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Application Group

具室內與室外光能獵能器之能源自主無線傳訊系統

A Self-sustained Wireless Communication System with Indoor-light and Outdoor-light Energy Harvesters

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作品摘要

因應萬物聯網（IoE）概念的快速發展，無線感測節點必須具備低功耗、高效率、小體積之特性。本作品透過自行開發之四顆晶片為核心（室內、室外光獵能器、接收機、與發射機晶片各一），整合實現一個具室內與室外光能獵能器之能源自主無線傳訊系統。應用於智能居家之情境，各式家電產品可透過所開發之超低功耗無線感測裝置，經由遠端操作，而無線收發機所需消耗之能源，則完全由環境光源獵取，僅使用超級電容儲存電能，實現免電池、永久待機之遙控裝置。

為了滿足應用上的需求，接收端之接收機晶片，只需要 54 μW 之超低功耗，可不間斷地監測通道，並快速地反應通訊需求；室外光獵能器之轉換效率達 97%，可輸出之功率達 300W 以上，足以供應接收端電器之負載使用。使用於發射端之室內光獵能器，轉換效率達 93%，足以驅動 750 μW 之低功耗發射機晶片；所整合之遙控器體積僅 10.7×3.6×1.9 cm^3，便於使用者操作與攜帶，在室內光線充足下，平均 2 秒所獵取之能源即可負擔單次訊號傳輸，在傳輸速度為 200 kbps，實測傳輸距離達 8 公尺以上，成功驗證系統可行性，實現智能居家之目標與需求，並具備商品化之可行性。

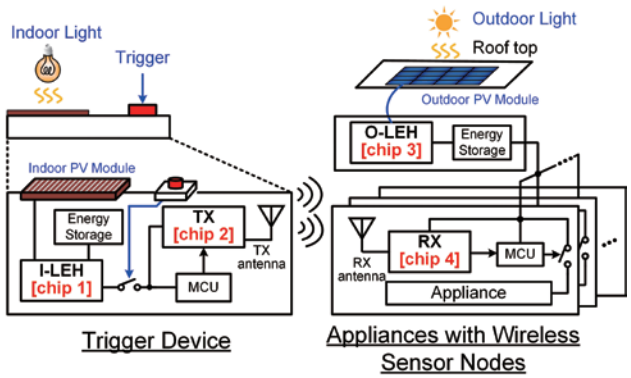

Fig 1. System architecture

Abstract

For the rapid development of the internet of everything (IoE), the wireless sensor nodes should be low power consumption, high efficiency, and small volume. As shown in Fig. 1, this work presents a self-sustained wireless communication system with indoor-light and outdoor-light energy harvesters. The four self-developed chips play the important roles in the system, i.e., indoor and outdoor light energy harvesters (I-LEH, O-LEH), transmitter (TX), and receiver (RX). In the smart home applications, all appliances with the wireless sensor nodes can be remotely controlled by the trigger device. The required energy is totally provided by ambient light harvesters. For cost reduction, the proposed trigger device uses a super capacitor to store the harvested energy and achieves a battery-less system with infinite standby time.

At the receiving site, the proposed always-on RX achieves an ultra-low power of 54 μW, enabling the prompt response to the communication request. The O-LEH performs fast transient response to the environment, and achieves a high conversion efficiency of 97% with an output power of over 300W. At the transmitting site, the I-LEH applies energy recycling technique and provides 15 mW with a high conversion efficiency of 93%. The TX consumes only 750 μW, thereby greatly reducing the demand of the PV-module. In conclusion, the integrated trigger device has small volume of 10.7×3.6×1.9 cm^3, which is easily operated and carried by the consumers. The average consumed energy per shot for the overall trigger device is 163 μJ, which can be harvested within 2s with indoor light harvester. The measured communication distance is up to 8 meters. This work satisfies the demanding specifications for smart home applications and has the great potential for commercial products.