Design and Implementation of Horn and Schunck Algorithm with BIST Architecture

Student's Name	**G. Upendra**	**VLSI (FT-2011)**
Academic Supervisor(s)	Abdul Imran Rasheed	
Industrial Supervisor(s)		

G. Upendra
g.upendra457@gmail.com
Ph. No: 0 97315 39287

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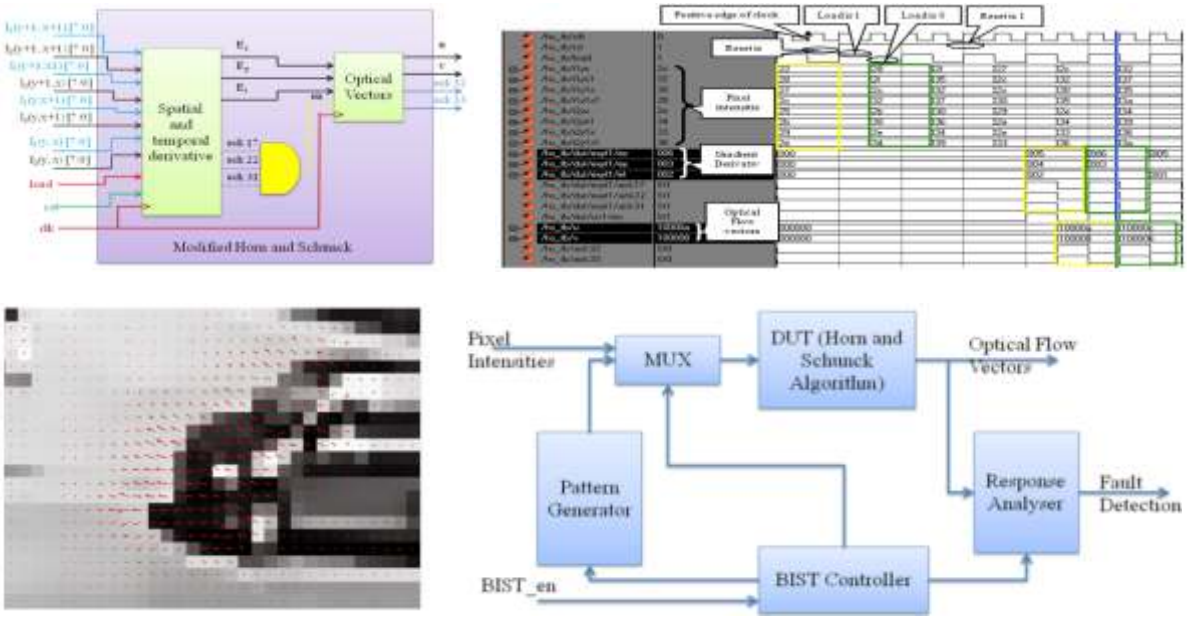
Abstract:

Optical flow has become integral part of computer vision based navigation and control system. Optical flow defines apparent motion of brightness pattern in an image sequence. High accuracy and fast computational speed are challenges for real time implementation of optical flow algorithm in UAV navigation system. Horn and Schunck is widely used optical flow algorithm for hardware implementation. In existing Horn and Schunck optical flow algorithm, more number of iterations is used to achieve high accuracy but it trades off with less processing speed and more hardware utilization.

In this work, an approach for modified optical flow algorithm has been proposed focusing on least hardware resource utilization and high computational speed with accuracy. In modified optical flow algorithm mathematical equations have been restructured to obtain high computational speed. In proposed optical flow algorithm more number of image sequences has been used and replaced iterations to obtain optical flow vectors. Modified optical flow algorithm has achieved high accuracy with less computational time. Piplined RTL architecture has been developed to achieve high performance.

In the proposed approach resource sharing between spatial derivatives has been done to reduce hardware utilization. For testing modified Horn and Schunck design, BIST architecture has been developed. Modified optical flow algorithm has been developed in MATLAB and compared with existing Horn and Schunck algorithm. Optical flow vectors have obtained in 3.39 sec using existing Horn and Schunck algorithm and in 1.54 sec using the modified Horn and Schunck algorithm. Hardware Implementation of pipelined RTL architecture of modified Horn and Schunck has been done on low power 65 nm technology at maximum operating frequency of 1 GHz. Proposed RTL architecture takes 1ns to compute optical flow vectors with 2291 logic cells utilization and total power consumption is 4.49 mW. Maximum operating frequency of modified Horn and Schunck RTL architecture with BIST is 997 MHz.



Modified optical flow architecture and simulation result