Demo: Mobile Wireless Charging and Sensing by Drones

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1. INTRODUCTION

Wireless rechargeable sensor networks (WRSN) are promising platforms for a wide range of applications. Although sensors in a WRSN can be replenished by mobile wireless chargers over distance, challenging issues remain in many aspects. For example, stable wireless charging is hardly achievable in remote locations, and harvested energy on sensor nodes is usually insufficient to establish an ad hoc network with multi-hop communications [1].

We propose DSENSE, a mobile wireless charging and sensing platform using drones to alleviate the pain of energy delivery and data gathering in WRSN. The drone in DSENSE is equipped with a wireless charger which can power nodes in remote locations (e.g., embedded in walls, in soil), retrieve and forward sensor data packets to the cloud. This mobile charging and sensing method executed by drones is demonstrated to be effective and efficient – DSENSE successfully drives WRSN-based monitoring services in both a high-rise building and a large farmland.

2. SYSTEM DESIGN

DSENSE consists of three parts: energy transfer system, programmable drone platform and a cloud server. The system architecture is shown in Figure 1.

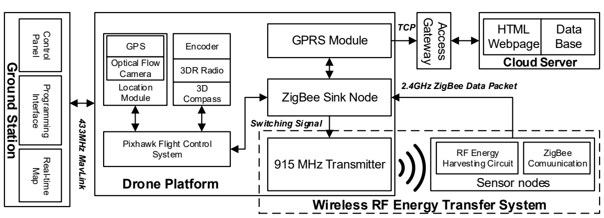

Figure 1: System architecture.

DSENSE adopts the electromagnetic radiation harvesting technology for energy delivery. Compared with magnetic induction, far field radiation-based charging achieves longer ranges and a high degree of freedom [2]. During the charging process, sensor nodes firstly harvest electromagnetic waves produced by the transmitter at 915MHz, and then converted the signals into continuous DC voltage through a chopper circuit. Once completed, the sensor data is transmitted to a sink node placed on the drone through ZigBee protocol, and then is forwarded to the cloud server using 3G/4G network. A trajectory file with node locations is generated and pre-downloaded to the drone. Nevertheless, users can also take over the control at any time through the 433MHz MavLink. To improve the flight and hovering stability, an optical flow camera and a duplicate image detection algorithm are proposed and implemented.

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3. IMPLEMENTATION

We fully implemented DSENSE on a Pixhawk open-source drone platform and conducted field experiments in two different scenarios (see Figure 2). In the first experiment, rechargeable sensor nodes were deployed on side walls of each floor of a 12-floor, 38m-height dormitory building to monitor the temperature, humidity, strain and displacement etc. In addition, we deployed seven sensor nodes in a large farmland in the north of Hangzhou to monitor soil temperature, moisture and illumination of crops. With a trajectory file downloaded, the drone flew to sensor nodes, one after another, charged them and retrieved the data. Received data was also displayed on a cloud web page, together with all flight information.

Figure 2: Field experiments.

We will demonstrate the rechargeable sensor nodes and the charging system on site, and show a short video featuring the motivation, system description and details of field experiments [3].

References

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