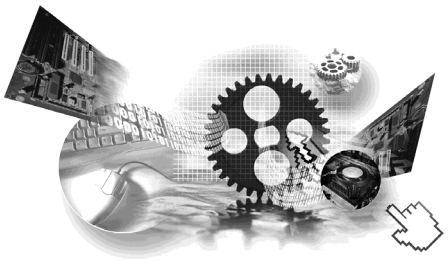

基於預估控制之自適應巡航控制決策設計

Design of an Adaptive Cruise Control Strategy Using Predictive Control

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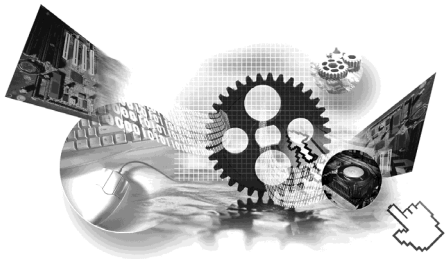
關鍵詞(Keywords)

・自適應巡航控制決策	Adaptive Cruise Control Strategy
・預估控制	Predictive Control
・Bellman's 最佳化	Bellman's Optimality
・行車安全	Driving Safety

摘要(Abstract)

近年來，隨著汽車數量增加和公路建設的擴大，交通事故問題日漸嚴重；根據世界衛生組織WHO統計資料顯示，全球每年有將近124萬人死於交通事故，且超過一半的死亡事故是因駕駛者疏忽分心所導致，且又以車對車追撞事故為最大宗。據Daimler Benz研究指出，駕駛者若能多0.5秒反應時間，則可避免60%的追撞事故，若能再爭取1.5秒，則追撞事故可減少90%。因此本文主要基於一預估控制方法發展一套智慧型自適應巡航控制決策，其主要利用Bellman's最佳化原理與移動區間方法預估出未來最佳的回授控制命令與最適的系統響應；其中二次目標函數的定義亦同時考慮本車與前車之最小追蹤誤差與加速度限制。本文所提出之控制決策不僅能依據前車速度並透過預估控制方式提前開始緩慢減速，有效減少煞車距離，增加行車安全性，此外更能透過減少急煞、急加油門的情況發生，達到節能駕駛之功效。最後並透過不同的行車情境進行功能驗證與量化分析。

Recently, as the amount of vehicles increasing and road construction expanding, the traffic



accidents have become a serious world-wide issue. According to the latest estimate of the Global status report on road safety 2015 from the World Health Organization (WHO), approximately 1.24 million people die in traffic accidents each year. More than half of the deaths were caused by the negligence of the drivers, especially in rear-end collision. A study by Daimler Benz showed that an extra 0.5 second early warning can avoid 60% of rear-end collisions, and 1.5 seconds will prevent 90% of them. An intelligent adaptive cruise control strategy based on predictive control approach was developed to predict an unavoidable collision and helped the drivers maintain a safe distance between themselves and vehicles ahead. The formalism was based on the Bellman's optimality principle and the receding horizon strategy to predict the optimal future feedback control command and the plant responses. Moreover, a quadratic cost function was designed that considered the contradictions between the minimal tracking error and the acceleration limits of the vehicle equipped with ACC. Hence, the characteristics of permissible following distance and acceleration command were expressed as linear constraints simultaneously. The developed control strategy not only effectively reduced the braking distance according to the speed of the preceding vehicle but also provided smoother acceleration and deceleration. It enhanced the driving safety as well as successfully achieved economy driving. Finally, the extensive simulations with various driving conditions were well performed to verify the proposed design and quantitative analysis.

1. 前言

由於近年來各國交通事故發生率日趨嚴重，因此在行車安全輔助相關之駕駛安全輔助(advanced driver assistance systems, ADAS) [1]應用近年來逐漸受到各車廠與消費者重視，從過去的被動安全輔助系統如安全氣囊、安全帶進階到主動安全輔助如車輛循跡防滑系統(traction control system, TCS)、前方防碰撞警示(forward collision warning, FCW)、車道保持輔助系統(lane keeping assist, LKA)、全周環場監視系統(around view monitor, AVM)、胎壓偵測系統(tire pressure monitoring system, TPMS)、自適應巡航控制(adaptive cruise control, ACC)等系統；皆是基於安全駕駛與用路人安全前提下，透過 ADAS 行車安全防護彌補駕駛者因感官判斷錯誤或技術不足所造成的疏失，減少危險或意外事故之發生。根據 104 年交通部根據警政署資料統計[2]得知，其 103 年追撞前車或遭到後車追撞的(rear crashes)交通意外所占比例達 15.03%，其追撞碰撞之二大主因是不專心與不安全之跟車距離，因此近年來各大車廠均已將自適應巡航控制系統作為選配裝備，透過該系統可有效輔助駕駛人保持車速、前車間距、減低駕駛疲勞、甚至達到自動駕駛之車輛控制應用，此外亦可達到節能的效果。此外值得注意的是 ACC 系統原僅侷限於高階汽車才擁有的配備，如今也已擴展到中低階市場，再加上政策

更完整的內容

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