資訊學院陳志成教授團隊運用磁力進行隧道內定位榮登國際頂尖會議 MobiCom 2021

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資訊學院陳志成教授師生團隊運用磁力進行隧道內定位的研究，近期於國際頂尖會議 ACM International Conference on Mobile Computing and Networking (MobiCom) 2021 發表論文。該會議每年接受率約 10%，為世界各國頂尖團隊競相發表之殿堂。自 MobiCom 1995 年開辦以來，陳教授團隊論文為第二篇所有作者皆為台灣團隊人員發表至該頂尖國際會議之長篇論文。同時團隊亦榮獲 MobiCom 2020 Student Research Competition 研究所組第一名，為全台首度於此國際知名競賽締造佳績。

陳志成教授表示，自駕車是世界未來的趨勢，目前自動駕駛系統所遇到的難題為進入隧道、多層道路等衛星定位失效的區域，則無法有效定位，沒辦法讓駕駛安心信任自駕系統。本研究利用磁場在衛星定位失效的區域進行定位，研究成果「MVP: Magnetic Vehicular Positioning System for GNSS-Denied Environments」於 MobiCom 2021 發表。

定位在自駕車上為不可或缺的功能，車子需要依靠它來辨認自己的位置，但衛星定位系統在隧道、停車場、地下道等地無法接收到衛星訊號，在這些場域中失去了自動駕駛的能力。此外，在有多層結構的道路中，衛星定位亦無法確定車子目前是位於高架道路上或是平面道路上，駕駛有可能接受到錯誤的指令，也讓車子的自動駕駛增添了很多風險。陳教授團隊研究中，使用車輛搭載磁力計量測磁場，並將測量的磁場與磁場地圖藉由該團隊所開發的演算法進行比較，可以在沒有衛星訊號的情況下進行定位，且能提供 5.14 公尺的定位精度。目前研究團隊已在兩個國家、56 座隧道和 23 座橋樑進行了 36 個月的大規模實際道路實驗，用 5,943 筆資料驗證了此系統的有效性，成功對這些場域提供正確的定位。此外，此系統可在智慧型手機上使用，不須高價格之定位設備，大大的降低了在無法使用衛星定位的情境下，精確定位的成本，是第一個使用磁場實現車輛於衛星失效區域精準定位的研究，也讓自動駕駛系統更加的完整與安全。

MobiCom 自 1995 年開辦以來，只有不到十篇論文有台灣研究機構作者在列，且大多數為與國外大學合作；陳教授團隊為第二篇所有作者皆為台灣團隊人員之研究，距前一篇 1999 年之發表研究，迄今已 22 年。此篇論文陳教授指導之王嘉誠博士生為第一作者，其餘作者為陳教授與陳教授指導之碩士班研究生。王嘉誠同學亦獲得 ACM MobiCom 2020 Student Research Competition 研究所組第一名，從 2005 年該比賽開辦以來，王嘉誠同學為台灣的大學第一次於此國際知名競賽中獲得研究所組前三名。

陳教授團隊表示希望這次的研究成果能讓自駕車於任何環境具備定位能力，讓自駕車系統更加完善，也讓用路人可以更加安心。陳教授團隊並開放所有資料於 http://wire.cs.nctu.edu.tw/mvp，供其他研究人員免費使用。

Professor Jyh-Cheng Chen and Team at CCS Positioning inside Tunnels via the Use of Magnetic Fields, Published on MobiCom 2021

Professor Jyh-Cheng Chen and his team conducted research on positioning inside tunnels via magnetic fields, which was published on MobiCom 2021 - The 27th Annual ACM International Conference on Mobile Computing and Networking, a prestigious international conference. The acceptance rate of MobiCom is typically around 10%. MobiCom is firmly established as the premier international forum for research in all areas of mobile computing and wireless and mobile networking. This was the second time that a full paper of all authors affiliated with Taiwanese organizations was published on MobiCom since its establishment in 1995. At the same time, the team took first place in the MobiCom 2020 Student Research Competition (Graduate category), marking the first time the Taiwanese team has ever won in this internationally renowned competition.

According to Professor Chen, self-driving cars will be the future of the automotive industry. One of the current challenges of the self-driving system is that it cannot effectively position where satellite positioning fails, such as tunnels and multi-level roads, thereby hindering drivers from trusting the self-driving cars. Therefore, this study used magnetic fields to position areas where satellite positioning fails. The achievement, “MVP: Magnetic Vehicular Positioning System for GNSS-Denied Environments,” was published on MobiCom 2021 as a full paper.

Positioning is essential for self-driving cars because cars rely on it to identify their locations. However, cars cannot receive satellite signals to perform self-driving in areas such as tunnels, parking lots, and underpasses. In addition, on multi-level roads, satellite positioning cannot determine whether the car is currently on an elevated road or a ground road. Drivers may receive wrong driving instructions. Besides, it will be risky when operating self-driving vehicles. Professor Chen's team used magnetometers to measure magnetic fields and compare the measured magnetic fields with the magnetic field map using an algorithm developed by the team. The results showed that the system could enable positioning without satellite signals and reach a positioning accuracy of 5.14 meters. The research team conducted large-scale road experiments in 56 tunnels and 23 bridges in two countries for 36 months and confirmed the system's effectiveness with 5,943 datasets, successfully providing precise positioning for these fields. Moreover, the system can execute on smartphones without expensive positioning equipment, significantly reducing the cost of precise positioning when satellite positioning is unavailable. It is the first research to use magnetic fields to achieve precise vehicle positioning in satellite failure areas, making the self-driving system safer.

Since the inauguration of MobiCom in 1995, less than ten full papers have listed authors from Taiwan research institutions. Most of them were collaborating with foreign universities. Professor Chen’s paper is the second full paper with all Taiwanese authors published on MobiCom. Twenty-two years have passed since the first one of all authors affiliated with Taiwanese organizations was accepted in 1999. In this paper, Chia-Cheng Wang, a Ph.D. student advised by Professor Chen, is the first author and the other authors are Professor Chen and his master’s students. Furthermore, Mr. Chia-Cheng Wang won first place in the graduate category in MobiCom 2020 Student Research Competition. Since the competition was launched in 2005, Mr. Wang has been the first student from a university in Taiwan to have won the top three in this internationally renowned competition.

Professor Chen’s team hopes that the research achievement may enable self-driving cars to retain positioning capabilities in any environment, make the self-driving car system more complete, and reassure road users about safety. The materials of Professor Chen's team are freely accessible to all at http://wire.cs.nctu.edu.tw/mvp.