A16-287
Application Group

複合感測元件之行人偵測系統
Pedestrian Recognition System Combined with Compound Sensor

隊伍名稱　潛力股 / Diamond in The Rough
隊　　長　李俊德 / 雲林科技大學電子工程系
隊　　員　羅上堡 / 雲林科技大學電子工程系
　　邱泓達 / 雲林科技大學電子工程系

指導教授

蘇慶龍 / 雲林科技大學電子工程系

交通大學電子工程研究所博士，目前任職雲林科技大學電子工程系副教授以及典範計畫智慧節能創新產業中心副營運長。於 2004 年起任教於雲林科技大學電子工程系，2013 年獲得國家發明獎。

研究領域：車用安全影像系統、多核心嵌入式運算、3D 視訊處理、數位視訊壓縮。

作品摘要

隨著科技的日新月異，車輛已經是我們生活上的必要交通工具之一，但隨著車輛的普及也導致，行人在道路上的安全也越發值得注意。根據內政部 A1 類交通事故的統計數據顯示，肇事原因以駕駛人過失和未注意車前狀態的發生率最高。原因是行駛的過程中需要集中精神，長時間所造成駕駛人精神疲勞，容易發生意外。因此，近年來各大汽車原廠及駕駛者對於行車安全日漸重視，行車安全設備也提供越來越多的行車安全技術供選用，其中車用行人辨識技術更是重點功能之一，藉此提早讓駕駛者知道車前有行人的存在，並預防意外的發生。

行人偵測系統是藉由感測器的輸入，進行 ROI 之選取，找到可能為行人之區塊，再進行篩選可能行人區塊，並整合輸出訊號是否為有行人出現的系統，藉以告知駕駛者車前行人資訊。目前車廠上使用之行人辨識技術，通常都藉由多感測器或支持向量機（Support Vector Machine, SVM）分類器進行多階層的特徵比對方式來偵測，由於運算量問題須以開額外電路進行硬體加速，但 Tape-out 很難在行車上回收，故難以實現至實車上。多感測器的部分，則一感測器的選擇而有著不同優劣勢，如：各別環境偵測率高低與偵測的距離限制等。故本團隊建立一套複合感測元件之行人偵測技術（Pedestrian Recognition System Combined with Compound Sensor），透過環景光達的深度資訊以及光學攝影機高資料密度之特性，達到複合多重特徵，藉此強化影像特徵與型態，並改善單用光學攝影機所進行之 ROI 選取效能，讓演算法效率提升，提升本系統偵測率與偵測距離增長，讓駕駛人能更早知道前方行人出現的資訊。

本作品利用環景光達與光學攝影機把接收到的資訊傳至擁有異質多核心之 ARM 核心平台 NVIDIA Jetson TK1，將環景光達的資訊運用三維旋轉矩陣至鏡頭對應點，並依照距離與鏡頭畫面進行不同的 ROI 分析，再透過鏡頭畫面進行色彩分群、邊緣線偵測、梯度運算、頭肩樣本比對等多種方式，最後把篩選後的行人區塊顯示距離與相對應顏色來告知駕駛者。為了達至即時運算的要求，本系統透過 CUDA 的平行運算能力加速環景光達的大量浮點數處理以及篩選行人區塊時所需運算，以滿足即時處理的需求，其中包含色彩分群、邊緣線偵測、梯度運算、頭肩樣本比對等多種方式，透過多重特徵來實現之含距離資訊的複合感測元件之行人偵測技術。

圖 1. 感測器架設位置 / Fig 1. Sensor Setup Location

圖 2. 系統成果圖，包含早上、逆光、晚上 / Fig 2. Detection Result

Abstract

As the progress of technology and popularization of vehicles, vehicles have become one of necessary transportation equipments in our lives so we need to pay attention to pedestrians' safety on roads. According to Ministry of the Interior's statistical data, it illustrates the reasons of traffic accidents which the highest accident rates are caused by drivers' negligence and not paying attention to front car condition. Drivers need to concentrate during driving and long driving will make drivers have mental fatigue and cause accidents easily. Therefore, in recent years, vehicle factories and drivers start to pay much attention to driving safety. Vehicle safety equipments provide more and more vehicle safety technology to be applied and pedestrian identification technology of vehicle is one of the most important functions. This technology can prevent accidents from happening and thereby make drivers know the presence of pedestrians in front of vehicles ahead.

Pedestrian detection system processes ROI selection to find the block which may be pedestrians by input of sensor. Then system will sieve out possible pedestrian block and integrate output signal that whether there are pedestrians detected by system to inform drivers pedestrian information from front vehicles. Currently, pedestrian identification technology implemented by vehicle factories usually applies multisensor or support vector machine to detect by multi-level feature comparing method. Since the computation has to turn on additional circuit for speeding up hardware and tape-out is hard to be recycled in vehicles, system is difficult to be materialized in real vehicle. According to selection of sensors, there will be different strength and weakness, such as level of individual environment detection rate, restriction of detection distance and so on. As a result, our team establishes pedestrian recognition system combined with compound sensor. By information of 3D LiDAR and characteristics of optical camera's high data density, system can achieve composite multiple features and reinforce image features and types. Furthermore, system can also improve ROI selection effectiveness which only processed by optical camera. Consequently, drivers can know information about pedestrians from front vehicle much earlier through enhancing operational efficiency, improving system's detection rate and increasing detection distance.

Our work employs 3D LiDAR and optical camera to transmit signals to ARM core platform NVIDIA Jetson TK1 of heterogeneous multiple core. First, system applies three dimension rotation matrix to transmit 3D LiDAR's information to corresponding point. Second, system processes different ROI analysis in accordance with distance and camera screen. Third, system implements classifying color, detecting edge line, computing gradient, contrasting with head and shoulder samples and other variety ways by means of camera screen. Lastly, system informs drivers filtered pedestrian block which shows distance and corresponding color. For achieving real-time operation's requirement, system accelerates 3D LiDAR's bulk floating-point processing and operation of sieving pedestrian block by CUDA's parallel computation capability. CUDA's parallel computation capability includes classifying color, detecting edge line, computing gradient, contrasting with head and shoulder samples and other variety ways and achieves pedestrian detection technology of complex sensing element which contains distance information. Pedestrian detection technology of complex sensing element employs single developed version NVIDIA Jetson TK1 and doesn't employs additional hardware so as to reach low cost. Besides, system applies CUDA to process 3D LiDAR bulk floating-point matrix operation and employs complex features to reach 92% correct rate, detection distance 40meters and fps 20. Comparing to C2-270, our system can solve the problem of detection rate in the night and improve the restriction of detection range. Therefore, our pedestrian detection system is able to provide more comprehensive functions.