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多節式輕型偵察車

Light-Weighted Articulated Rover

隊伍名稱　三隻毛毛蟲
Three Caterpillars
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研究領域

智慧型控制系統、人形機器人、服務型機器人、人工智慧、元啟發演算法

作品摘要

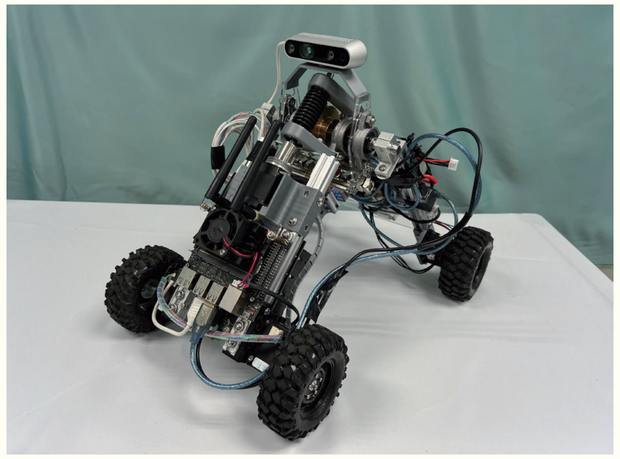
本企劃提出了一款擁有獨特機構設計的多功能輕型偵察車之雛型。車身分為兩節式，分別由兩顆主動輪帶動前行，前後兩節車體的中間輔以一顆機器人專用的智能馬達，搭配上蝸桿、蝸輪的機構，使其能夠任意地改變車輛的姿態，去應付各式崎嶇狹小地形。再搭配上深度感測相機和前後輪軸上的IMU資訊做車體姿態估計，讓車子可以全自動地跨越障礙物，或是讓使用者配合及時串流畫面自行手動操作，來獲取偵察探勘的資訊。全自動部分靠的是車載電腦計算車身當下收到的IMU資訊，配上深度感測相機回傳的障礙物距離資訊，選擇最佳策略去執行跨障或避障的動作。相對於以往其他越野偵察車，本車在體積、重量上皆有一定的優勢，成功地集結可控制性、適應性及可應用性於一身，輕量敏捷且不失強度。

控制性方面，目前全自動做到的項目有跨障和避障，前者能攀越障礙物，後者則能在遇到過大障礙時即時停止和轉向。馬達控制部分選用速度上的PD控制，不僅能減少車載電腦的運算量，亦能及時修正目標方向上的偏差。手動部分利用Wi-Fi通訊將深度感測相機的即時影像回傳給使用者，除能提供使用者環境的資訊，也能透過改變車體中央關節去獲取不同高度下的實地影像，使資訊更具全面性。

適應性方面我們可以透過切換全自動或手動模式，為其在崎嶇地形中帶來許多便利。例如在通訊優良的區域，搜救人員可藉由即時的影像回傳來操控偵查車深入崎嶇狹小的地方；而在通訊不良的地區，則能夠切換為全自動模式，不僅能透過車載電腦做策略的運算和即時避障，也能設定自動拍照頻率，獲得無通訊時的資料。

可應用性方面能結合不同場域使用，最大的特性歸功於能自主攀爬，若配上同時定位與地圖構建（Simultaneous localization and mapping）技術，將有機會做到跨樓層輸送。放在工廠內，能減少人資成本；放在公司內，能增加收送公文的便利性，減少時間成本；放在家庭內，不僅能做到遠端居家照護，也能在不同樓層間做到巡邏的效果。

目前實驗成果展現，已研製出多功能輕型偵察車的雛型，完成了上述所提的控制和適應性層面，可應用性功能則是還需與SLAM結合，雖尚未完善，但性價比非常高，具備廣泛應用場域的發展性。接下來，我們將更進一步開發多台多節式輕型偵察車隊系統。



圖一 全車實體圖

Abstract

This project designs and implements a prototype of a multi-functional lightweight rover with a special mechanism architecture, whose body is split into two parts. There are a steel worm, a worm wheel, and an intelligent motor in the middle of two main bodies, which enables the rover to change the attitude of the vehicle arbitrarily to cope with all kinds of rugged and narrow terrain. The rover is equipped with a depth camera and two IMUs to estimate the attitude of the vehicle, which allows the rover to automatically cross obstacles. Compared with other off-road rovers, the developed rover has certain advantages in size and weight. It successfully possesses controllability, adaptability, and applicability. Also, it is light-weighted, agile, and robust.

About controllability, the rover can climb over obstacles fully automatically when obstacles are not too large. PD controller is utilized to implement the motor speed control, which reduces the computational complexity. Wi-Fi communication is adopted to send the real-time image of the depth camera back to the user for manual control. The real-time images provide information about the current scene, and we can obtain more comprehensive information from the camera by adjusting the angle of the central joint.

As for adaptability, it brings a lot of convenience in crossing rough terrain by switching between automatic or manual mode. For example, when we have a steady signal, the rescue team can use the real-time image to control the rover to enter the narrow and rugged area. While the signal is weak, they can switch to fully automatic mode, where the on-board computer can select the best strategy according to the information obtained by IMUs and depth-camera.

In terms of applicability, the rover can be used in various kinds of scenarios. The biggest feature for this rover is its autonomous climbing ability. When it is equipped with SLAM technology, it will have the ability to achieve cross-floor transportation. In the factory, it can reduce the cost of human resources. In the company, it can increase the convenience of delivering official documents. For the application of family scenes, it can achieve remote care and so on.

The prototype of the multi-functional lightweight rover has been designed and implemented in this project. The controllability and adaptability mentioned above have been examined. As for the applicability, it still needs to be combined with SLAM technology. In the future, we are going to establish a fleet of multiple multi-functional lightweight rovers.

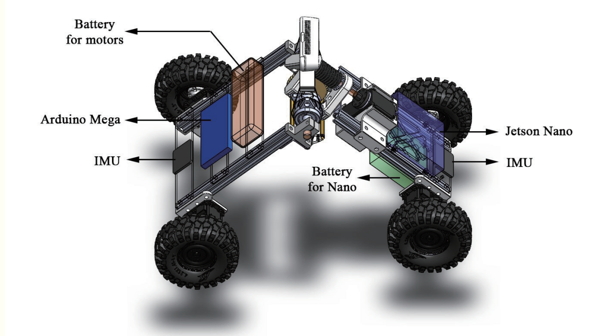


Fig. 2 Hardware configuration