

**ON REAL TIME STEREO IMAGE PROCESSING AND  
SONIFICATION METHODOLOGIES APPLIED  
TOWARDS SVETA**

**G. BALAKRISHNAN**



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**SCHOOL OF ENGINEERING AND INFORMATION  
TECHNOLOGY  
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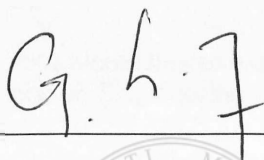
## DECLARATION

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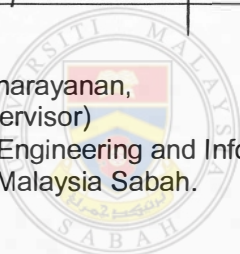
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## ABSTRACT

The main objective of this thesis is to develop a Stereo Vision based Electronic Travel Aid (SVETA) for visually impaired people. A hardware system is developed, which includes stereo cameras and stereo earphones molded in a headgear and Compact Computing Device (CCD) duly placed in a designed pouch. The stereo cameras capture stereo images of the environment. The captured images are processed and mapped to stereo musical sound patterns to the earphones. Earlier efforts mentioned in the literature towards single camera based vision aids, did not provide 3D information about the environment. Obstacle detection and its distance information are the significant features for comfortable blind navigation. In this thesis, to incorporate the distance information, stereo imaging techniques are proposed. Stereo image processing requirement in this application is critical and therefore conventional stereo matching methodology cannot be applied directly in this problem. The stereo image processing developed in this thesis, is designed to highlight the object properties from background and compute its distance in real time. Three methods are proposed for stereo image processing namely isolated object matching method, fuzzy relation method and improved area correlation method, whose merits and demerits are compared. The resultant image consists of 3D information of the objects with background suppressed. The resultant image is sonified to produce musical stereo acoustic patterns. Two methods are used for image sonification. The frequency of the sound depends on the height or elevation of the image pixels in the image plane. The amplitude of the sound depends on the intensity value of the image pixels. The left half of the image is sonified to left earphone and the right half of the image is sonified to the right earphone. The pleasantness of the sound is improved using octave frequencies and certain voice commands are also incorporated to alert the blind user about any impending obstacles. Blind and non blind volunteers were trained with the developed SVETA system and they were tested to identify the environment using SVETA. They were able to identify the objects based on its distance and other characteristics with the help of the musical sound. They were also able to navigate in indoor and restricted outdoor environments.

## ABSTRAK

### KAEDAH-KAEDAH PEMROSESSAN IMEJ STEREO DAN SONIFIKASI DALAM MASA SEBENAR UNTUK SVETA

Objektif utama tesis ini adalah untuk merekabentuk 'Stereo Vision based Electronic Travel Aid' (SVETA) untuk orang yang cacat penglihatan. Sistem yang direkabentuk mengandungi kamera-kamera stereo dan fontelinga stereo yang dicantumkan di dalam gear kepala dan alat komputer kompak (Compact Computing Device) yang diletakkan di dalam kantung yang direka khas. Kamera stereo merakamkan imej di persekitaran orang buta. Rakaman imej yang di proses dan ditukarkan kepada isyarat bunyi muzik stereo akan disalurkan kepada fontelinga stereo. Melalui penyelidikan penglihatan alternatif berdasarkan kamera terdahulu, informasi tiga dimensi (3D) mengenai persekitaran tidak dapat dikenalpasti. Pengenalpastian halangan dan informasi jarak adalah penting untuk navigasi yang selesa. Di dalam tesis ini, untuk menggabungkan informasi jarak, teknik pengimejan stereo telah dicadangkan. Keperluan pemprosesan imej stereo untuk aplikasi ini sangat kritikal kerana kaedah penyepadanan stereo yang konvensional tidak dapat digunakan. Pemprosesan imej stereo yang direkabentuk dalam tesis ini akan mengutamakan unsur-unsur objek di dalam imej dan komputasi jarak akan dilakukan dalam masa sebenar. Tiga kaedah yang dicadangkan untuk pemprosesan imej stereo adalah kaedah penyepadanan objek terasing, kaedah hubungan 'fuzzy' dan kaedah korelasi kawasan yang diperbaiki. Kelebihan dan kelemahan ketiga-tiga kaedah ini akan dibandingkan. Hasil imej akan mengandungi informasi tiga dimesi yang berkaitan dengan objek dengan latarbelakang yang terhad. Hasil imej juga akan ditukarkan kepada isyarat bunyi muzik stereo. Dua kaedah telah dicadangkan untuk sonifikasi imej. Frekuensi bunyi bergantung kepada ketinggian atau menaikkan piksel-piksel imej di dalam satah imej. Amplitud bunyi bergantung kepada nilai kecerahan piksel-piksel imej. Separuh imej dibahagian kiri akan disonifikasikan ke fontelinga kiri dan separuh imej dibahagian kanan akan disonifikasikan ke fontelinga kanan. Keselesaan bunyi dipertingkatkan dengan menggunakan frekuensi oktaf dan arahan audio akan digabungkan untuk memberi amaran kepada orang buta mengenai halangan di hadapan mereka. Sukarelawan-sukarelawan yang cacat penglihatan dan normal telah dilatih dan diuji untuk mengenalpasti persekitaran mereka dengan menggunakan SVETA. Mereka dapat mengenalpasti objek berdasarkan jarak dan sifat-sifat objek yang lain melalui bantuan bunyi muzik yg direka. Mereka juga dapat bernavigasi di dalam bangunan dan di persekitaran luar yang dihadkan.

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