



Faculty of Electrical and Electronic Engineering Technology



**DEVELOPMENT OF DEPTH MAP RECONSTRUCTION
ALGORITHM FROM STEREO IMAGES USING LOCAL-BASED
TECHNIQUE**

UNIVERSITI TEKNIKAL MALAYSIA MELAKA

IZZAT BIN MOHAMAD SAUPI

Bachelor of Computer Engineering Technology (Computer Systems) with Honours

2022

**DEVELOPMENT OF DEPTH MAP RECONSTRUCTION ALGORITHM FROM
STEREO IMAGES USING LOCAL-BASED TECHNIQUE**

IZZAT BIN MOHAMAD SAUPI

**A project report submitted
in partial fulfillment of the requirements for the degree of
Bachelor of Computer Engineering Technology (Computer Systems) with Honours**



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DEDICATION

*I would like to dedicated and special thanks to
My beloved father and mother,
To my beloved family, my respected lecturer and fellow friends
And for the rest, might Allah have blessed you
Thanks for all the guided and support*



ABSTRACT

This project provides a method for solving the issue of correspondence when matching the stereo image using local-based techniques. This technique is called "Sum of Absolute Differences" (SAD). MATLAB software provides the tool. A map of disparities is produced through the block matching algorithm, Sum of Absolute Differences (SAD). For example, there are four basic steps in the stereo vision method for imaging the reconstruction. There are typically four phases to this. The distortion of the captured images from the camera lens is extracted first in the undistortion step. The next step is to adjust the distance and the elevation angle between the two camera images to determine the focal length and the epipolar axis, as presumed beyond. The comparison between the left and right image will be calculated in the correspondence stage and used to measure the map of disparities. This method is often known as being interoperable. This project was able to develop a stereo matching algorithm using the sum of absolute differences to do the depth map reconstruction from the proposed algorithm and a simple stereo algorithm that computes results comparable to the current state-of-the-art on the Middlebury benchmark.

ABSTRAK

Projek ini menyediakan kaedah untuk menyelesaikan isu surat-menyurat apabila memadankan imej stereo menggunakan teknik berasaskan tempatan. Teknik ini dipanggil "Sum of Absolute Differences" (SAD). Perisian MATLAB menyediakan alat tersebut. Peta ketaksamaan dihasilkan melalui algoritma padanan blok, Jumlah Perbezaan Mutlak (SAD). Sebagai contoh, terdapat empat langkah asas dalam kaedah penglihatan stereo untuk pengimejan pembinaan semula. Biasanya terdapat empat fasa untuk ini. Herotan imej yang ditangkap daripada kanta kamera diekstrak terlebih dahulu dalam langkah tidak herot. Langkah seterusnya ialah melaraskan jarak dan sudut ketinggian antara dua imej kamera untuk menentukan jarak fokus dan paksi epipolar, seperti yang diandaikan di luar. Perbandingan antara imej kiri dan kanan akan dikira dalam peringkat surat-menyurat dan digunakan untuk mengukur peta jurang. Kaedah ini sering dikenali sebagai saling boleh kendali. Projek ini dapat membangunkan algoritma pepadanan stereo menggunakan jumlah perbezaan mutlak untuk melakukan pembinaan semula peta kedalaman daripada algoritma yang dicadangkan dan algoritma stereo ringkas yang mengira hasil yang setanding dengan keadaan terkini pada penanda aras Middlebury.

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LIST OF SYMBOLS



LIST OF ABBREVIATIONS

<i>SAD</i>	-	Sum Absolute Difference
2D	-	Two Dimensional
3D	-	Three Dimensional



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CHAPTER 1

INTRODUCTION

1.0 Introduction

This chapter summarizes the procedure for finding the disparity mapping using the local-based approach known as the Sum of Absolute Differences (SAD). Besides, the problem's background and problem statements are explained next. Following the research's objective and main purpose, which is to investigate depth map reconstruction from stereo images using the Local-Based Technique.

1.1 Background

In finding correspondence between two input pictures, there is an issue with matching stereo. This is one of the fundamental issues of computer vision for a wide variety of applications and has thus been thoroughly studied in computer vision for many years.[1] Stereo matching is the process of determining which point in the right picture corresponds to which position in the left image. The disparity, which is the similarity in horizontal distances between those sites, A disparity map is a collection of all the disparity-related outcomes associated with a picture. This style of map is essentially a depiction of the scene's perceived profundity. As a result, inequality maps were employed to address challenges successfully.

There are three types of stereo matching techniques: area-based, phase-based, and feature-based. Due to the fact that SAD-based applications may be run directly on hardware, they are the most beneficial area-based techniques in real-time stereo vision. Since there are

only summaries and absolutism principles, the computations required in the tenure of design units are easily accessible. Simultaneous design units may be used to accommodate diverse sets of inequalities while still reducing computing time.

In general, at least two images are required for the reconstruction of an object; please consider the related points on these images and create a depth map. Several factors influence image quality, including illumination, object type, camera angle, and camera focal length. Many stereo matching algorithms are based on the constraints of similarities, epipolarity, consistency, continuity, and ordering and take the basic steps of matching cost calculation, matching cost aggregation, variance calculation, and refinement of differences.[2] The matching cost for the images on the left and right is measured by the disparity in grey values of the respective pixels.

Traditional stereo matching techniques, such as Sum of Square Differences (SSD) and Sum of Absolute Differences (SAD),[3] are built for simple scenes and are susceptible to light and noise variations. Normalized cross-correlation (NCC), on the other hand, can avoid noise better and does not affect light variants, but it is a computationally expensive technique. Stereo matching is all about locating the equivalent picture in the right image for each junction in the left image. The variance is the difference between all points in horizontal intervals. A disparity map is made up of all the possible disparity values within a picture. A road map is nothing more than a depiction of the scene's apparent size. While this method works well in images with no texture, it varies depending on the centralised sample pixel, so the resulting effects can be minimised if noise influences the central pixel.

1.2 Problem Statement

Computer vision is an important area of research.[4] This necessitates image collection, delivery, presentation, and comprehension strategies. Computer vision

approaches use a variety of mathematical methods to recreate a dynamic visual environment. One of the aims of computer vision is to describe the environment we perceive using one or more pictures and to reconstruct its features, such as light, color, and shape distribution. Stereo vision is a branch of computer vision that handles a significant research challenge: depth estimation is mapped using tridimensional point reconstruction.

A stereo vision system is comprised of a stereo display and two sensors positioned horizontally (one on the left and one on the right). Following that, the two pictures acquired concurrently by such cameras are analyzed to yield visual depth information. The objective is to identify the most efficient way of computing the differences between the two photos in order to chart (e.g., plot) the environment's correlation (e.g., disparity). A chart of inequality intuitively depicts the horizontally displaced pixels between the left and right pictures. Each year, new ideas and strategies are developed to handle this issue, with a focus on accuracy and efficiency.

1.3 Project Objective

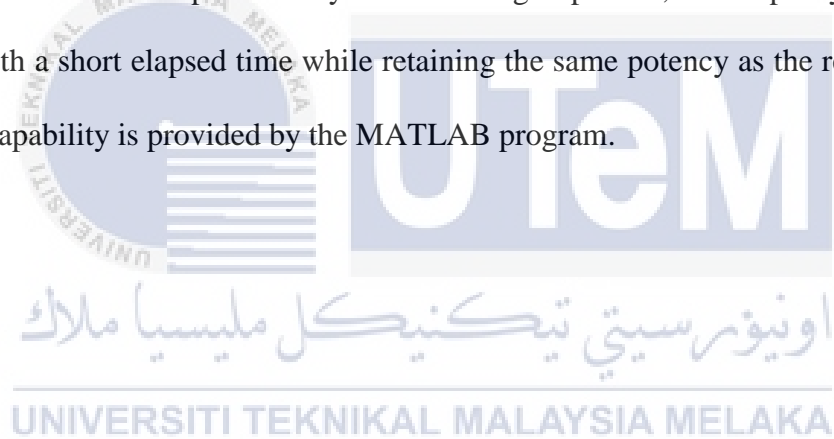
The aim of this project is derived from some analysis and a problem statement. This goal explained the aim of the project as well as its results. The following was mentioned as the goal:

- a) To develop stereo matching algorithm using Sum of Absolute Differences (SAD).
- b) To reconstruct depth map from the proposed algorithm.
- c) To analyze the performance of the proposed algorithm using Standard benchmarking evaluation system.

1.4 Scope of Project

Stereo matching's objective is to discriminate between two very close perspectives. When there are many picture noise and divergence disturbances, conventional stereo matching algorithms might result in erroneous matching. This endeavor to build divergence (difference) maps demonstrates a number of outstanding issues that remain unanswered in stereo vision systems. Numerous strategies are used to generate disparity maps.

The stage geometry produced by comparing pixels between two photographs is a frequently used method. By using edge information extracted from recorded stereo images, the SAD algorithm tries to alter the way disparity is computed. While the suggested technique uses a less computationally intensive edge operator, the disparity map may be rendered with a short elapsed time while retaining the same potency as the reconfiguration map. This capability is provided by the MATLAB program.



CHAPTER 2

LITERATURE REVIEW

2.0 Introduction

This section will analyze the literature review on which the necessary project information is based. It will cover both the previous project's concept and the theory required to complete this project. This research focuses on the algorithm that combines the Stereo and the technique that was used for this related project.

2.1 Related Work

2.1.1 Depth Estimating in Disparity Mapping

Several techniques and applications for estimating disparity maps have been proposed in recent decades. A system for monitoring trees and plants based on satellite photos is presented[5]. To generate disparity maps, stereo matching algorithms are computed from stereo satellite images. The estimated depth map of the level of trees and plants at the base points is inversely proportional to the level of disparity. The computation of the depth map was suggested using dynamic programming (DP) and block matching with energy reduction.[6]

[7] provides a pedestrian recognition system based on a complex map of inequalities for Smarter Vehicles. The dense map of disparities is used to improve pedestrian identification. The technique is divided into several phases: hazard area identification using information on road and column identification characteristics, pedestrian zone classification

using segmentation based on complicated maps with disparities, and pedestrian zone classification using ideal criteria.

[8] conducted an object tracking experiment in which a stereoscopic camera identifies objects, resulting in a low-cost method for target identification. Its purpose is to check and track things in a video frame over the duration of the film without prior knowledge of the items. Using a handful of stereo images, compute the disparity map. Instead, to detect object blobs, the disparity map is deeply segmented, and the appropriate region in the corrected stereo picture represents the item of interest.

A methodology [9] in a value multiples stereo disparity method is presented for the detection of sturdy obstacles for autonomous driving applications in outdoor scenarios using modern technologies and artificial knowledge. Reflections, texture degradation, and repetitive object patterns all have a significant impact on disparity calculation. This can cause wrong estimations, which can contribute to bias in techniques to obstacle detection that use the disparity map. To overcome this issue, instead of calculating the disparity of a single attribute, a new study is proposed that employs a wide range of possibilities for each location in the picture. These are chosen based on a mathematical analysis distinguished by the success of several metrics: the number and distance between the candidates based on the actual value of the discrepancy. It continues to generate a location map that estimates the obstacles.

However, [10] describe the many phases of depth estimation: first, function extraction, initial measurement, and final optimization of the predicted depth. [11] propose a new optimization method based on tight smoothing constraints achieved in a neural network. The goal is to offer rigorous softening of the output disparity map. The initial step in this investigation was to investigate the CNN design, known as DD-CNN, to see if the

inequalities were discontinuous. This approach was tested using real data from Middlebury's stereo data.

Then, using the [12] technique, they define an objective function that consists of a given term and a term designed to penalize disparities. Finally, a dual-structured network is constructed [13]. The system requires an input picture that goes through a finite number of layers before being standardized and linear corrected. In their studies, several filters were evaluated for each layer, and the parameters were exchanged between the two structures.

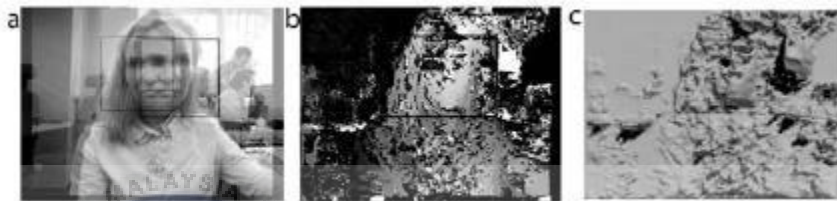


Figure 2.1 a) Combined images ; b) depth map ; c) 3D model of the depth map

2.1.2 Stereo matching based on SAD

Stereo vision is the most significant field of computer vision, and it provides many techniques for constructing the disparity map. The scene Depth may be derived from two different locations with certain displaced values combining various stereo images. The correlation values of the left image compared to the right image are the outcome of stereo matching. The disparity map or stereo matching is used to determine the depth map of a photograph.[6] It is quite difficult to compute the accurate depth map using the stereo matching function. In order to place more focus, [14] proposed a cross-scale design to improve cost averaging for effective stereo matching. [15] Recursive Edge-Aware Filters (REAF) allowed for accurate and accurate stereo matching.[2]

The disparities in global stereo matching are estimated by reducing the global energy feature. A method for detecting depth discontinuities in stereo images. Their method is capable of handling dynamic programming acceleration. A new stereo matching method