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無人載具安全監控之無鉛壓電MEMS三軸加速規晶片系統開發

The Development of Lead-Free Piezoelectric MEMS Triaxial Accelerometer Chip System for Safety Monitoring of Unmanned Vehicles

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研究領域

電子陶瓷材料及元件、表面聲波元件、奈米光電材料及顯示器元件、微奈米壓印技術、有機發光元件

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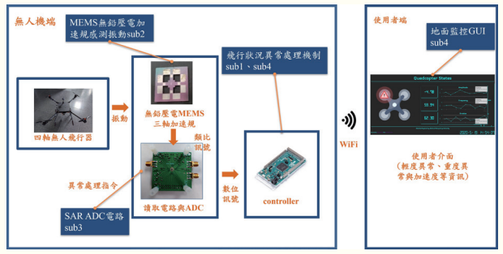
研究領域

混合信號積體電路設計、測試與可測試設計、電腦輔助積體電路設計

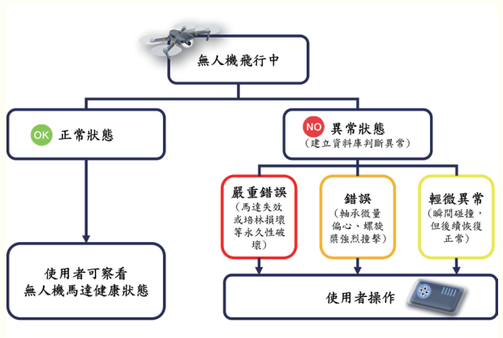
作品摘要

監控無人載具馬達之感測器需要同時具備體積小、抗雜訊能力優良、高靈敏度與低功耗等特點。目前市售的振動感測器因物理特性與體積等問題，較難應用於無人飛行載具之馬達監控。以目前的技術而言，開發無鉛壓電材料與MEMS製程技術整合且製備出MEMS無鉛壓電三軸加速規具有相當的難度，因此目前世界上沒有公司研發成功更沒有相關產品。壓電材料的特性高低，將會影響元件的效能，由於無鉛壓電薄膜之壓電特性普遍較低，無法製備成MEMS三軸壓電加速規。本團隊採用4元材料摻雜技術，成功將壓電薄膜的壓電特性提升5倍以上，在將此材料與MEMS製程技術整合並突破技術瓶頸，成功開發出無鉛壓電MEMS三軸加速規，該元件為全球市場首發之無鉛壓電MEMS三軸加速規元件，本元件不需要施加任何電源即可運作，屬於零功耗之元件。此外，本團隊成功設計出壓電感測器專用的低功耗SAR ADC複合式晶片，它具有電荷轉換、訊號放大與類比數位轉換器等功能，該晶片是目前全球最低功耗之ADC晶片。

本團隊所開發之項目可分為MEMS無鉛壓電三軸加速規元件、低功耗SAR ADC晶片、微處理器程式開發（訊號處理&資料庫建立）與使用者介面開發等四個部分，將這四個部分整合成無人載具馬達健康監控系統。本系統能將監控到不同的振動訊號特徵，存入資料庫並加以解析，目前已經成功判斷或預測馬達毀損之狀況以及載具遭受撞擊等異常現象，該系統提供載具操作者可立即判斷目前狀況，避免地面人生安全。期望該系統能提升各國政府對無人載具的信心，使得無人載具更快普及於市場。



圖一 系統運作架構



圖二 系統判斷異常架構

Abstract

In addition, the sensor for monitoring the motor of the unmanned vehicle needs to have the characteristics of small size, excellent anti-noise ability, high sensitivity and low power consumption. At present, the commercially available vibration sensors are difficult to apply to the motor monitoring of unmanned aerial vehicles due to problems such as physical characteristics and volume. In terms of current technology, it is quite difficult to integrate lead-free piezoelectric materials with MEMS process technology and prepare MEMS lead-free piezoelectric triaxial accelerometers. Therefore, there is currently no company in the world that has successfully developed and has no related products. The characteristics of piezoelectric materials will affect the performance of the components. Since the piezoelectric characteristics of lead-free piezoelectric films are generally low, they cannot be fabricated into MEMS triaxial piezoelectric accelerometers.

The team used 4-element material doping technology to successfully improve the piezoelectric properties of the piezoelectric film by more than 5 times. After integrating this material with the MEMS process technology and breaking through the technical bottleneck, the team successfully developed a lead-free piezoelectric MEMS triaxial accelerometer. This element is the first lead-free piezoelectric MEMS triaxial accelerometer element in the global market. This element does not require any power supply to operate, and is a zero-power consumption element.

In addition, our team has successfully designed a low-power SAR ADC composite chip for piezoelectric sensors, which has the functions of charge conversion, signal amplification, and analog-to-digital converter. This chip is the ADC chip with the lowest power consumption in the world.

The project developed by this team can be divided into four parts: MEMS lead-free piezoelectric triaxial accelerometer element, low-power SAR ADC chip, microprocessor program development (signal processing & database establishment) and user interface development. These four parts are integrated into the unmanned vehicle motor health monitoring system. The system can monitor the characteristics of different vibration signals, store them in the database and analyze them. At present, it has successfully judged or predicted the damage of the motor and the abnormal phenomena such as the impact of the vehicle. The system provides the vehicle operator to immediately judge the current situation. situation, avoid the safety of life on the ground. It is hoped that this system can enhance the confidence of governments in unmanned vehicles and make unmanned vehicles popularized in the market more quickly.