House Diary: a Digital Home Data Monitoring and Visualization System

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Problem Definition

With the development of modern computer technology, people nowadays have unprecedented number of choices to gather the information created by the actions inside or around their houses, such as video recording, motion detecting, temperature or sound monitoring. While many smart home monitoring systems are able to record and store the data under time sequence, most of them keep the data separately. This makes people in the house less likely to review the data, since it consumes much time and effort. Smart video cameras can store the surveillance video continuously, but people might not willing to watch the content, and research also indicates that people might feel uncomfortable to have all their movement at home recorded. If users purely want to know whether their family members or pets were at home at a certain time, motion sensors might more favorable than cameras.

Other types of information, such as the sound, light, temperature or power consumption of a house, are rarely tracked based on the time. Although they are less expressive than the video footage, combining and comparing different types of data might be enlightening and interesting to common people, as that can be seen as the life log of the house. However, it is hard to find an implementation that successfully visualized those data in common houses. It can be intriguing if a device can blend in the household environment and visualize information from multiple source in the house in an artistic way.

Motion detectors can be used not only as a way to detect intruders of the house, it can also be used to track the movement status of the residents. As we known that sitting in front of the computer or TV are usually not healthy for people, it is possible that motion detectors can track residents' motion in the room and notify them when they have sat too long.

Related research

Figure 1. Laurie Frick's Pokey Red is a physical visualization of sleep data over a month

Figure 2. Emoto: Visualizing the global response at the London 2012 Olympic Games on Twitter

Combining different sensors in surveillance has become an evolving research area [2]. Johns Hopkins provided a method to design such multimedia surveillance system, which addressed the problem related to deployment of multiple sensors [3]. Efforts were also made to address the issue about coordination of multiple video camera. However, less researches explore dimensions of the representation of surveillance data around the house. Eun Kyoung Choe and Sunny Consolvo, demonstrated that people would not want to be recorded at home through an anonymous survey. This indicates the importance of the use of sensors and the approach of data visualization.

Except the purpose of home surveillance, there are other reasons for deploying sensors around the house. Research study around home system is another reason. Jennifer Beaudin and Stephen Intille described the problems and solution they found when using ubiquitous sensors for data collection in real homes [4]. Their core kit contained a thin wire reed switch, a magnet and a storage board with coin battery, which was fixed with physically manipulated object around house to record the actions. Additionally, they also included infrared beacons on the ceiling to detect the position of the user who wear a receiver. This paper defined problems around such tool kit for study purpose, such as the visibility, attachability, the installation and so on.

Self-reflection is another important issue around the activity tracking topic. This issue of how technology should be designed to support people's reflection has been raised and discussed [5]. Most of reflection and awareness technology in HCI have been focused on affective system, which reflect the emotion and feeling, such as EmoteMail [6], affective diary [7], or Affector [8]. There are also discussion and researches related to reflection of body physiology, movement and behaviors. For example, Enhancing Self-Reflection with Wearable Sensors [9], Personal Informatics in the Wild: Hacking Habits for Health & Happiness [10], And Footprint Tracker [11]. However rare research mentioned the reflection about the house. Combining the surveillance system and data visualization to contribute the reflection of our home, could be an interesting and valuable topic.

We are considering visualizing the home data in physical form. There are various physical forms presenting periodical data to emphasize the reflection. The studio NAND has presented EMOTO, which use 3D physical data sculpture to visualize the global response around the London 2012 Olympic Games on Twitter [Figure 2]. In other work, Laurie Frick demonstrates her daily activities and nightly sleep data with 2D ink and watercolor drawing [Figure 1]. And the Physical Visualization website [http://dataphys.org/list/] also shows a list of physical data visualization examples.

On the whole, we realize that discussion related home surveillance system less focused on the expressions of its data, which however have rise a reasonable research interest.

Proposed solution

Our group believes that based on what we have learned in this course, it is possible to build a system which collects one or several types of data from sensors, then records and presents the data with a less intrusive output. We think users can benefit from looking at this output to learn more about what has happened recently. As pet owners can check how was their pet doing along at home; tenants can check how the public space and utilities are used; families can share more detailed information with each other and know deeper about the house. Since the data is transmitted through the internet, when the sensors separate from the output, users might able to see the status of their house or share it with other people.

Implementation

As Figure 3 shows, we are thinking about using several internet-enabled micro-controllers with sensors to monitor the house and send the data to a central micro-controller which controls the output system. The output system is in charge of visualizing the data under timely order. As we are inspired by the electrocardiograph device, our current design it to build the output system with several colored pens controlled individually moving on a roll of paper or a plate of paper. Other materials will be considered if possible. If pen heads are moving in a circular motion, it might be also used as a wall clock, which the hour hand is drawn on the paper with colors. But this will require users to change the clock face paper each 12 hours after on circle is completed. Otherwise, if the paper is going from one roll to another, the drawing can be kept longer than a day.

Currently, we are going to attach micro solenoids to a 3D printed arm which controls the movement of color

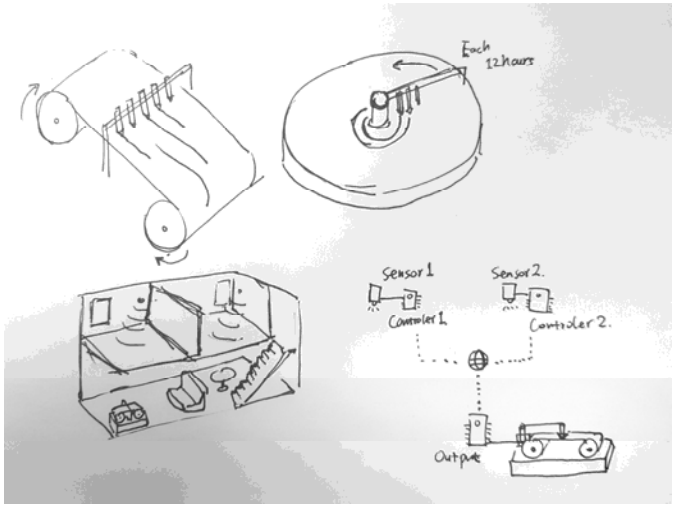

Figure 3. The design of the system (below) and the drawing output (above)

pens. A set of gears will be set for moving either this arm or the paper base under a timed order. Based on our last project, the motor and the control board are capable of providing strong torque in a very low speed. We also have gained experience on controlling multiple magnets with integrated circuit. The basic moving mechanism can be either close to the Linear Clock or the Arduino clock v.2.0. We will determine the best implementation based on our project's need. Since this system is designed to work indoor at home, it should be better working with Wi-Fi enabled microcontroller. We plan to keep using Particle Photon because it is small and we have learned a lot about how to develop program on this platform. The data collection will be accomplished with a sensor such like the PIR Motion Sensor for sparkfun.com, a Photon, a power source

such like a Lithium Ion Battery and some serve circut. Using the cloud service, the Photon in the output system can easily subscribe multiple information source from other Photons.

We are still discussing and finding a better way of implementing our concept, more interaction might be added if time permits.

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