交通燈號偵測之晶片設計

Hardware Implementation of a Traffic Light and Arrow Recognition System

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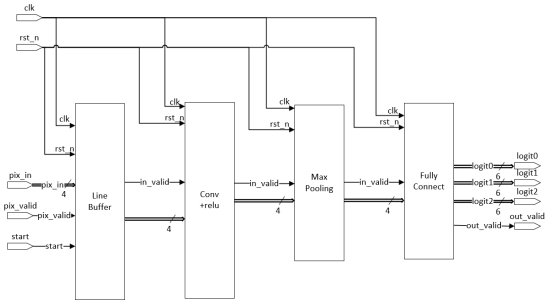
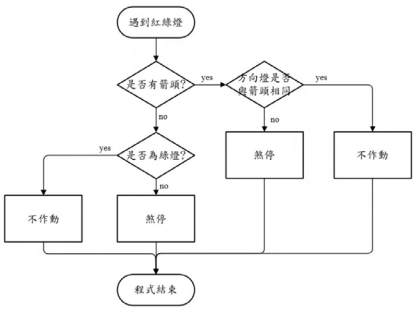
摘要

本專題提出一個基於卷積神經網路(CNN)實現的交通燈號偵測系統，利用影像辨識結合依據台灣常見的交通燈號組合所提出的行車邏輯進行模擬，並將其進行硬體實現。本次實驗採用的CNN架構是依據LeNet-5 CNN架構去進行層數優化並維持高辨識準確率，並搭配定點數模擬達到減少參數量節省硬體資源的效果。根據最後的實驗結果顯示本次實驗的軟體辨識準確率高達97.8%，而硬體實現後仍維持97.5%。

硬體架構圖



軟體判斷流程圖



軟硬體準確率比較

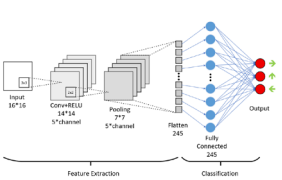
判斷 / 預期	go	break
go	386	12
break	6	320
準確率	97.5%	

硬體程式執行準確率

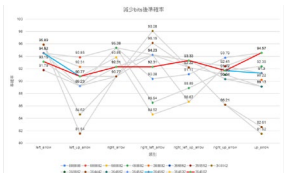
判斷 / 預期	go	break
go	384	14
break	2	324
準確率	97.8%	

軟體程式執行準確率

CNN架構&定點數模擬結果



CNN架構

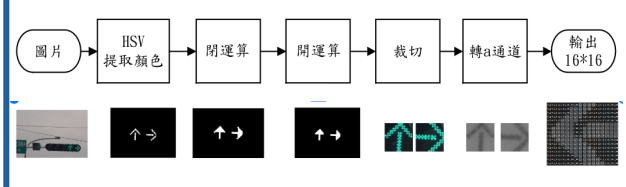


定點數模擬比較圖

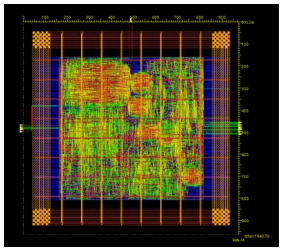
input	conv_weight	conv_bias	fc_weight	fc_bias	output
3	5	4	5	0	2

定點數模擬後各步驟小數點下位數

箭頭ROI裁切法



硬體實作結果



CNN 箭頭偵測晶片規格		
Technology		UMC 180 nm
Period		9 (ns)
Frequency		111.1 (MHz)
Core Utilization		70.146 %
Power	Core	6.76 (mW)
Area	Chip size	941555.01 (μm^2)
	Gate count	31515
Core VCC		1.62 V

參考資料

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