overall snowfall occurring region resulting from flight runway area with (heavy), (medium) and (light) snowfall as a background situations is assessed through DBSCAN algorithm. The output from the proposed methods implemented through prediction of overall snow fall coverage area and density of the snow fall occurrence and identifies the best geographic location to land the flight. Several assessment methods investigated such as binarization of the image, RGB to Gray Conversion and removal of noise using median filtering.

The proposed methodology reveals the splitting of snow fall region using density based segmentation, and clustering the pixels using DBSCAN clustering with scaling factors.

The results of the above estimates are presented and compared to efficiency of the proposed methodology.

B. Data for Research

In this research work, aerial digital images can be gathered from various background situations with 7.2MP resolution. All the images correspond to day light scenes. The original images where resized to a lower resolution of approximately 457x630 pixels so the algorithms chosen can process them more efficiently. Figure 1 (a) through (d) shows the image of datasets used for this study.

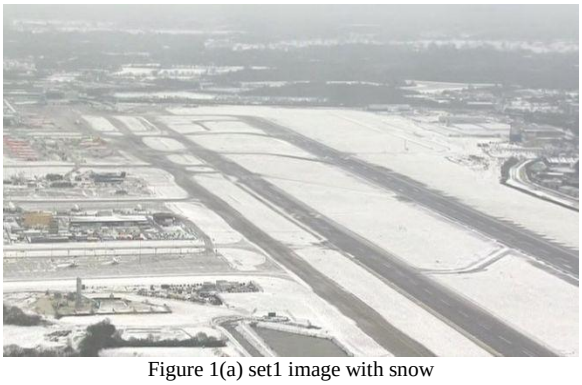

Figure 1(a) set1 image with snow

Figure 1(b) set2 image with snow


Figure 1(c) set3 image with snow


Figure 1(d) set4 image with snow

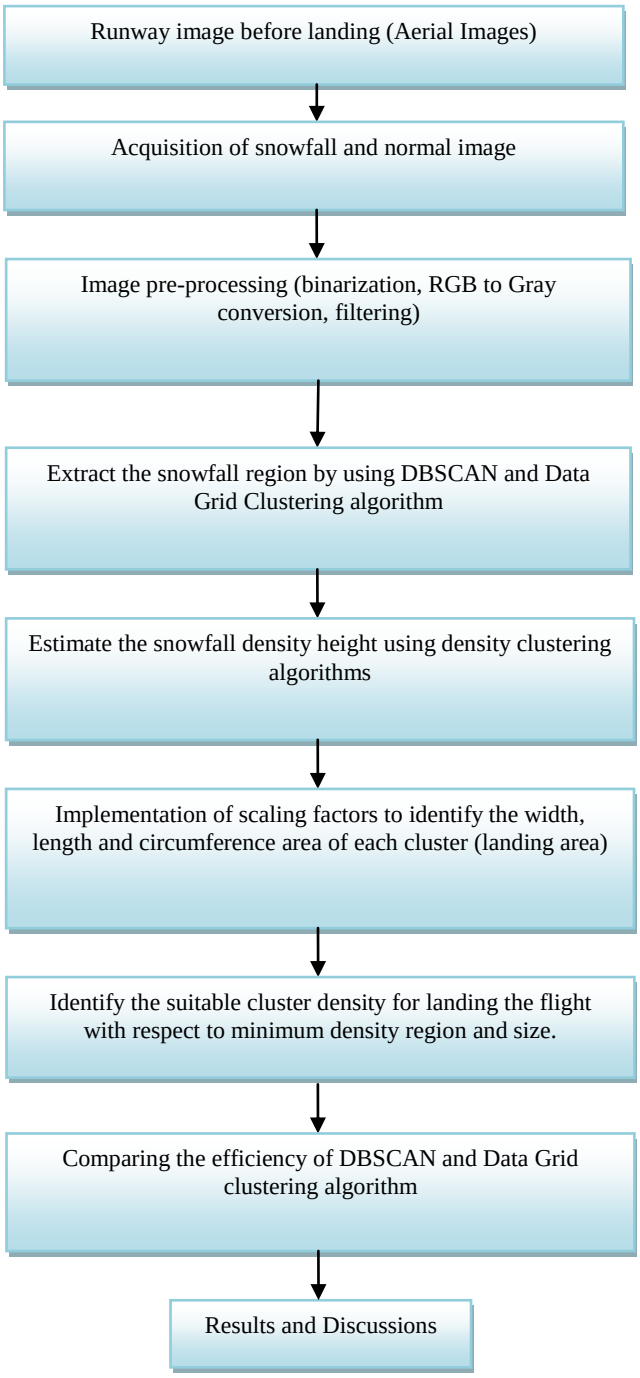

Figure 2. Proposed Research Framework

C. Research Framework

The following figure 2 illustrates and summarizes the concept of proposed Research framework design. The research work develops, tests, analyze new methodology for each and every phase. After the Acquisition of snowfall and normal image have been chosen, the proposed methodology

carry out an image pre-processing techniques such as (binary conversion of image (0's and 1's), RGB to Gray conversion and filtering of image for (4) different sets of normal and snowfall images.

Due to the nature of the proposed image data, extract the snowfall region by using DBSCAN and Data Grid Clustering algorithm. After identifying the snowfall area the main objective is to estimate the snowfall density height using density clustering algorithms. After estimating the snowfall density, the secondary objective is to implement the scaling factors to identify the width, length and circumference area of each cluster (landing area). Final objective is to identify the suitable cluster density for landing the flight with respect to minimum density region and size for different sets of images. Finally, the efficiency of the proposed methodology is obtained using the DBSCAN algorithm with respect to memory usage and running time of the algorithms for different sets of aerial images

IV. IMPLEMENTATION

The proposed methodology design given below based on the research framework can be used for analyzing, clustering and comparing the image dataset sequence for a step by step process which is implemented in MATLAB 7.10. The methodology to be followed is wrecked along into the following steps.

1. Acquisition of normal and snowfall image
2. Image Pre-Processing(Binarization, RGB to Gray Conversion, Median Filtering)
3. Identify the snowfall region using clustering algorithm
4. Estimation of density of each Clusters size
5. Estimating image scaling factors
6. Identify the best density cluster for safe landing
7. Efficiency Comparison of DBSCAN algorithm

V. RESULTS

The aerial images are normalized and pre-processed, with the help of DBSCAN algorithm the snowfall region has been identified. The experiment is implemented using MATLAB 7.10. The following figure 3 & 4 shows the output of the DBSCAN algorithm as clustered regions. Figure 3 gives the distance between two pixels with two clusters. Figure 4 represents the average distance between the two pixels with two clusters.

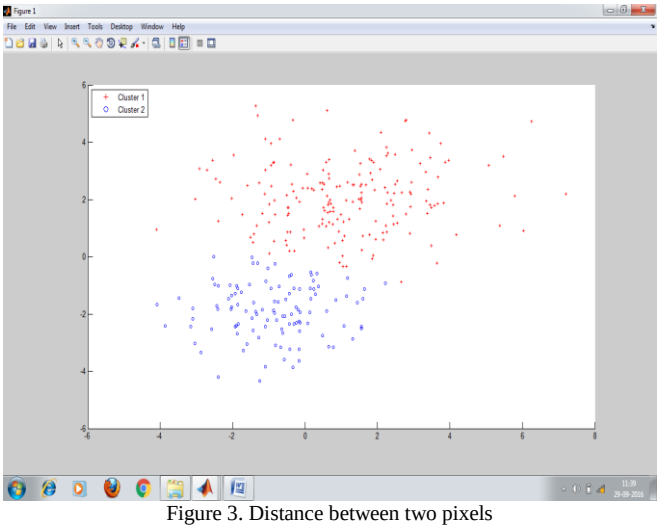

Figure 3. Distance between two pixels

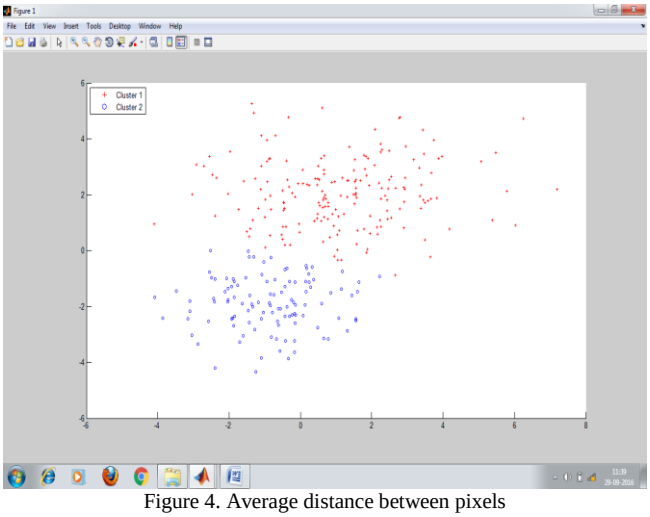

Figure 4. Average distance between pixels

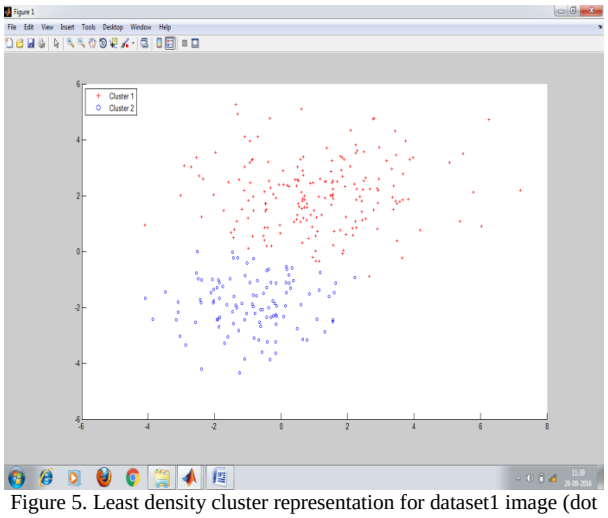

Figure 5. Least density cluster representation for dataset1 image (dot representation)

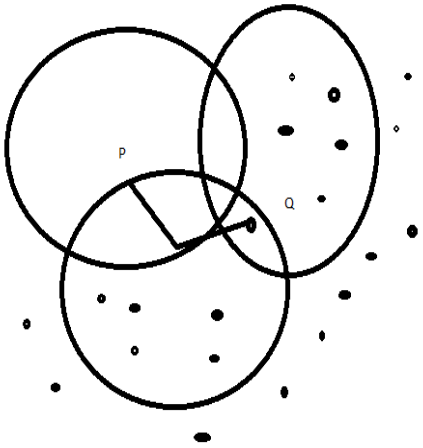

Figure 6. Least density cluster representation for dataset1 image (Cluster Representation)

In the above figure 5 the snowfall least density height are estimated using the 3 different snowfall clusters size and shape as in figure 6. According to the minimum distance the snowfall area are clustered, the red dot represents the snowfall area considered as black pixels(1's) and other area are considered as white pixels (0's) represented using blue dots.

In order to land the flight in the safe area the best density clusters are estimated at 0.01069 mts as represented in the figure 7 which provides the estimation of minimum density for aerial image using DBSCAN algorithm.

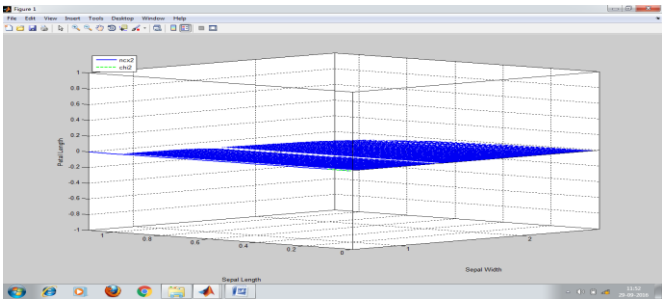

Figure 6. DBSCAN estimation of minimum density for aerial image dataset2

VI. CONCLUSION

In this paper, DBSCAN algorithm is applied for analyzing and estimating the snowfall cluster segmentation of snowfall area in the flight runway digital images. The performance of algorithm is analyzed from the estimation of the total no. of black pixels in snowfall area with heavy snow/ medium snow and ordinary snow using DBSCAN algorithm. To extract the snow fall region from the original image and convert the corresponding original image to binary conversion and Gray conversion of (black and white pixel) the image. The proposed segmentation method can be used for estimating and analyzing the least density for various image dataset for landing the flight safely.

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