

Crowd-Aware Space Monitoring by Crowdsourcing a Micro QA Task

Yi-Ching Huang and Jane Yung-jen Hsu

Graduate Institute of Networking and Multimedia
Department of Computer Science and Information Engineering
National Taiwan University
{d00944010, yjhsu}@csie.ntu.edu.tw

Abstract

Effective space monitoring helps improve utilization of seminar rooms in the work place. This paper presents CrowdButtons as a simple solution to real-time space monitoring by crowdsourcing. CrowdButtons are tangible reporting devices designed to collect room status data from passersby. Anyone may participate in the micro QA task instantly by clicking a button, while the dashboard displays real-time room status as well as visualization of space usage patterns over time.

Introduction

Properly schedule meetings to a limited space is a challenge. We should satisfy the time needs of a group of people and allocate the selected time slot into an available meeting room. However, meeting schedule is not always static. It is constantly changing over time. For instance, in a university, the prior schedule is used to schedule regular meeting. But, there are many temporary meetings or modified schedule happening anytime. They use post-it to make a reservation (see Figure 1). In addition, available rooms are often located in different place. It's no easy way to check whether the room is available. Thus, knowing the actual use of space can help for planning a meeting, especially for an ad hoc meeting or adjusting schedule by a conflict.

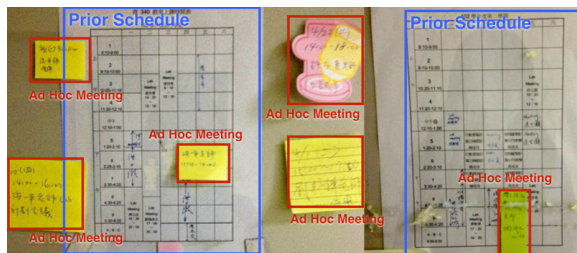


Figure 1: Prior schedule and ad hoc meeting reservation

Identifying activities in real world is difficult for computer. The same high-level activity may be performed in various ways by different people in different context. Traditional sensor-based activity recognition demands an full

Copyright © 2014, Association for the Advancement of Artificial Intelligence (www.aaai.org). All rights reserved.

infrastructure which incorporates multiple sensors for real-time sensing the environment, large database for storing time sequence data, and intelligent software for reasoning, learning and inference (Yang 2009). In contrast, human is able to recognize activities well based on commonsense knowledge and high-level reasoning ability.

In the paper, we introduce a crowd-aware monitoring mechanism which allows occasional crowds to report room activity by a tangible device in one second. The monitoring dashboard presents the real-time room status to help people seek the available space and show the long-term usage pattern for deeper understand the space utilization.

Crowd-Aware Space Monitoring

Figure 2 shows the proposed crowd-aware space monitoring system. The buttons offer an easy opportunity for any passerby to report the current activity in the room, and the dashboard presents time-indexed usage and room status as predicted by simple majority from data collected.

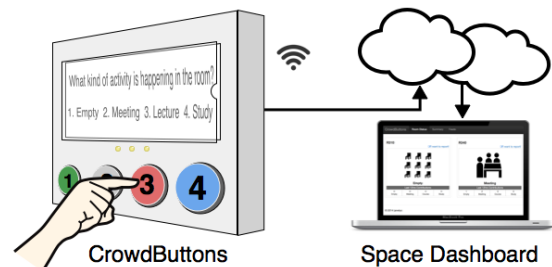


Figure 2: The crowd-aware space monitoring system.

Collecting Room Status by Crowd

Careful design of task, location and incentives is required to successfully engage people to help us identify the room status.

Micro QA Task Inspired by twitch crowdsourcing (Vaish et al. 2014) and communitysourcing (Heimerl et al. 2012), we encourage people to make small contributions by answering a simple multiple-choice question as shown below.

- Q: What kind of activity is happening in the room now?
- A: 1. Empty 2. Meeting 3. Lecture 4. Study

Crowd Reporting Device We developed the CrowdButtons, a physical reporting device that allows passersby to report the room activity in an instant. Each device comprises one customizable question area, four colorful buttons numbered 1 through 4, three LED lights, together with an Arduino Yún microprocessor. The CrowdButtons are deployed in common areas with many people passing by on a regular basis. As a person can easily recognize the activity in the room, anyone can contribute by pressing a button and the data will be submitted via WIFI to the server. The LED lights provide visual feedback on reporting progress.

Space Dashboard

The dashboard is designed for presenting space usage data. We use simple majority to decide the current room activity within a time interval. The most possible answer among multiple candidates is selected by referring to the prior schedule. If there is no report for a while, we assume the room to be empty. Otherwise, the crowd data are aggregated into hourly, daily and weekly reports. The detailed history may be filtered by event type or location. We use multiple and stacked bar chart to visualize the time-based data for better understanding of the long-term trend.

Pilot Experiment

We conducted a pilot experiment in a university and collected the crowdsourced data from CrowdButtons, ground truth data from 4 volunteers and prior schedule from reservation calendar.

From March 20 to April 6, 2014, there are 584 contributions from CrowdButtons with very good data coverage as shown in Figure 3 and Figure 4). We are able to observe the correlation between the number of people and contributions. We collected only 41 ground truth data from the recruited volunteers during the same period, which indicates that unpaid volunteers made relatively few contributions with poor data coverage.

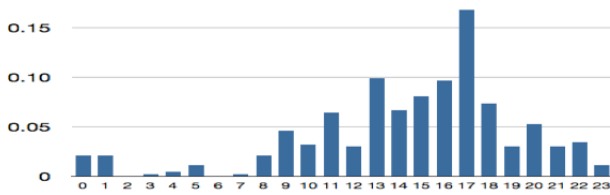


Figure 3: Average hourly contribution.

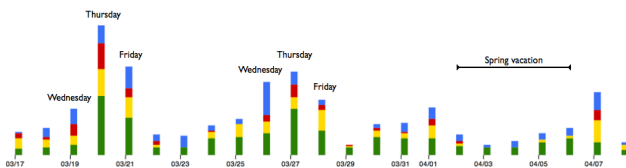


Figure 4: Daily contribution.

Preliminary results suggest that crowd data are more effective in capturing actual space usage than prior schedule.

As summarized in Figure 5, crowd data performed competently in predicting room status with frequent reporting. Instead of jumping to the wrong conclusion as prior schedule, incorrect predictions are avoided with the admission of missing data from the crowd.

	R340		R324		R310		All	
	Crowd	Schedule	Crowd	Schedule	Crowd	Schedule	Crowd	Schedule
Correct	43.75%	31.25%	50%	42.86%	27.27%	45.45%	41.46%	39.02%
Incorrect	18.75%	68.75%	7.14%	57.14%	0%	54.55%	9.76%	60.98%
Missing	37.5%		42.86%		72.73%		48.78%	

Figure 5: Pilot experiment results

Conclusion and Future Work

We designed and deployed a crowd-aware space monitoring system in a university department. The results show that crowd data can effectively capture the actual space usage, outperforming prior schedule. It is interesting to observe that the building is always half empty and the unexpected empty situation happens very often (see Figure 6).

A successful system relies on active participation of people for reporting room activity. We plan to make the CrowdButtons more interactive to encourage sustainable contributions from the crowd.

	R340	R324	R310	All
Empty	46.15%	58.33%	50%	51.43%
Unexpected Empty	66.67%	28.57%	80%	55.56%

Figure 6: Half empty situation

Acknowledgments

This work is supported in part by National Taiwan University, Intel Corporation and Ministry of Science and Education under Grants NTU103R7501, NSC102-2911-I-002-001, NSC 101-2627-E-002 -002 and MOST 103-3113-E-002-008.

References

- Heimerl, K.; Gawalt, B.; Chen, K.; Parikh, T.; and Hartmann, B. 2012. Communitysourcing: Engaging local crowds to perform expert work via physical kiosks. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '12, 1539–1548. New York, NY, USA: ACM.
- Vaish, R.; Wyngarden, K.; Chen, J.; Cheung, B.; and Bernstein, M. S. 2014. Twitch crowdsourcing: Crowd contributions in short bursts of time crowd contributions in short bursts of time. In *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, CHI '14. ACM.
- Yang, Q. 2009. Activity recognition: Linking low-level sensors and high-level intelligence. In *Proceedings of the Twenty-First International Joint Conference on Artificial Intelligence (IJCAI '09)*.