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Object Discernment using Scale Invariant Feature Transform with Python

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Abstract: Optical object detection and pose estimation are very challenging tasks in automobiles since they have to deal with problems such as different views of an object, various light conditions, surface reflections, and noise caused by image sensors. Presently available algorithms such as SIFT (Scale Invariant Feature Transform) can to some extent solve these problems as they compute so-called point features, which are invariant towards scaling and rotation. However, these algorithms are computationally complex and require powerful software in order to operate in real time. In self-propelled applications and generally in the field of mobile devices, restricted processing power and the stipulated for low battery power consumption play an important role.

Hence, taking on those cultivated point feature algorithms to mobile hardware is enthusiastic, but also mandatory computer engineering task. The SIFT (Scale Invariant Feature Transform) algorithm is a catch-up for extracting distinctive invariant features from different images.

It has been strongly applied to various computer vision problems based on feature match-ups including object detection, pose estimation and many others. However, in actual applications there is a need for improvement of the algorithm's toughness with respect to the matching of SIFT features. In this work, the purpose to use original SIFT algorithm to provide more reliable feature matching for the purpose of object recognition. The algorithm will be implemented on ARM processor for portable device applications.

Keywords: Object detection, Python, irrespective positions, Angles, object images, Open-cv model, features, SIFT (Scale Invariant Feature Transform), Key-points.

I. INTRODUCTION

The work presented here demonstrates increased matching process performance robustness with no additional time costs. The high effectiveness of the SIFT descriptor has motivated the authors to use it for object recognition in service robotics applications.

Through the performed experiments it was found that SIFT (Scale Invariant Feature Transform) key points features are highly distinctive and invariant to image scale and rotation providing correct matching in images subject to noise, viewpoint and illumination changes. However, it was found that sometimes the number of exactly matched are insufficient for object detection, particularly when the target object, or part of it appears very small in the test image with respect to its aspect in model image.

Objects look different under varying conditions: Changes in lighting or color, Changes in viewing direction, Changes in size or shape. A single example is unlikely to succeed reliably. It is impossible to represent all appearances of an object.

The similarity of images in order to establish a measure of their matching-up is a key problem in various computer vision-tasks. Robot emplacement and navigation, object recognition, building perspectives and image registration represent just a small sample among a various number of possible applications. Here the emphasis is on object recognition. Generally, the existing object detecting algorithms can be categorized into two as global feature-based algorithms and local feature-based algorithms.

The advantages of local over global features are illustrated. Local features-based algorithms focus mainly on the so-called key points.

In this, the general schema for object detection usually involves three important stages:

A. The first one is the pulling out the salient feature points (corners) from both test and model object images.
B. The second stage is the construction of regions around the salient points using mechanisms that aim to keep the regions characteristics insensitive to viewpoint and illumination changes.
C. The final stage is the match-up between test and model images based on uprooted features. Global features-based algorithms aim at detection of an object as complete object.

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II. LITERATURE REVIEW

To truly embrace image similarities and 3D modelling it is necessary to understand the previous work that is preceded with the chosen algorithms and methods. Feature detection is the first step towards image matching which in return represents the ground for 3D modelling. The reviewed tracks the earlier attempts is to achieve robust feature detection starting about two decades ago. During the process of looking for documentation on 3D modelling, a lot of work was found that addresses the early feature detection and the posterior image matching. These are good indicators of their importance to the process. Most of early executions that are developed seemed to work well under particular limited image picture conditions. The challenge for those users was to achieve true invariant feature detection under any image conditions (i.e. illuminations, rotations, blurring, scales, clutters, etc). The consistency of the previous results that appears to have been controlled by the type of images that are used. This literature review aims to provide with an insight on what have been done, what is currently being studied and where the future work is pointing in the field of image matching and automated 3D model reconstruction.

A method on single object detection by using set of local-feature templates which can use with corner detector and filters. It has verified plane object recognition using SIFT(scale invariant feature transform) features which can generated a match for geometric alignment. Other well known Feature-based object detection methodology is the Bag of key points given by Csurka et al. 2004[4]. Csurka et al. 2006[5], object detection problem is separated into different parts — Object representation, learning and classification. Another technique is the pixel-based methodology, which is the combination of segmentation and detection/recognition technique. Other recognition methods are not mentioned in the literature, which is not in the scope of the project.

III. EXISTING SYSTEM

As of before researchers, the implementations are executed using different methodologies. Few of them are:

A. *Implementation of object detection using SURF*

1) *SURF:* Speed-Up Robust Features — The description of Speed-up Robust features uses continues responses in horizontal and vertical direction (again, use of integral pictures make objects is easier). Particulars of size 20sX20s is taken from the key-points where ‘s’ is the size. It is separated to 4x4 sub-regions. For each sub-region, horizontal and vertical continuous reactions are taken and a vector is formed, $v=(\sum{d_x}, \sum{d_y}, \sum{|d_x|}, \sum{|d_y|})$. It is represented as vector that gives SURF feature descriptors with 64 dimensionalities. Low values of the dimension, high the speed of computations and similarities, but give the best distinctiveness of features. For more distinctiveness, SURF feature descriptors have an extended 128-dimensional version. The sums of d_x and $|d_x|$ are computed separately and for $d_y < 0$ and $d_y \geq 0$. Similarly, the sums of d_y and $|d_y|$ are splited up to the sign of d_x, thereby doubling the number of features available. It doesn’t add much computation complexity. OpenCV supports both by setting the value of flag extended with 0 and 1 for 64-dimensionality, 128-dimentionality respectively (default: 128-dimensionality). Another important development is to use the sign of Laplacian (trace of Hessian Matrix) for underlying point. It doesn’t add any computation cost as it is already computed during recognition. The mark of the Laplacian prominent bright blobs on dark back-grounds from the reverse places. In the similar stage, only compare the features if they are of same type of contrast. The minimal data allows for quick matching, without decreasing the descriptor’s performances.

B. *Implementation of object detection using MATLAB*

MATLAB gives an easy approach for advanced matrix software and implemented and executed by the LINPACK and EISPACK projects, which combinedly represent the state-of-the-art in software for matrix evaluation. MATLAB has evolved over a period of years with input from different applicants. In university surroundings, it is graded instructional tool for preliminary and further courses in mathematics, engineering, and science. In today’s industry, MATLAB is the tool of choice for high-efficient research, development, and evaluation. MATLAB features a group of application-specific solutions called toolboxes. Very important to various users of MATLAB, toolboxes allow to grasp and appeal specialized technology. Toolboxes are comprehensive collections of MATLAB functions(M-files) that extends the MATLAB environment to solve particular classes of problems. Areas in which toolboxes are available include signal processing, control systems, neural networks, fuzzy logic, wavelets, simulation and from other users.

1) *Disadvantages of Existing System Are:* The drawback is mathematically complicated and highly computational. SIFT (Scale Invariant Feature Transform) algorithm is based up-on Histogram Gradients in which the gradients of each and every Pixel in the patch is necessary to be computed and these calculations cost time.

It's not effective for low powered devices.

a) MATLAB implementation cannot be used for further hardware or electronic purposes.
b) Still a bit slow (SURF provides similar performance while running faster).
c) Generally, it doesn't work good with lightening changes and blur.

IV. PROPOSED SYSTEM

The major challenge in this problem is that of the variable dimension of the output which is caused due to the variable number of objects that can be present in any given input image. Any general machine learning task requires a fixed dimension of input and output for the model to be trained. Another important obstacle for widespread adoption of object detection systems is the requirement of real-time while being accurate in detection. The more complex the model is, the more time it requires for inference; and the less complex the model is, the less is the accuracy. This trade-off between accuracy and performance needs to be chosen as per the application.

1) *Implementation of object detection using SIFT Algorithm with Python:* Image matching is a fundamental aspect of many problems in computer vision, including object or scene recognition, solving for 3D structure from various input images, stereo resemblance, and motion tracing. The description of image features that have many properties that make them suitable for matching differing images of an object or scene. The features are invariant to image scaling and rotation, and partially invariant to change in illumination and 3D capturing viewpoint. They are restricted well in both spatial and frequency domains, reducing the probability of disruption by occlusion, clutter, or noise. Large numbers of features can be extracted from various images with efficient methodologies. Furthermore, the characteristics are highly remarkable, which allows each and every characteristic to be matched perfectly with maximum probability against a huge database of characteristics, providing a basis for object and scene detection. The value of extraction for these features are reduced by pulling a cascade process methodology, in which the higher expensive operations are have to do with in the locations that passes an initial test. SIFT, isn't just scale invariant.

Fig 1 To Find These Objects in above Image

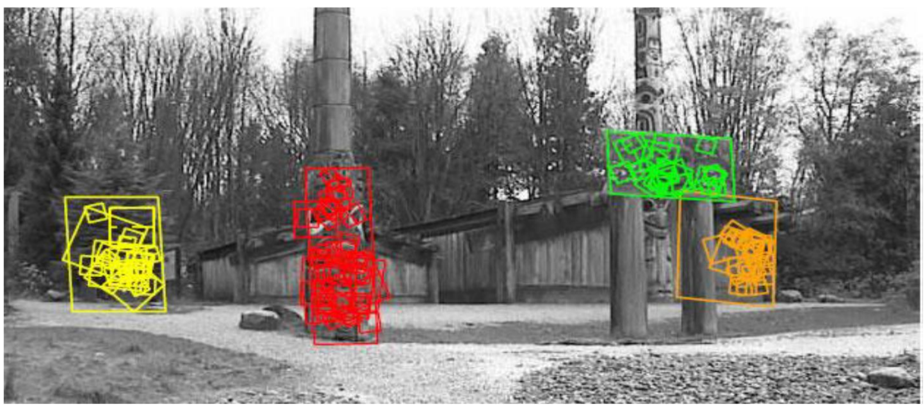

Fig 2 The Results Using SIFT-Algorithm

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A. Algorithm Outline

SIFT is quite an involved algorithm. It has a lot going on and can become confusing, so We have splited up the entire algorithm into multiple parts. Here's an outline of what happens in SIFT.

TABLE 1
Algorithm Outlines of SIFT

Outline Name	Explanation
Constructing a scale space	Firstly, create the internal representations from the original picture to ensure scale invariance. It is done by a scale space.
LoG Approximation	The Laplacian-of-Gaussian is good in finding such points (or key-points) in an image. But it's computationally expensive. So, approximate it using the representations that are created earlier.
Finding Key points	With the speedy approximation, try to find key points. These are maxima and minima in the Difference-of-Gaussian image we calculate previously.
Get Rid of Bad Key Points	Edges and low contrast regions aren't the best key points. Discarding them make the algorithm more efficient and robust. A methodology similar to Detector is used.
Assigning Orientation to the Key-points	An orientation is measured for each key-point. Any further calculations are done similar to the orientations. These effectively cancel out the effect of orientations, making for rotation invariance.
Generate SIFT Features	Lastly, with the help of scale and rotation invariance for an object, one more representation is achieved which uniquely find the features.

B. Algorithm Steps

The Scale Invariant Feature Transform will be done in four steps. They are:

1) Scale Space Extrema
2) Laplacian of Gaussian
3) Finding Key-points
4) Assigning Key-point Orientation
5) Key-point Descriptor

V. RESULTS

The following are outputs for the project in different operating systems like Linux, Windows, Debian. As in Linux the python is in-build structure so, the installation is not necessary. Where as in Windows there is no such advantage so the installation of python portal is necessary to run the python programming. Apart from this, the OpenCV is also needed for the project, which is installed through the command prompt with the respective commands in the operating systems.

Fig 3 Execution of Output

Fig 4 Displaying Output

VI. CONCLUSION

The SIFT-algorithm was proposed and developed by Lowe. The algorithm for the object discernment has successfully applied using python and open-cv and ported the algorithm on prepared development board. The system's hardware code is gated to which it must contain webcam for image capturing and SD card for saving the captured images and operating system to display the detected object. The development corresponds to enhancement of feature matching robustness. The new methodology was tested using real pictures which are captured with the webcam. The results had shown the potency of the proposed system. The expanded of Scale Invariant Feature Transform features on previous approaches by being wide invariant to changes occurred in scale, illumination. Larger robustness would be obtained by recognizing various feature types and relying on the indexing and clustering to choose those that are most helpful in the image. The exact and methodical object recognizing system has obtained that achieves similar metrics with the present state of art system. The project uses new technologies in the field of computer vision. Random dataset was generated with the label-image and the results were consistent. It will be used in real-time implementations that require object recognition for pre-processing. The main scope is to train the system on a video sequence for using tracking applications.

1) *Future Scope:* Object tracking, Video stabilization, Robot Mapping and Robot localization, Gesture recognition.
   a) Using 3-D objects for noise less objects.
   b) Trying to detect objects from videos.
   c) Working for the implementation of this algorithm in hardware and electronics related projects.
   d) Can be implemented in real time Security and military purposes.

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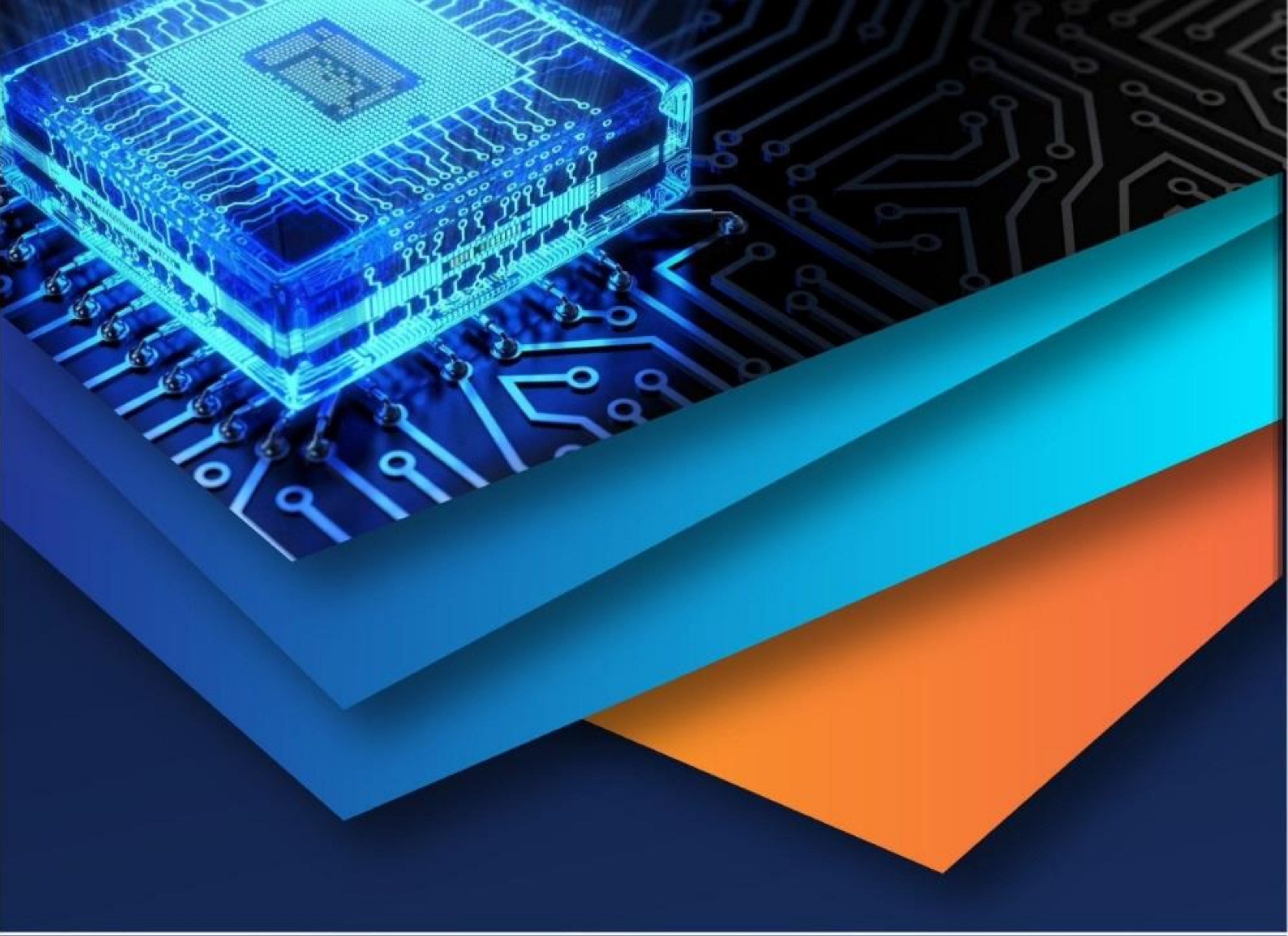

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