MakerView: An integrated camera-monitor network for promoting collaboration in educational Makerspaces

Samuel Woolf, Ethan Danahy,
CEEo, Tuft University, Medford, MA, USA

Abstract - MakerView, a new technology development from Tufts University, utilizes an integrated network of cameras and monitors to promote participation, collaboration, and evaluation amongst educational Makerspaces. Previously, these spaces have functioned in isolation, which is a juxtaposition to the general Makerspace ethos, as the Maker community is often the pinnacle of collaboration. By providing a glimpse into the everyday happenings of these spaces, MakerView has the potential to greatly increase participation, both in person and virtually, in these Makerspaces. The MakerView project is comprised of three key technical elements: remote camera nodes that can easily be installed anywhere, strategically placed TV monitors that give an observer a window into a space, and a central web-server and user-interface for system coordination. Leveraging low-cost Wi-Fi enabled microprocessors, MakerView utilizes a cloud based network, connecting previously disjoint spaces, projects, and communities.

Keywords: Makerspace, collaboration, community, Internet of things, education

1 Introduction

In a world that is becoming increasingly connected, it is important to leverage new technologies to support collaboration. Makerspaces, which pop up in schools, libraries, and businesses worldwide, are a prime example of twenty first century collaboration. They are hotbeds of human to human idea sharing, skill teaching, and product development [1]. MakerView enhances the incredible human centric benefits of Makerspaces, using a connected IOT network to promote education, collaboration and participation.

2 System Overview

MakerView has a clear goal: improve the inherent collaborative and educational benefits of Makerspaces by leveraging the capabilities of low-cost, internet enabled technologies [2][5]. MakerView strives to use visual and contextual information to virtually connect these spaces, thus bolstering their appeal and utility [9]. We believe that by pushing pertinent information to participants, we can passively enhance user behavior, increasing the benefits of makerspaces for current makers, and increasing participation among potential makers. Additionally, moving the modern Makerspace into a more public view has the potential of furthering collaboration and education [3][4].

2.1 Technical Implementation

On a conceptual level, MakerView is comprised of three key elements; MakerView Nodes, MakerView Access Points, and the MakerView Server. First, a Node is comprised of an internet enabled camera and can be installed in any room around a campus. These units have been specifically designed for easy setup, so one can dynamically add any number of camera Nodes to a MakerView network. Second, Access Points take the form of connected TV monitors that are installed in strategic locations around a campus. By displaying a series of images and videos pulled from the MakerView cameras, these ‘digital windows’ give a peek into Makerspaces, motivating a casual passerbyer to engage in the growing community. Third, the MakerView Server houses a repository for the Camera Node data, and pushes new content to a central web interface where users can access all of the information. The website view provides users with real time Makerspace data as well as historical information catered to researchers and management.

![Figure 1. A diagram displaying the MakerView system design, highlighting Camera Nodes, Access Points, and joint Camera-Monitor nodes. The data is sent to a cloud storage server, which, in turn, pushes new content to the web interface.](image-url)
MakerView’s current implementation focuses on easy, low cost scalability, maximizing the use of off-the-shelf components and reproducible designs. Each Camera Node is inexpensive and can be quickly installed. Comprised of a Raspberry Pi, a PlayStation Eye camera, and configurable software, a new Camera Node costs under $50 and requires less than 15 minutes of setup time. Similarly, a new Access Point is composed of a TV monitor connected to an internet enabled computer (the Tufts MakerView implementation uses a Raspberry Pi). These monitors constantly display an Access Point specific website page, which includes intelligently compiled content, determined by both Access Point location and software configuration (i.e. easy to include bus schedules, announcements, etc.). Both the Camera Nodes and the Access Points have been strategically designed to run on the same core architecture. Thus, when adding another physical component to the system, one can install either a freestanding Camera Node or Access Point, or combine the two into a multifunctional station. The data is stored on the cloud via an on campus server, running a version of the free, open source cloud storage software, OwnCloud [10].

Figure 2. An image of the MakerView’s web-interface front page. The website allows the user to see the current status of a community’s Makerspaces.

3 Initial Impact

A prototype of the MakerView system has been implemented on the Tufts University campus, and is currently running, connecting spaces and collecting data. The university supports a variety of Maker facilities spread across the campus, creating a spatial divide that affects how makers use the spaces. Often a student will simply head towards the geographically closest MakerSpace without even considering the benefits (different tools, different people) that the other MakerSpaces could provide. By installing MakerView in just two of the spaces on campus, students now have a better understanding of the full Maker Network, viewing it as a conjoined service as opposed to autonomously functioning spaces. This connection has the potential to boost both interpersonal collaboration and space utilization. Now, we are in the process of scaling MakerView, first to the other spaces on campus, and then to other institutions. As it scales, the true collaborative and educational benefits of this technology begin to emerge.

Already in this nascent form, MakerView provides substantial benefits. The network has already altered how management views the spaces. Previously, estimations of attendance and hours of use had been based on hearsay. Now, with the new data provided by MakerView, definite answers to these questions can be obtained. In examining one week of data, we found that fewer people utilize the spaces than had been previously estimated. Additionally, the spaces are underused, remaining closed for a large percentage of the week. Armed with this new information about actual use, the Tufts maker community has begun an effort increase Makerspace utilization.

Additionally, MakerView has the potential to lower the barrier of entry for new students thinking about utilizing the infrastructure, tools, and social networks inherent to the Makerspaces [11]. Either through the Access Points or web interface, a prospective maker now has a full mental image of the space, and immediately begins to picture him or herself working in the facilities. Now venturing across campus to a new area is far less daunting, as the student already has an association with the space.

4 Conclusions and Future Work

With the successful launch of a minimum viable product, we eagerly look towards the implications of future developments. We are now working on a key element of MakerView: analytics. The existing network supplies a large quantity of high quality image and audio data. With this data, MakerView will be able to report a wealth of useful statistics and feedback. By monitoring space usage over time, the community will be able to better understand which locations and times of day/week/year are the most popular, and allocate resources accordingly (i.e. more staff, change in hours of operation). Additionally, Makerspace organizers will be able to get instant feedback on pilot studies (i.e. does the additional 3D printer entice more students).

There is a strong want for user-specific information that may not be conveyed by the existing image data. A data visualization tool is currently under development to allow users to glean a greater understanding of Makerspace status from the web interface [8]. This tool will allow users to see who is currently using the room (i.e. a trainer for tool usage, or an on-duty proctor), as well as give insight into tool availability. Additionally, a user could be notified when a specific team or project occupies a space.

The next iteration of MakerView will be accompanied by an increased testing effort. Only through deeper analysis of the data collected by the MakerView system will its benefits be proven. Thus, these subsequent tests will focus a quantitative
analysis on increases in user participation and user collaboration (both intra- and inter- Makerspace)

At the moment MakerView connects people and spaces by giving users access into a remotely located makerspace. This virtual connection provides many aforementioned benefits. In time, MakerView hopes to enhance the interactions catalyzed by this virtual connection, providing a method for space-to-space collaboration [7]. These improvements open up possibilities such as enabling remotely located designers to co-design an idea in physical space. The current model of Makerspaces draws like-minded people together in a single location to share ideas and collaborate. MakerView strives to provide this ‘local community experience’ to individuals with shared interests regardless of physical location [6].

Acknowledgements
This material is based upon work supported by the National Science Foundation under Grant No. 1119321. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the views of the National Science Foundation.

5 References


