AEROPLANE SAFE LANDING SITE DETECTION SYSTEM

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ABSTRACT

Conventionally, pilots are trained to identify safe landing sites by looking to the ground with raw eyes. But human vision can be significantly affected by weather conditions. Also the crucial decision greatly depends on the pilot's flight experience. In addition, the pilot will be under the high pressure in such extremely urgent situations. Time is another vital factor of the survival of passengers and the pilot himself. Aero plane safe landing-area detection system is invented for aero plane emergency landing, which is based on images acquired by aero plane-mounted high resolution cameras. Top-four important factors of unplanned landing (emergency landing) are aero plane hijack, running out of fuel, extremely bad weather, medical emergency. So, the proposed system focuses on the detection mechanism of safe landing area. Firstly, terrain images are acquired by aircraft-mounted cameras (Here, goggle map images are used). Each camera looks in a specific direction covering a portion of the region in front of the airplane. Second, the separate images that are acquired at the same time instant are registered and stitched together to form a larger panorama image that covers the full bigger field-of-view (FOV) in front of the airplane. Third, if the images are captured under poor illumination or weather conditions, we make use of the image enhancement method to minimize the effect of environmental factors, and improve the contrast and sharpness of images. The first three modules are necessary for getting high quality images and directly affect the performance of the subsequent module. Specifically, Fourth Module horizon detection is used to identify the ground in the image & separate the sky. The fifth module assesses the roughness of each block of the ground, which is measured by canny edge detector .Then; Sixth Segmentation & Classification module classifies the blocks into a category based on the degree of roughness. Segmentation is used to find out various clusters, performed by K-Mean Method. Principle component analysis is used for feature extraction & Classification of various clusters done by Cross correlation Classifier. Morphological operation such as dilation & sobel operator is used for extracting image components useful in the representation and description of region shape, such as boundaries, skeletons and convex hulls. For the concern of efficiency, isolated tiny spots and narrow branches of merged areas can be removed by applying the morphological operation .The length and width of the detected landing sites are measured in the eighth module. Dimension of detected smooth & large region is measure by using blob Analysis. Then, detected landing sites are sorted in descending order, based on size of area in visualization module. If the dimensions of a candidate region exceed the minimum requirement for safe landing, the potential landing-site is considered a safe candidate and is highlighted on the human machine interface. At the end of the process, the pilot makes the final decision by selecting a landing site from the recommended candidates, also considering external factors such as wind speed and wind direction, etc.

Keyword – *Image Stitching, Horizon Detection, Roughness Assessment*

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1. INTRODUCTION

An Aero plane safe landing-area detection system is proposed for aircraft emergency landing based on images captured by aircraft-mounted cameras. Emergency landing is an unplanned event in response to emergency situations. The top-four leading factors of unplanned landing, which is also called emergency landing, are 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 .once these happen a forced landing process has to be immediately carried out. So, finding a safe landing-area is important for the survival of passengers and crew. Conventionally, the pilot chooses the landing-site visually by looking at the terrain through the cockpit. This 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. In addition to that, visual angle of the human eyes can simultaneously cover is limited. When the pilot looks to the left side, what is on the right side is missed and vice versa. The inability to simultaneously scan on both sides of the cockpit is a distinct disadvantage. Imaging sensors (Cameras) can compensate this problem by creating panorama images that provide the entire field-of-view (FOV) in front of the aero plane. 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-area detection system is greatly desirable.

Before introducing the design of the system, investigate the appropriate criteria to assess the safeness of the landing-sites. Elevation and landform are two geographic concepts, are taken into consideration. The gradient of elevation generally determines the roughness of the terrain. Landform describes terrain covering, i.e., forest, grass, water, rock, buildings, etc. Smooth elevation gradient by itself is not sufficient to guarantee a safe landing-site since the associated landform could be hazardous to the landing procedure. 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 meet both of the requirements Therefore; Aeroplane safe landing-site detection system is presented.

2. RELATED WORK

Many achievements of autonomous landing have been accomplished [2-6] for known landing-sites by utilizing vision-based approaches to support unmanned aerial vehicles (UAVs) or helicopters. Landing marks, which often appear in high-contrasting the image so that can be easily detected, play a important role in these approaches by giving relative position information for state estimation. Then, for a landing strategy to be match in unknown environments which is usually the case for emergency landings of airplane, the dependence on known landing marks is limiting, therefore, annexable means of finding safe landing-sites is desired. Isaac Kaminer [2] designed a New nonlinear filter structures to estimate the position of an aircraft with respect to a possibly moving landing site, such **as** a Naval vessel, based on measurements provided by airborne vision and inertial sensors. By exploring the geometry of the navigation problem, the navigation filter dynamics are cast in the framework of linear parametrically varying systems (LPVs). Omid Shakerniat [3] presented the problem of using computer vision to control the landing of an Unmanned Air Vehicle. They derived a geometric method of estimating the camera angular and linear velocity relative to a planar scene, and a presented performance evaluation of the algorithm. The vision sensor was put into the feedback loop of a UAV controller based on differential flatness.

Courtney S. Sharp [5] present the design and implementation of a real-time computer vision system for a rotor craft unmanned aerial vehicle to land onto a known landing target. This vision system consists of customized software and off-the-shelf hardware which perform image processing, segmentation, feature point extraction, camera pan/tilt control, and motion estimation. In [7]Garcia-Pardo, et al. designed a two-step autonomous safe landing-site detection strategy. First, they applied a local contrast descriptor which is derived by normalizing the neighborhood of the to-be-tested pixel and then by manipulate & calculate the mean and the standard deviation of its neighborhood, to assess the roughness of the ground under the assumption that the boundaries of hazards appear as high-contrast edges in the image, reacted by small values. A contrast threshold required to be selected to separate smooth areas and boundaries, and the middle contrast threshold is found to have a linear relationship with the ratio of mean and standard deviation of the whole image in the system. Then the landing-sites with a convenient size are search in the smooth areas. The main system was tested in an offline fashion, which are captured by real fights over a synthesized environment that means keeping white boxes on grassy ground. The detection results are implemented by a failure rate defined as the percentage of images in which the system fails to search any safe landing-site[8].The previous some authors are used the Spacecraft Landing Footprint for Safe Planetary Landing, in this system they used footprints for landing sites, but this system is not recognizing accurate space or area, one more author used

UAV forced landings using machine vision system for landing , but they also shows approximate chances of exact area of space

Fitzgerald, et al. also applied a two-step safe landing-site detection strategy. Firstly canny edge detector is used to describe the edges in the image. Such detection is computationally more efficient than the local contrast descriptor mentioned above. Secondly, the safe landing-sites are found by scanning the smooth area with a set of rectangular masks that are predefined in different scales and rotation angles. Three problems associated with the second step are as follows.
1) It is not suitable or even impossible, to predefine a sufficiently large number of masks with all possible scales and angles. For example, if a potential safe landing-site has a shape which is not covered in the predefined mask set, the system is very likely to miss it.
2) Several aeroplanes have different requirements for safe landing-sites in terms of the minimum length and width. Using a predefined set of masks limits the application of the system to different aeroplanes
3) It is computationally costly to move all the masks over the smooth area. The computational cost is proportional to the number of masks so that the requirement of time conflicts with the requirement of detection accuracy.

Related research of spacecraft landing has been conducted by many groups in recent years. The NASA Jet Propulsion Laboratory (JPL) proposed a [10] LIDAR-based hazard avoidance approach for safe landing on Mars. They made use of elevation maps generated by scanning synthetic terrains with a simulated LIDAR model. Later, JPL introduced a fuzzy rule-based safety index to evaluate landing-sites [11].In this, once the characteristics of the viewable scene are extracted, the terrain safety must be assessed and classified. To accomplish this task, they have developed a set of fuzzy logic rules which classify the safety of the terrain based on the characteristics present in the given sensor data set. The Fuzzy Rule-Based Safety Index thus obtained succinctly quantifies the ease-of-landing a spacecraft on the terrain based on the terrain physical characteristics In addition, they brought multi-sensor images into their approach [12]. They use novel multi-sensor information fusion method for terrain classification from a safety standpoint. The fusion strategy directly incorporates information regarding the terrain characteristics extracted from heterogeneous active and passive sensors.The JPL also proposed a method to estimate the reachable area for the spacecraft [13]. In this, methodology is developed based on a ballistic analysis to estimate the landing footprint associated with the powered terminal descent phase of a spacecraft soft landing. The analysis is based on an idealized two-impulse thrust maneuver and leads to an analytical expression for the elliptical boundary of the landing footprint. The footprint generated from the ballistic analysis is also compared with the footprint resulting from numerically integrating a representative guidance law. In addition to its application to landing on Mars, autonomous landing and hazard avoidance technologies (ALHAT) are also utilized for lunar landing and UAV landing [14]. Therefore, the proposed system has a wide range of potential applications.so to overcome these drawbacks; we are using this new advanced system called as Aero plane Safe Landing-Area Detection System

3. PROPOSED SYSTEM

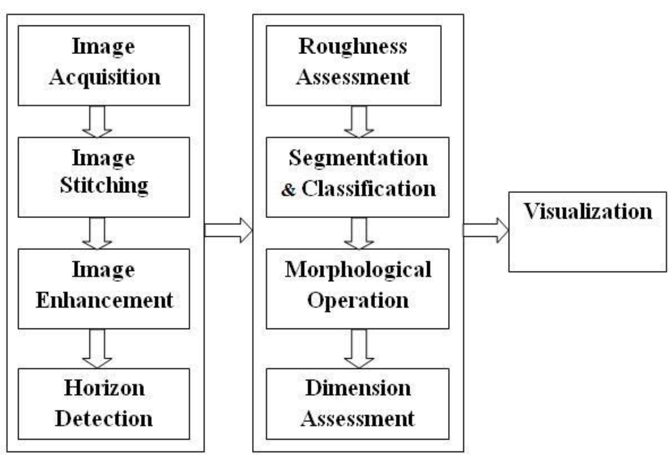

Fig-1: Flow Diagram of safe landing detection system

The proposed safe landing-area detection system consists of nine modules as follows:
1.Images Acquisition :-Terrain images Captured by aircraft-mounted cameras. (Here, Google Earth Images used)
2.Image Stitching-(SIFT Algorithm):- Image stitching is used for a creating bigger field-of-view
3.Image-Enhancement (Imadjust):- Image improvement used for improved visibility of image.
4.Horizon detection (K Mean Method): Horizon detection algorithm to identify the ground & sky in the image.
5.Roughness Assement (Canny Edge Detector): It assesses the roughness of each block of the ground.
6.Segmentation &Classification (a) K-mean clustering method b) PCA &Cross correlation Classifier):- Segmentation & Classification module segment the blocks (Region) into a category, based on the degree of roughness. Segmentation is used to find out various clusters, performed by K-Mean Method. Principle component analysis is used for feature extraction & Classification of various clusters done by Cross correlation Classifier
7.Morphological operation: -Morphological operation such as dilation & sobel operator is used for extracting image components useful in the representation and description of region shape
8.Dimension Assessment (Blob Analysis) :-Dimension of detected (length and width) landing sites are measured
9.Visualization : - Detected landing sites are sorted in descending order, based on size of area in visualization.

Finally, the pilot makes the final decision by deciding one of the candidates and also by considering many factors such as wind speed and wind direction, etc. Ideally, when the aircraft is flying in the upper air, it can be guided to an approximately smooth area according to the gradient information extracted from the elevation map.Then, the proposed detection system leads the aircraft to asafe landing-site. In practical,most aircraft's do not have either a database of elevation maps or a LIDAR sensor system.The images captured by aircraft-mounted cameras is the only available information source, so the proposed system plays a important role in this scenario also.Description of Some important algo.as Follows,

3.1 Image Stitching

Image stitching is considered as an active research area in computer vision and computer graphics. Image stitching is concerned with combining two or more images of the same scene into one high resolution image which is called panoramic image. In this module, the separate images that are acquired at the same time instant are registered and stitched together to form a larger panorama image that covers the full FOV in front of the airplane. In this process, Scale Invariant Feature Transform (SIFT) algorithm can be applied to perform the detection and matching control points step, due to its good properties. This algorithm offers a way to overcome this problem by searching the small area around the expected central overlap pixel in order to find the best correlation point. The SIFT technique is one of the most robust and widely used image matching algorithm based on local features. It ensures a good mosaic image and a reliable result. SIFT is a feature detection and description technique. SIFT produces key point descriptors which describes the image features. SIFT technique has four computational steps for extracting key points:
1) Scale-space peak selection
2) Key-point localization
3) Orientation-assignment
4) Defining key-point descriptors.
To each image, it builds image pyramid by generating progressively blurred out images and it subtracts neighbor images to get the difference of Gaussian (DOG) pyramid. Then, it detects the extreme for DOG pyramid. The number of key points was reduced to help in increasing efficiency and also the robustness of the technique

3.2 Horizon Detection

Before assessing the roughness of the ground, the first problem that we need to identify where the ground & sky because, ground & sky both appear in the image. Firstly, terrain image is segmented based on color, which is used to find out 2-clusters by using K-mean. Secondly, Canny edge detector is utilized to find the major bounds. so, sky & ground are separated by line

Colour-Based Segmentation Using K-Means Clustering
This shows how to segment colors in an automated fashion using the L*a*b* colour space and K-means clustering.
1) Step 1: Read Image
2) Step 2: Convert Image from RGB Colour Space to L*a*b* Colour Space

3) Step 3: Classify the Colors in 'a*b*' Space Using K-Means Clustering
4) Step 4: Label Every Pixel in the Image Using the Results from KMEANS
5) Step 5: Create Images that Segment the H&E Image by Colour.
6) Step 6: Segment the Nuclei into a Separate Image

3.3 Roughness Assessment

Roughness of the ground and the presence of hazards are often reflected as boundaries and as a high-variance of pixel intensity values in visible images. If high-resolution elevation maps are not available, it is valid to assume that identifying rough areas or hazardous objects on the ground is equivalent to the process of edge detection in visible images. Canny edge detector optimal edge detection technique as provide good detection, clear response and good localization. The Canny method finds edges by looking for local maxima of the gradient of I. The gradient is calculated using the derivative of a Gaussian filter. The method uses two thresholds, to detect strong and weak edges, and includes the weak edges in the output only if they are connected to strong edges

Steps of Canny edge detector:
1. Smoothing: - Smooth the image with a two dimensional Gaussian Filter (i.e Removing noise by convolving with Gaussian filter.). In most cases the computation of a two dimensional Gaussian is costly, so it is approximated by two one dimensional Gaussian, one in the x direction and the other in the y direction.
2. Compute Gradients:-Take the gradient of the image. This shows changes in intensity, which indicates the presence of edges. This actually gives two results, the gradient in the x direction and the gradient in the y direction. (i.e Edges should be marked where the gradients of the image has large)
3. Non-maximal suppression:- Edges will occur at points the where the gradient is at a maximum. Therefore, all points not at a maximum should be suppressed. In order to do this, the magnitude and direction of the gradient is computed at each pixel. Then for each pixel check if the magnitude of the gradient is greater at one pixel's distance away in either the positive or the negative direction perpendicular to the gradient. If the pixel is not greater than both, suppress it. (Only local maxima should be marked as edges.)
4. Edge Thresholding :-The method of thresholding used by the Canny Edge Detector is referred to as "hysteresis". It makes use of both a high threshold and a low threshold. If a pixel has a value above the high threshold, it is set as an edge pixel. If a pixel has a value above the low threshold and is the neighbor of an edge pixel, it is set as an edge pixel as well. If a pixel has a value above the low threshold but is not the neighbor of an edge pixel, it is not set as an edge pixel. If a pixel has a value below the low threshold, it is never set as an edge pixel. At the end, Input image resulted into edge extracted image

4. RESULT & DISCUSSIONS

The visualization module is designed to highlight the smooth and largest safe landing site candidates on the human-machine interface for the pilot’s final decision. 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. Therefore, only largest candidate landing-sites are visualized on the human-machine interface and labeled with preference indices. The landing-sites are sorted in a descending order based on their areas. So,that the pilot can efficiently evaluate the recommended candidates in a rational order. The pilot will make his final decision by choosing one emergency landing-site from the recommended candidates and by taking into account other factors as well, i.e., wind direction, wind speed, maneuvering ability, etc. In general larger areas are preferable when compared with smaller ones.

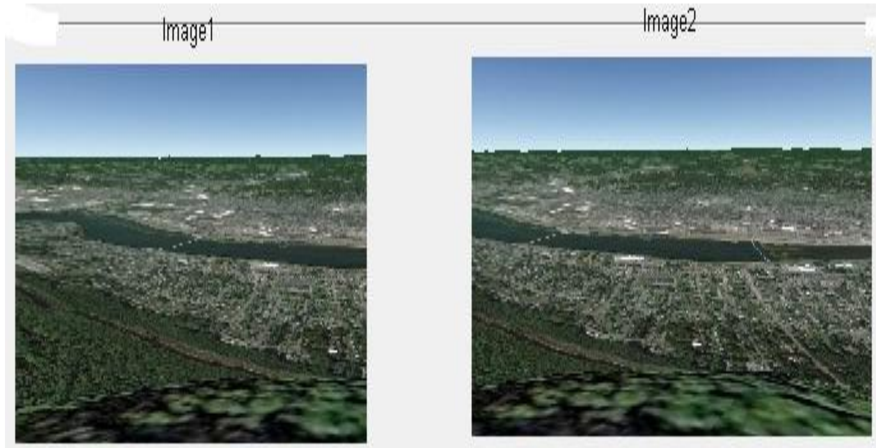

Fig-2: Input Images for Detection System

Fig-3: Panorama Image for Bigger field of view

Fig-4: Image Enhancement

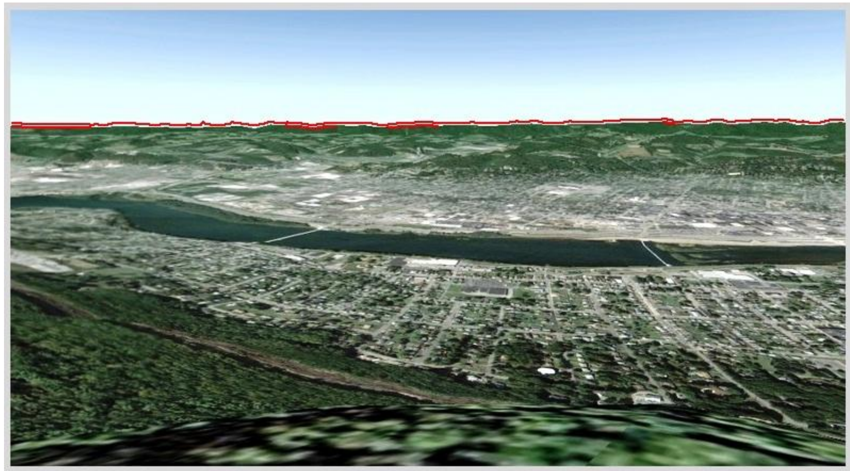

Fig-5: Horizon Detection

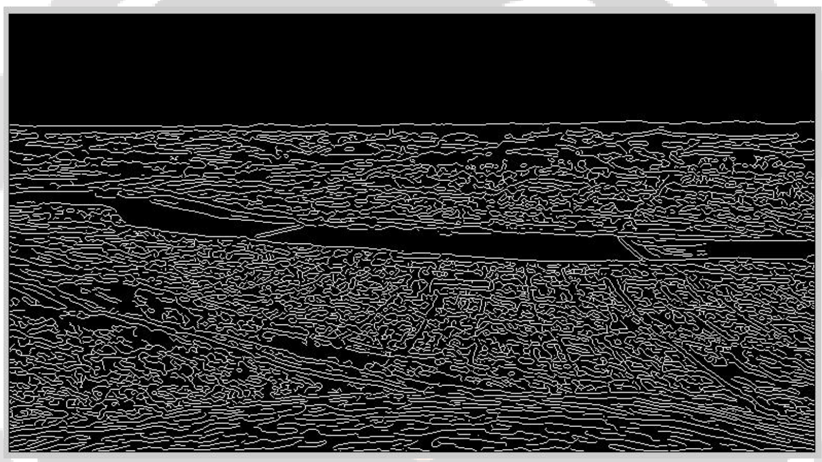

Fig-6: Roughness Assessments

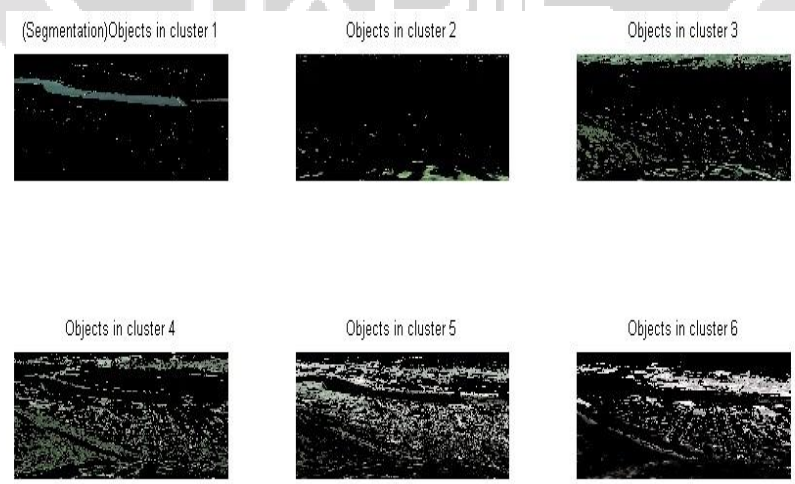

Fig-7: Segmentation & Classification

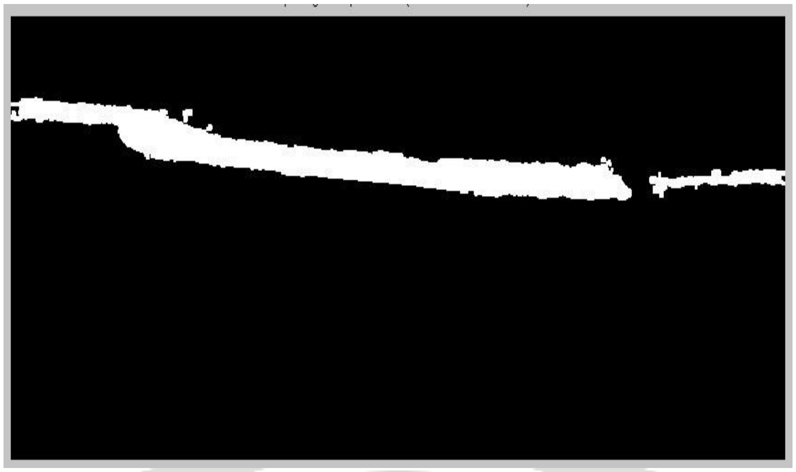

Fig-8: Morphological operation

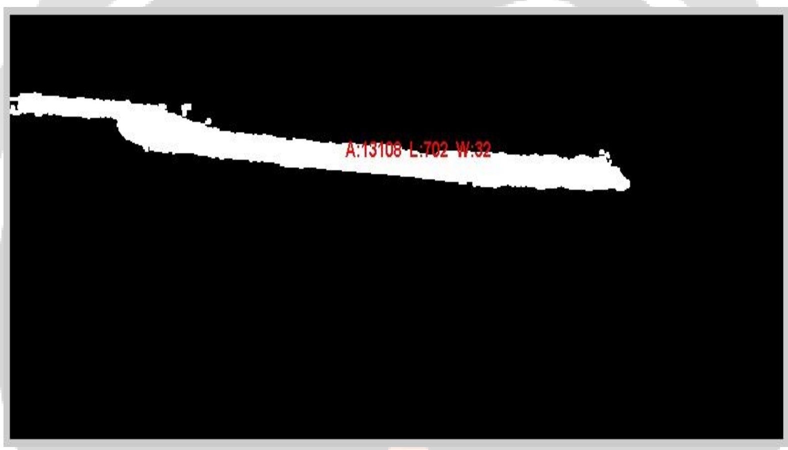

Fig-9: Dimension Assessment

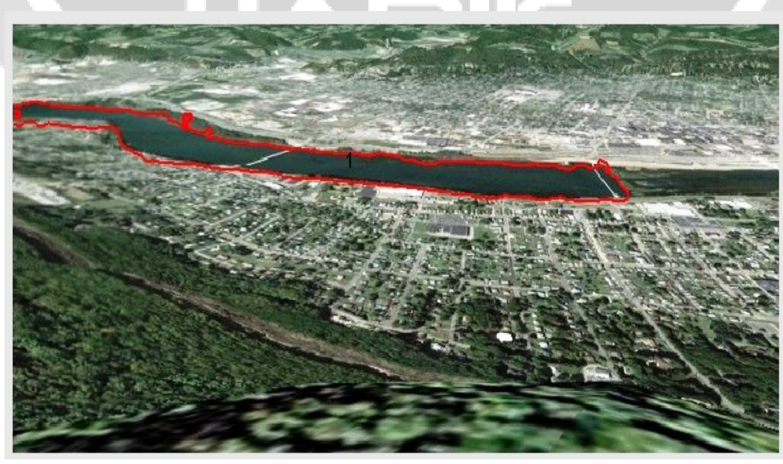

Fig-10: Visualization

5. CONCLUSIONS

This methodology mainly focused on safe landing-area detection system for robust, reliable, and efficient emergency landing of aero plane. This proposed system removes limitations of human eyes which works mainly, assists the pilot to find safe landing-sites. And more important, it saves time under emergency conditions at the time of work. In the further step the proposed system will be further extended to better meet practical demands and applications in the system.

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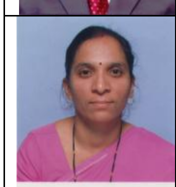	Prof. Archana A.Hatkar Assistant Professor in Sir visvesvaraya institute of technology, Nashik. She has done his Masters in Electronics