INTISARI

Proyek Akhir ini membahas proses identifikasi *tie-point* yang merupakan tahapan penting dalam pengolahan foto udara, khususnya dalam proses *image matching*. Masalah utama muncul ketika foto udara yang dianalisis memiliki tekstur rendah atau tampak homogen, sehingga algoritma *tie-point matching* seperti SIFT mengalami kesulitan dalam membentuk deskriptor dan menentukan *tie-point* secara akurat. Kesalahan ini disebabkan adanya kekurangan tekstur, skala, dan gradien pada gambar. Kualitas hasil *tie-point matching* sangat bergantung pada karakteristik citra input yang diolah sehingga *pre-processing* dengan teknik penajaman bertujuan untuk meningkatkan kontras lokal, memperkuat tepi (*edges*), dan memunculkan detail-detail halus yang sebelumnya tidak terdeteksi, sehingga menciptakan kondisi optimal bagi algoritma SIFT. Proyek Akhir ini mengkaji teknik penajaman citra pada foto udara menggunakan tiga metode filterisasi yaitu *Gaussian Blur*, *Guided Filter*, dan *Gabor Filter* guna meningkatkan kemampuan algoritma SIFT dalam mendeteksi *tie-point* pada objek bertekstur rendah.

Pelaksanaan Proyek Akhir dimulai dengan pengumpulan dataset foto dan akuisisi data fotogrametri terestrial yang berfokus pada objek *textureless* atau minim tekstur sebagai studi kasus. Data yang diperoleh kemudian diproses melalui dua *pipeline* tahapan yaitu dengan *pre-processing* dan tanpa *pre-processing*. Metode *pre-processing* menerapkan *Gaussian Blur* dan *Guided Filter* untuk mempertahankan kejelasan tepi objek serta Gabor Filter untuk mengekstraksi pola tekstur berdasarkan parameter frekuensi dan orientasi. Foto udara hasil *pre-processing* dan tanpa *pre-processing* selanjutnya diproses menggunakan algoritma SIFT untuk mendeteksi *keypoint*, membentuk deskriptor, dan menghasilkan *tie-point* sebagai dasar pencocokan foto udara. Proses berikutnya meliputi *image stitching* dan rekonstruksi model tiga dimensi dalam bentuk *point cloud tie-point*. Evaluasi dilakukan dengan menilai jumlah *keypoint* dan tie-point, tingkat akurasi pencocokan, waktu pemrosesan, serta kualitas hasil rekonstruksi yang dianalisis menggunakan statistik perbandingan antara dua *pipeline* untuk menilai efektivitas metode *pre-processing*.

Hasil Proyek Akhir menunjukkan bahwa metode penajaman dengan *Gaussian Blur*, *Guided Filter*, dan *Gabor Filter* mampu meningkatkan kemampuan *image matching* pada foto udara bertekstur rendah. Dari 25 pasangan foto udara yang diproses, 56 persen menunjukkan hasil yang lebih baik dibandingkan metode tanpa *pre-processing*. Secara spesifik, jumlah *keypoint* meningkat rata-rata sebanyak 33.249 persen, jumlah *valid point* meningkat sebanyak 26.618 persen, dan waktu pemrosesan menjadi lebih efisien dengan pengurangan 16.849 persen. Temuan ini menegaskan bahwa penerapan filterisasi sebagai tahap penajaman sebelum *image matching* menggunakan SIFT merupakan langkah efektif untuk meningkatkan kecepatan komputasi dan stabilitas hasil pencocokan fitur, khususnya pada foto/citra dengan objek *textureless*, sekaligus mendukung pengembangan teknologi pengolahan foto/citra yang lebih presisi dan efisien.

Kata kunci: *Image Matching*, *Textureless*, *Gaussian Blur, Gabor Filter, Guided Filter, Tie-point, Preprocessing,* SIFT.

ABSTRACT

This final project discusses the tie-point identification process, which is an important stage in aerial photo processing, particularly in the image matching process. The main problem arises when the aerial photos being analysed have low texture or appear homogeneous, making it difficult for tie-point matching algorithms such as SIFT to form descriptors and determine tie-points accurately. This error is caused by a lack of texture, scale, and gradient in the image. The quality of tie-point matching results is highly dependent on the characteristics of the input image being processed, so pre-processing with sharpening techniques aims to increase local contrast, strengthen edges, and bring out fine details that were previously undetectable, thereby creating optimal conditions for the SIFT algorithm. This final project examines image sharpening techniques in aerial photographs using three filtering methods, namely Gaussian Blur, Guided Filter, and Gabor Filter, to improve the SIFT algorithm's ability to detect tie-points on low-texture objects.

The research began with the collection of a photo dataset and the acquisition of terrestrial photogrammetric data focusing on textureless or minimally textured objects as case studies. The data obtained was then processed through two pipeline stages, namely with pre-processing and without pre-processing. The pre-processing method applied Gaussian Blur and Guided Filter to maintain the clarity of object edges and Gabor Filter to extract texture patterns based on frequency and orientation parameters. The pre-processed and non-pre-processed aerial photographs were then processed using the SIFT algorithm to detect *keypoint*s, form descriptors, and generate tie-points as the basis for aerial photograph matching. The next process involved image stitching and three-dimensional model reconstruction in the form of a tie-point point cloud. The evaluation was carried out by assessing the number of *keypoint*s and tie-points, the accuracy of matching, processing time, and the quality of the reconstruction results, which were analysed using comparative statistics between the two pipelines to assess the effectiveness of the pre-processing method.

The results of the study show that the sharpening method using Gaussian Blur, Guided Filter, and Gabor Filter is able to improve image matching capabilities in low-texture aerial photographs. Of the 25 pairs of aerial photographs tested, 56 per cent showed better results than the method without pre-processing. Specifically, the number of *keypoint*s increased by an average of 33,249 per cent, the number of valid points increased by 26,618 per cent, and processing time became more efficient with a reduction of 16,849 per cent. These findings confirm that the application of filtering as a sharpening stage prior to image matching using SIFT is an effective measure to increase computational speed and feature matching stability, particularly in photos/images with textureless objects, while also supporting the development of more precise and efficient photo/image processing technology.

Keyword: Image Matching, Textureless, Gaussian Blur, Gabor Filter, Guided Filter, Tie-point, Preprocessing, SIFT.