Emergency Landing Sites Detection System

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Abstract- *An automatic safe landing-site detection system is proposed for aircraft emergency landing based on visible information acquired by aircraft-mounted cameras (here we are using database images). Emergency landing is an unplanned event in response to emergency situations. If, as is usually the case, there is no airstrip or airfield that can be reached by the unpowered aircraft, a crash landing or ditching has to be carried out. Identifying a safe landing-site is critical to the survival of passengers and crew. Conventionally, the pilot chooses the landing-site visually by looking at the terrain through the cockpit. The success of this vital decision greatly depends on external environmental factors that can impair human vision and on the pilot's flight experience, which can vary significantly among pilots. Therefore, we propose a robust, reliable, and efficient detection system that is expected to alleviate the negative impact of these factors. We focus on the detection mechanism of the proposed system and performed operations on database image.*

Keywords- Histogram Equalization, K-mean Clustering, Canny Edge Detector, Morphological Operation.

I. INTRODUCTION

The top-five leading factors of unplanned landing, which is also called emergency landing, are engine failure, running out of fuel, extremely bad weather, medical emergency, and aircraft hijack. Under the two most emergent situations, engine failure and running out of fuel, the aircraft may quickly lose flying power, and its maneuverability may be restricted to gliding. Once these happen a forced landing process has to be immediately carried out. If, as is usually the case, there is no airport, or even a runway, that can be reached by the unpowered aircraft, a crash landing or ditching is inevitable. Finding a safe landing-site is vital to the survival of the passengers and the pilot.

Conventionally the emergency landing-site is visually selected by the pilot by looking at the terrain through the cockpit. This is a required, fundamental skill acquired in the flight training program. However, many external environmental factors, i.e., fog, rain, illumination, etc., can significantly affect human vision so that the decision of choosing the optimal landing-site greatly depends on the pilot's flight experience–the most significant internal factor–which can vary a lot among different pilots.

The contribution of the project work consists of the following:

1) A delicate automatic safe landing-site detection mechanism is developed by seamlessly combining some existing image-processing and analysis techniques.
2) A horizon detection algorithm is to identify the ground in the aerial image so that the camera is relieved from the limitation of looking straight down to the ground.
3) The efficiency of the system is improved by applying the canny edge detector.
4) A K-mean clustering operation is done to identify smooth regions.
5) Visualization of the smooth regions to make it convenient for the pilot to choose from.

Since time is of supreme importance in the scenario we are considering, the inability to simultaneously scan on both sides of the cockpit is a distinct disadvantage. Imaging sensors can alleviate this problem by creating panorama images that encompass the entire field-of-view (FOV) in front of the aircraft. In order to compensate for the natural inadequacies of human vision and also to alleviate the negative effects of both external and internal factors, a robust, reliable, and efficient process for safe landing-site detection is greatly desirable. Therefore, we present a vision-based, automatic safe landing-site detection system.

Before introducing the design of the system, we first take the database images to assess the safeness of the landing-sites. Landform describes terrain covering, i.e., ground, sky, rock, etc. In addition the landing-site must have sufficient length and width-which can vary with the type of airplane-to enable a safe emergency landing. In summary we evaluate the "safeness" of a potential landing-site by considering its surface roughness and its dimensions.

A landing-site is considered safe only if its surface is smooth and if its length and width are adequate. The proposed safe landing-site detection system is designed to automatically detect landing-sites that is the requirements.

II. IDENTIFY, RESEARCH AND COLLECT IDEA

In last few years, various researches have seen attracted to emergency landing-site detection system and have also have contributed to the area of detection. Most of the work done present in the literature are devoted to overcome the problem of visualization. Although extra research has been carried out to implement best methods for detection purpose.

The proposed project work focuses on safe landing-site detection using automated segmentation method. The segmentation methods like K mean clustering, canny edge detector and histogram equalization for enhancement methods. The roughness of the land is also detected.

The features like length, width and area of the landing-sites will be calculated using dimension assessment method. Landing-sites will be sorted in descending order based on areas for pilot to evaluate candidates. Particularly project work is proposed to overcome all this factors which are not previously implemented.

This system proposes an automatic safe landing-sites detection system that provides robust, reliable, and efficient detection image analysis algorithm to detect smooth areas, avoid hazards, and measure dimension of areas.

III. WRITE DOWN YOUR STUDIES AND FINDINGS

The system implementation design of proposed automatic safe landing –site detection system is shown below in fig. 4.1. It consist of six main modules of our system.

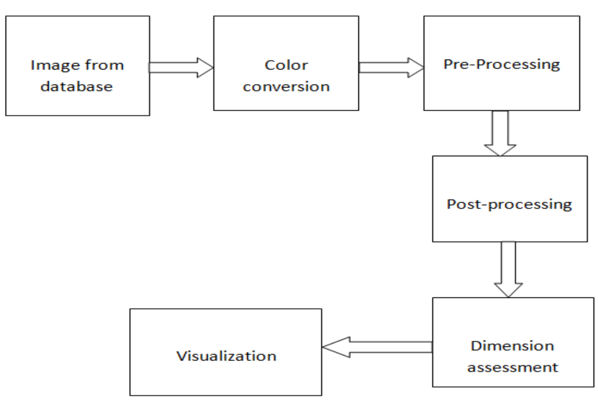

Fig. System Block Diagram

1. Image from database:-

For automatic safe landing-site detection system, some images are already captured using cameras and now we are processed image using various methods.

2. Color conversion:-

Generally, our database images are colored means RGB image. Then we need to convert it into grayscale image. A grayscale image is also called a gray-scale, or gray-level image. The rgb2gray syntax converts true color image RGB to the gray scale intensity image rgb2gray converts RGB images to grayscale by eliminating the hue and saturation information while retaining the luminance.

3. Pre-processing:-

Preprocessing includes image enhancement and horizon detection.

Enhancement method:-

We make use of histogram equalization image enhancement method to ameliorate the effect of environment factors and to improve the contrast and sharpness of the images.

- Histogram Equalization (HE):-

  Histogram equalization is widely used for contrast enhancement in a variety of applications due to its simple function and effectiveness. It works by flattening the histogram and stretching the dynamic range of the gray levels by using the cumulative density function of the image. One problem of the histogram equalization is that the brightness of an image is changed after the histogram equalization, hence not suitable for consumer electronic products, where preserving the original brightness and enhancing contrast are essential to avoid annoying artifacts.

  X0 – XL-1 -> 0 to 255 Gray levels
  P(x) -> Number of pixels

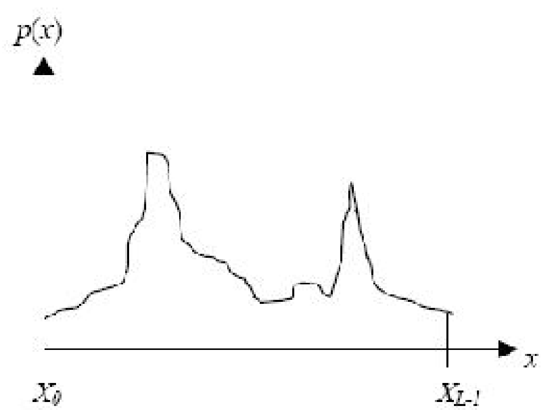

Fig. 4.2.Simple Histogram

Above Fig. 1 shows the histogram equalization is used to maps the input image into the entire dynamic range, (Xo, XL-1) by using the cumulative density function as a transform function.

Horizon detection:-

We make use of canny operator for edge detection. It is an optimal edge detection technique as provide good detection, clear response and good localization. It is widely used in current image processing techniques with further improvements. On analyzing all these edge detection techniques, it is found that canny gives optimum edge detection.

4. Post processing:-

Post-processing includes roughness detection, segmentation and morphological operation.

Roughness detection:-

The Canny edge detector is an efficient tool for computing the sharpness of edges, which is, from smoothest to sharpest, quantified to the range from 0 to 255. This method is applied at the beginning of the roughness detection module. To characterize the difference, the map is first divided into non overlapping blocks. We define the cumulative hazard strength(CHS) of each block as;

$$CHS_B = \sum_{P \in B} H(ES_P) \ldots\ldots\ldots\ldots\ldots\ldots [4.1]$$

$$H(ES_P) = \begin{cases} 1, & ES_P > T \\ 0, & ES_P \leq T \end{cases} \ldots\ldots\ldots\ldots\ldots\ldots\ldots [4.2]$$

Where is the edge strength of each pixel p in block B, and H( ) is the hazard-indicator function. If is greater than the pre-specified safeness threshold T, then the pixel p is considered hazardous, and the CHS of block B, is incremented by 1. In contrast, if is no greater than T, then the pixel p is considered safe, and remains the same. The block size (BS) in the unit of pixels is adaptively determined based on the height of the camera.

Segmentation:-

1. Classify our data based on attributes/features into K number of group.
2. It is used to classify the cumulative hazard strength (CHS) of each block into a number of clusters. For example, if the number of clusters is specified as three.
3. The clusters can be interpreted as “very rough”, “moderate smooth”, and “very smooth”. Colors are assigned to them, while classification.

We make use of K mean clustering for segmentation. The K- means algorithm is an iterative technique that is used to partition an image into K clusters.

- K mean clustering algorithm:
    1. Pick K cluster center, either randomly or based on some heuristic.
    2. Assign each pixel in the image to the cluster that minimizes the distance between the pixel and cluster center.
    3. Re-combine the cluster center by averaging all of the pixels in the cluster.
    4. Repeat step 2 and 3 until convergence is attained (e.g. no pixel change clusters).

Morphological operation:-

Morphology is a broad set of image processing operations that process images based on shapes. Morphological operations apply a structuring element to an input image, creating an output image of the same size. In a morphological operation, the value of each pixel in the output image is based on a comparison of the corresponding pixel in the input image with its neighbors. By choosing the size and shape of the neighborhood, you can construct a morphological operation that is sensitive to specific shapes in the input image.

The most basic morphological operations are dilation and erosion. Dilation adds pixels to the boundaries of objects in an image.

Rule for dilation:- The value of the output pixel is the maximum value of all the pixels in the input pixel's neighborhood. In a binary image, if any of the pixels is set to the value 1, the output pixel is set to 1.

5. Dimension assessment:-

After the above steps, potential landing-sites are obtained. In this module, we measure their realistic dimensions and determine which are qualified to be candidate landing-sites. The realistic dimensionality of each potential landing-site is measured by converting its size from the image converting its size from the image coordinate system to the realistic world coordinate. For experimental purpose, dimension in pixel area can be found out.

6. Visualization:-

The visualization module is designed to highlight, at most, the five largest safe landing-site candidates on the human-machine interface for the pilot's final decision, though the system may detect more than five safe landing-sites. If the system provides the pilot with all the possible choices, he may get confused when seeing too many recommended areas on the screen, and the time cost of making a decision is very critical under the emergency situation.

IV. GET PEER REVIEWED

In last few years, various researches have seen attracted to emergency landing-site detection system and have also have contributed to the area of detection. Most of the work done present in the literature are devoted to overcome the problem of visualization. Although extra research has been carried out to implement best methods for detection purpose.

Some of the published papers are reviewed here:

YU-FEI SHEN et.al (2013) proposed a vision based automatic safe landing-site detection system. An automatic safe landing-site detection system is proposed for aircraft emergency landing based on visible information acquired by aircraft-mounted cameras. In this paper, k-mean clustering and canny edge detector was used. Dimensions like length and width was calculated. But the drawback of this system is area of landing sites is not calculated.

Gaurav S. Sukhatme et.al (2001) proposed an towards vision based safe landing for an autonomous helicopter depends on the decision of where to land and generation of signal to guide the vehicle to safe landing. The features of this system are vision based landing, safe landing, contrast measures and texture scale. But the roughness of landing site was not found in this system. And dimensions are also not calculated.

Navid Serrano et. al (2006) proposed an landing site selection using Fuzzy Rule-Based Reasoning. The key criteria for landing success; namely, terrain safety, fuel consumption, and scientific return. It introduces the rule-based method used to determine landing site quality. In this scheme the fuzzy rule based approach and roughness detection is more complicated.

Timothy Patterson et. al (2012) proposed an modeling safe landing zone detection options to assist in safety critical UAV decision making. But the design of SLZ(safe landing zone) detection is too much complicated. It takes more time for detection. The drawback of this system is that dimensions of landing areas are not calculated.

Maximilian Laiackeret. al (2013) proposed an vision aided automatic landing system for fixed wing UAV. The system is composed of a high precision aircraft controller and a vision module which is currently used for detection and tracking of runways. It is used only for detection and tracking of runways but not for emergency landing sites. The design of this system was complicated. It takes more time to detect the safe landing-site.

V. IMPROVEMENT AS PER REVIEWER COMMENTS

We follow the algorithm of software implementation using MATLAB software. First of all, we create the GUI (graphical user interface). In that, we take some buttons and axes to plot the image on x-y axes. Then we give particular naming to the buttons. After that we save it. Then we use database images which are captured already. And then we make color conversion of that image. And then we apply pre-processing and post-processing using some methods in that. After that we calculate dimensions of the landing areas. In this way, we get expected results of our proposed system. The following figures show the step-by-step result of our project work.

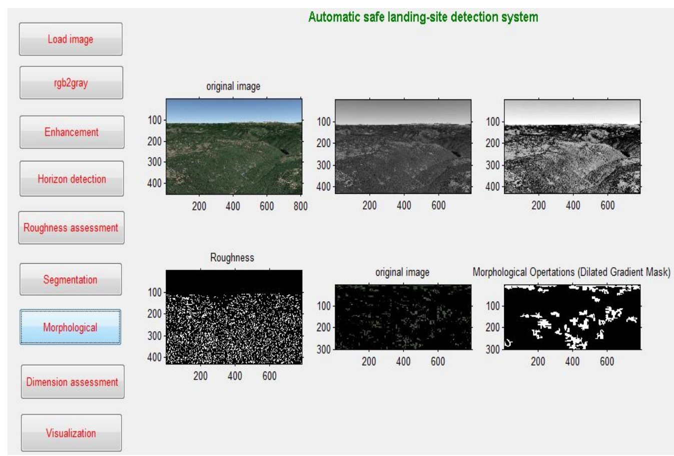

Fig. 1.

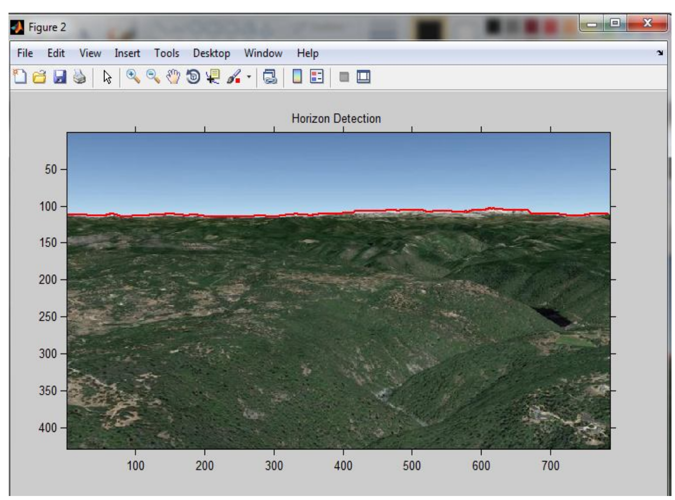

Fig. 2

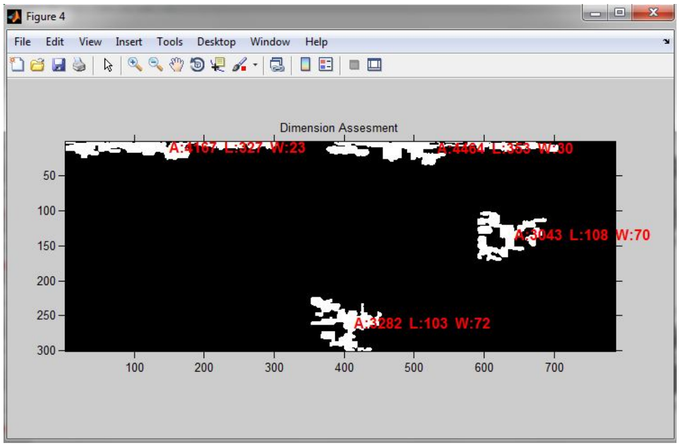

Fig. 3.

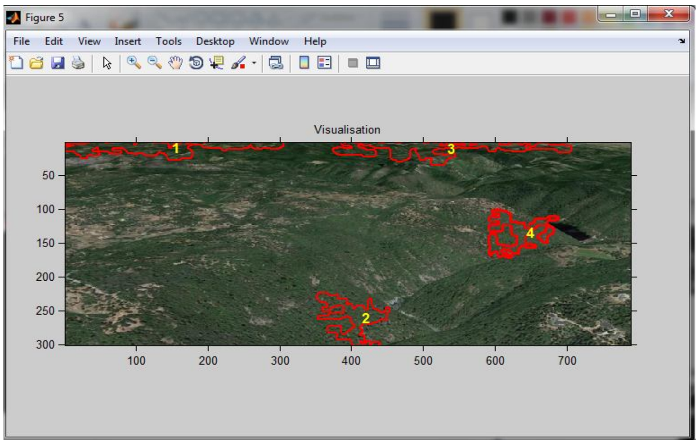

Fig. 4.

VI. CONCLUSION

This project work presents an automatic safe landing-site detection system for robust, reliable, and efficient emergency landing. The proposed system makes up for the limitations of human eyes, assists the pilot to find safe landing-sites, and more importantly, saves time for the pilot to devote to other necessary actions under emergency conditions. The proposed system is used for emergency landing purpose, for geographical survey and for security purpose. The expected results show the feasibility of the vision-based system. In the next step the proposed system will be fully developed to better meet practical demands and applications.

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