An Autonomous Aerial System for Air-Quality Surveillance and Alarm

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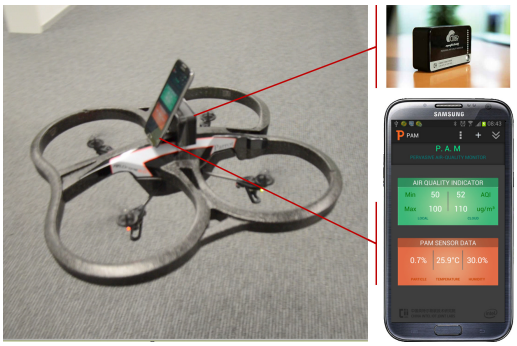

Figure 1: System Architecture

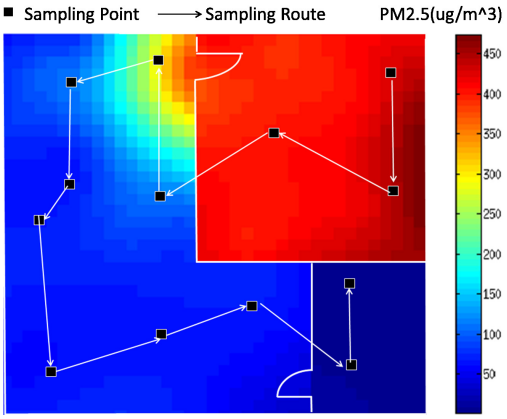

Figure 2: The real air-quality heat map in workspace

1. INTRODUCTION

The quality of air has deteriorated significantly over the past few years in some parts of the world. Air-quality monitoring, and $PM_{2.5}$ in particular, has become a hot research topic. In previous work [1], we designed a low-cost personal air-quality monitor to do this locally. In this demo, we use an autonomous aerial vehicle (drone) to monitor air-quality in larger areas, and to alarm civilians when air-quality is unhealthy using on-board sirens.

Instead of using many fixed monitoring stations which are expensive to install and maintain, the mobile aerial system can move easily around the location of interest and measure air-quality at low cost. Given a route, our system can autonomously fly and survey the area, while simultaneously provide audio feedback to civilians underneath by playing sounds corresponding to varying levels of air-quality.

Our mobile aerial system has many applications including city-wide air-quality monitoring, real-time feedback and alarm to civilians, and large-area smoke/fire detection and warning. In the future, we plan to add other sensors to our system.

2. SYSTEM OVERVIEW

As shown in Figure 1, our system mainly comprises of the following parts: 1) a custom-made portable air-quality monitor named miniPAM [1], which connects to a smartphone via bluetooth. 2) a smartphone with GPS and loudspeaker, which relays air-quality measurements from miniPAM and GPS coordinates to our server in real-time via 3G, and plays sounds according to air-quality levels. and 3) a quadcopter (drone), which can be directly controlled or pre-programmed to follow a route.

Our system takes full advantage of the flexibility of the drone and the portability of the miniPAM. Since air-quality across the city normally varies smoothly within a short time-window, our drone carrying miniPAM and smartphone can measure air-quality for a large area in a short period of time. Air-quality and GPS data are sent to our server in the cloud in real-time over 3G by the smartphone; this data is used to generate pollution concentration heat maps of the city. As a proof-of-concept, Figure 2 shows the real air-quality heat-map in our workspace, which can tell us a lot about the $PM_{2.5}$ situation. In addition, our aerial system broadcasts different warning sounds as air-quality changes in space, providing a direct audio feedback to occupants.

3. DEMONSTRATION

In this demo, we will setup a small area with a smoke source (incense) and an air-purifier, which create a gradient in particulate matter concentration. Our mobile aerial system will fly inside this area and send real-time data to our computer. Visitors will be able to see the real-time air-quality values and heat-map on a screen. Visitors will also be able to directly control the drone.

4. REFERENCES

[1] X. Jiang, J. Jia, G. Wu, and J. Z. Fang. Low-cost personal air-quality monitor. In *Proceeding of the 11th Annual International Conference on Mobile Systems, Applications, and Services*, MobiSys '13, pages 491–492, New York, NY, USA, 2013. ACM.