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IMPROVING MONOCULAR SLAM INVERSE DEPTH PARAMETERIZATION COMPUTATION TIME VIA SOFTWARE PROFILING AND PARALLEL MATRIX MULTIPLICATION

Mohd. Yamani Idna Idris[1], Hamzah Arof[2], Noorzaily Mohamed Noor[1]
Emran Mohd. Tamil[1] and Zaidi Razak[1]

[1]Faculty of Computer Science and Information Technology
[2]Faculty of Engineering (Electrical)
University of Malaya
Kuala Lumpur 50603, Malaysia
{ yamani; ahamzah; zaily; emran; zaidi }@um.edu.my

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Abstract. *Inverse depth representation is a parameterization method for feature locations which can handle initialization and standard tracking of a monocular SLAM. In this paper, software profiling is utilized to determine which section of program demands high processing computation. With the study conducted, it can be observed that one of the most time consuming process in inverse depth calculation is the computation of matrix multiplication. Inverse depth parameterization computation involves a great number of matrix multiplications. For instance, matrix multiplication is used for feature covariance and covariance prediction computations. The computation takes more processing time when the number of features applied to the depth estimation calculation is increased. Therefore, there is a need to design a fast matrix multiplication to accelerate the processing speed. FPGA has long been used to speed up many designs and applications due to their parallelism capability. For that reason, a design of parallel matrix multiplication using FPGA technology is introduced in this paper. The design will manipulate classical matrix multiplication algorithm into a parallel architecture with the aim of accelerating the execution time.*
Keywords: Matrix multiplication, Depth parameterization, Simultaneous localization and mapping (SLAM), FPGA

1. **Introduction.** Much attention in the progressing Simultaneous Localization and Mapping (SLAM) research was dedicated to the use of laser and sonar sensors. These sensors employ techniques such as Time of Flight (TOF), phase shift and Triangulation Based Fusion to build a map of an environment and at the same time use the map to compute its own location. One of the reasons behind the attention received is because these sensors have lower computational cost [1,2]. However, recent development shows that vision sensors are considered as a more attractive choice for SLAM since it has the capability to acquire large amount of information and mimic how humans and animals navigate. Vision sensors or cameras are also compact, accurate, noninvasive, well understood, cheap and ubiquitous [3]. As reviewed in [4], these advantages have encouraged many researchers to propose numerous approach and methodology using vision SLAM.

In monocular SLAM, a single camera is used to infer the depth of a feature by repeatedly capturing a ray of light from the feature to its optical center and translating them into a scene [5]. The monocular SLAM approach is fundamentally established by vision researchers from the field called Structure from Motion (SFM). SFM algorithms concentrate on reconstructing camera trajectory and scene structure from small image sets