Vehicle Damage Detection Using novel Image Processing Technique

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***abstract*—The determination of vehicular damage percentage after an accident is one of the biggest issues for insurance companies. Conventional methodology of damage determination largely depends upon manual inspection, which causes time, expense, trauma. Recently some research used deep learning technology for damage detection based on pre-saved dataset which is theoretically erroneous. In this paper, we present a novel algorithm for vehicle damage detection using image processing techniques. This method calculates the damage percentage comparing the previously captured image and damaged image to obtain accurate damage of vehicle.**

Keywords—vehicle, damage, insurance

I. INTRODUCTION (*HEADING 1*)

The proliferation of automobile industries is directly related to the increasing number of car incidents. In case of an accident, vehicle insurance come in which is a billion-dollar industry. However, there is much controversy in terms of damage detection and compensation after an accident. One of the biggest reasons behind this is the erroneous determination of the damage. Especially, there is no automatic system of damage detection for the insurance companies other than manual inspection-based method.

This most of the time results in customer dissatisfaction, time, energy and trauma. Recent research has come up with ideas to solve this issue. Especially, Kyu et. Al [1] have shown use of deep learning network to identify the damaged parts automatically. Patil et al. presented their work on Deep learning based car damage classification in 2017 which uses deep learning techniques to detect damage of a vehicle. Reichel et al. showed a method of damage detection [2] which uses a fixed placement of the vehicle to measure the damage. These techniques are in preliminary state and yet to be validated in real life scenario. Simple image processing methods have been also applied including segmentation and feature matching [3]. However, to our best knowledge, no simple and user convenient method using low level image processing techniques have been applied to solve the issue of vehicle damage detection. These aforementioned methods have an inherent issue due to that fact that they rely on other collected images which do not correlate with the vary vehicle in consideration. To tackle the issue, we propose a novel image processing method-based algorithm to determine car damage. The motivation of the study is to provide Auto Insurance Companies means of Vehicle Damage Documentation. Our developed algorithm is implementable on smartphone and offers not only automated damage documentation, but also differentiation of previous damages to the new one. Our approach is to offer a novel algorithm which is implementable in smartphone platform and which can be used by vehicle owners provided by the insurance companies to document the vehicle condition in case of damage.

According to our proposed method, after an accident or incident, the consumer will capture images of the damaged vehicle following the same procedure as the initially taken picture using smartphone. These images will be compared to the reference image to detect the damage in the vehicle.

II. MATERIALS AND METHODS

The factors that will affect the imaging are background, rotation, camera performance and perspective change. A sample image of the damaged vehicle (image size is different, perspective is changed, image is skewed) is given below.

(a) **(b)**

Fig. 1. (a) Original image, and (b) skewed image.

The block diagram of our proposed method is shown below:

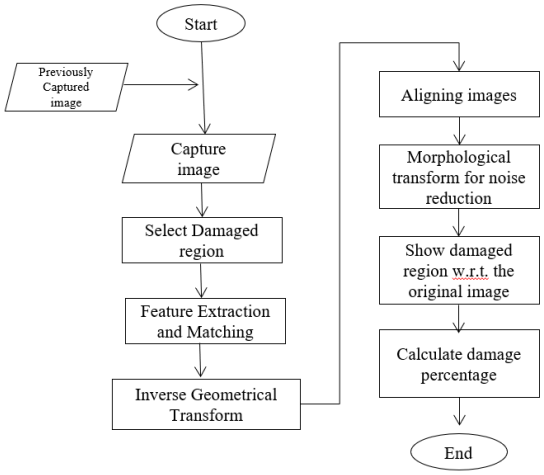

Fig. 2. Block diagram of the proposed method.

A. Data Collection

The images used in this project was collected from various sources including open databases, internet, car junkyard and car body shops. Some of the image augmentation technique were also used where one image was modified to represent damage. As no sensitive data was collected, IRB was not required. Simple image processing techniques to reduce noise has been applied.

B. Feature Extraction

Feature Extraction is described as detection of the points which is expressive in texture, at which the direction of the boundary of the object changes abruptly, and the intersection point between two or more edge segments. The Properties of an interest point includes well localization, invariance to illumination/brightness variations, and provides efficient detection. SURF (Speeded Up Robust Features) has been applied to extract the features from the images. SURF is a fast and robust algorithm for local, similarity invariant representation and comparison of images. SURF performs fast computation of operators using box filters, thus enabling real-time applications such as tracking and object recognition. Fig. 3. Shows feature extraction from an image.

Fig. 3. Strongest 10 feature points are shown on a damaged vehicle.

SURF uses box filters to approximate both convolution and second-order derivatives (hessian matrix). The equations below shows the hessian matrix and approximation of hessian matrix.

$$H(f(x,y)) = \begin{bmatrix} \frac{\partial^2 f}{\partial x^2} & \frac{\partial^2 f}{\partial x \partial y} \\ \frac{\partial^2 f}{\partial x \partial y} & \frac{\partial^2 f}{\partial y^2} \end{bmatrix} \quad (1)$$

These approximate second-order Gaussian derivatives can be evaluated at a very low computational cost using integral images. Figure 3 below shows the approximation as box filters.

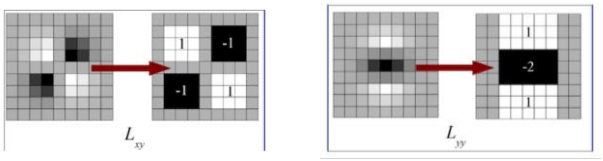

Fig. 4. Hessian approximation using box filters.

The sum of the original image within a rectangle can be evaluated quickly using the integral image, requiring evaluations at the rectangle's four corners. SURF uses scale space modeling increasing the filter size to evaluate feature descriptors at different scale. Figure 4 shows the scale space modeling.

Fig. 5. Scale space model of SURF

Features Description includes Orientation Assignment. A reproducible orientation based on information from a circular region around the key point. Descriptor Components is defined as construction of a square region aligned to the selected orientation and extract the SURF descriptor from it.

D. Feature Matching

By comparing the descriptors obtained from different images, matching pairs can be found. Figure 6 below shows the feature matching procedure.

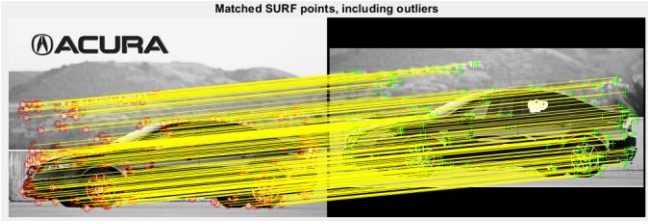

Fig. 6. Feature Matching between initial and damaged vehicle image.

E. *Geometrical Transform*

Inverse Perspective Transform includes aligning both images. Using the geometric transformation objects obtained from matched points of the images. In our proposed method, we warped the damaged image using inverse transformation onto the initial image. Overlapping the damage image to the original image finally shows the damaged area.

F. Pseudo-Code

```
Load initial_image (1)
Load damage_image (n)
Initialize match_threshold
Apply SURF feature
points
Select strongest n feature
points
For image_counter
increase from 1 to n
   Apply SURF features
   Match SURF feature
points
         If feature_match
         >
         match_threshold
            Apply
         geometrical
         transformation
            Overlap
         image
            Detect
         pseudocolored
         damaged part
         Else
            Go to next
         image in
         database
Show damaged part on
initial_image
Calculate
damage_percentage
```

III. RESULTS

Our proposed method can accurately detect the damaged area of a vehicle comparing it to the initial image using SURF based geometric transformation.

Fig. 7. Damage Detection Algorithm

Fig. 8. Damage detection on a damaged car image.

IV. DISCUSSION

Vehicle Insurance companies commonly face a problem for car damage claims. After an accident or any physical damage to cars, insurance companies conduct a manual damage assessment procedure where a company staff visits the damaged vehicle and assesses the damage, which is inconvenient, costly and inaccurate in most cases. Moreover, there is no accurate way to detect what the primary condition of the vehicle was before the damage (i.e., hail damage incident). Here, we propose a novel image processing based automatic solution to this problem of vehicle damage detection. Using image processing technique, our proposed method is able to not only detect the damaged part of the vehicle, but also categorize the damage in a scale of severity of the vehicle.

In this paper, we proposed an effective and smartphone implementable method to determine vehicle damage using image processing technique. This method is easy to use and accurate which can help insurance companies to effectively reduce issues regarding insurance claims and make a convenient relation between user and insurance companies.

REFERENCES

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