A Comparative Analysis of Feature Detection and Matching Algorithms for Aerial Image Stitching

Mohd Ismail Jolhip[1], Jacey-Lynn Minoi[1,2], Terrin Lim[2]
[1]*Institute of Social Informatics and Technological Innovations, Universiti Malaysia Sarawak.*
[2]*Faculty of Computer Science and Information Technology, Universiti Malaysia Sarawak.*
ismail.jolhip@gmail.com

***Abstract*—Features detection and matching are the essential processes in image mosaicing and computer vision applications. Our work intend to find descriptors that are obtained by considering all interest/feature points and its locations on images, and then form a set of corresponding spatial relations based on the interest points between images. Hence in this paper, we will evaluate and present the performance of a few detector-descriptor-matcher approaches on raw aerial images for stitching image purposes. We have experimented on Canny Edge Detector, SIFT and SURF approaches to extract feature points. The extracted descriptors are then matched using FLANN based matcher. Finally, the RANSAC Homography is used to estimate the transformation model so stitching procedure could be applied in order to produce a mosaic aerial image. The results have shown that SURF approach outperforms the others in terms of its robustness of the method and higher speed in execution time.**

***Index Terms*—Image Stitching; Interest Points; Feature Detection; Feature Matching.**

I. INTRODUCTION

Feature detection, feature extraction and matching process are essential processes and at the base of many image processing and computer vision applications. Its applications could be used to align images for stitching, and for object recognition. There are numbers of feature detection and extraction algorithms that have been researched. The development of feature extraction tasks continues to grow exponentially to build sophisticated imaging applications. All these applications require the presence of robustness on the extracted feature points on the images. Hence, attempts to achieve highly reliable matching results from a pair of images is a challenge for the most of feature detection and matching algorithms.

The suitability of the feature extraction and stitching approaches depends on the types of the image. Generally, images are variant of scale, illumination, orientation, noise, transformation and blurring, hence extracting and determining the corresponding feature points on each image are challenging [4]. Various methods are researched and developed to robustly overcome all these variants. At presently, existing feature extraction approach has been compromised between the robustness and the execution time, but the fastest method with best results in all conditions has not been achieved.

Comparative studies have been done to evaluate the performance of the feature extraction and image matching algorithms to create a panoramic image [11] [13]. In our paper, we will be analysing and discussing the performance of a few methods employed on raw aerial images and these images were captured using drones over unconstrained environment. The aim of the paper is to evaluate the robustness and the efficiency of the cost of time on the different approaches on the images.

We proposed to study the commonly used method, Canny Edge detector, as the base comparison approach, and a couple of scale and rotation invariant extraction methods, i.e. the Scale Invariant Feature Transform (SIFT), and the Speeded-Up Robust Feature (SURF). SIFT is an efficient way to solve scale changes of images, and it has high robustness and location precision. SURF is a speed-up algorithm of SIFT.

Based on these feature extraction methods, we detailed the stitching by building the correspondences of a set of aerial images, establishing the corresponding points and then generate a panaromic image. We proposed the Fast Local Approximate Nearest Neighbors (FLANN) and Random Sample Consensus (RANSAC) techniques. The details of these extraction and fitting algorithms can be seen in the next section.

II. LITERATURE SURVEY

Given a set of images, a common approach for stitching typically consists of three steps: feature detection, feature extraction and image matching. First, images are selected, and keypoints, or salient points in images are detected. Second, the regions content are extracted and local descriptors are computed using feature extraction algorithms. Finally, the point correspondences are computed using image matching algorithms by overlapping regions between images [1-3] to perform a stitching task.

There are various image stitching frameworks that address the early feature extraction and matching algorithms. Most of the developed algorithms worked well under certain image conditions. Invariants present a typical problem in these algorithms for consistent, accurate and fast feature matching.

Some research focused on the use of feature extraction algorithms to automatically mosaic images by employing SIFT [4]. Researchers [5] presented a comparative study of using SIFT and SURF algorithms in image registration. The results presented that SIFT could detects more feature points while SURF perform faster than SIFT algorithms. Authors in [6] discussed the combination of feature detector-descriptor in indoor images and then compared the performance of the algorithms. [7] did a comparative analysis SIFT and the traditional photogrammetric feature extraction methods and matching metrics by experimenting tests on images acquired by drones.

The commonly used feature detection, Canny Edge detection algorithm, was used in object detection, image