Augmented Reality Implementation of Digital Media in a Physical Environment

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*Abstract:*

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| In order to resolve the controversy regarding the legitimacy of graffiti on public property, our project provides a creative outlet for artists to have their work discovered while keeping public spaces free of physical art media. Our mobile app takes advantage of a new Google technology called the Tango, which provides a framework and support technology for the development of Augmented Reality applications. The early stages of our project will address the issue of allowing users to upload images and videos from the Tango gallery onto a wall or other surface. Further implementation will allow users to draw directly on the wall from their Tango or a paired device. |

*Purpose:*

The purpose of this project is to design and build an Android application and supporting infrastructure that allows users to upload and view digital media on real-world surfaces. The goal is to use Augmented Reality and mobile devices to create a virtual space for expression and communication in the same plane as the physical walls and rooms. This aims to promote creative expression at TJ while taking into consideration the opinions of those who do not support such a large-scale project.

*Background:*

Augmented Reality is a field that is quickly growing alongside its companion: Virtual Reality. Unlike VR, however, AR takes advantage of its surroundings by placing objects into the real world and transforming the user’s perception of the world through the lens. AR's reliance on the environment around it presents different – and often more difficult— challenges than those of VR. For example, AR needs algorithms that calculate depth for depth perception and needs to store information about the user's location as the user is moving. AR also needs to solve some of the problems that VR encounters, like motion tracking. Thankfully, Google has developed a new technology called the "Tango". The Tango is a tablet equipped with both hardware and software that takes into account the issues presented in AR, so that developers can have an easier time implementing it in their applications.

Specifically, the Tango addresses the issue of depth through its use of 3 different types of sensors: structured light systems, time of flight systems, and stereo systems. Structured light systems work by shining several infrared beams and measuring the size of the dots created when the beams intersect an object. Time of flight systems work by calculating the amount of time it takes for an infrared beam to bounce back to the camera; the longer the time, the greater the distance. Thirdly, the stereo systems employ the use of two cameras at a short distance apart. The device estimates the depth by triangulating the perspectives of the offset cameras.

Tango also has innovative technologies for remembering locations. Previous technology relied heavily on GPS, which works exceedingly well when the user is outside. However, with short distances like the length of a hallway in a house, GPS becomes less accurate in determining the user's location. Tango gets around this by introducing a concept called: Area Learning. Instead of having the technology to pinpoint exactly where a user is at any moment, the Tango will start off with no knowledge about the user's location, but will learn when the user shows the Tango around his/her surroundings. As these places are visited more often, the Tango becomes increasingly familiar with the structure around it, and can imagine the structure under different lighting and/or different times of day. In a way, Area Learning is intuitive and is closely related to the way a human thinks.

The Tango is able to address the issue of motion tracking because the device has 6 degrees of freedom. When programming motion tracking, it is important to make the experience "natural". This means that the degrees of rotation must match the speed that the tablet is turning. If these basic conceptions are not followed, then the human brain will have a hard time adjusting towards these slight variations, making the viewing experience unsatisfactory.

Employing AR on a large scale can have many positive effects for a certain location. One benefit is being able to safely interact with the environment, without disturbing any natural processes or damaging the surroundings. A powerful example of the potential benefits of AR could be its effect on graffiti. While it can add vibrancy to ordinarily drab surfaces, it can also deface already aesthetic and noteworthy structures.  Graffiti artists are acclaimed for their skill and often have the power to promote conversation about controversial topics in their art. They are also technically criminals. An AR implementation of virtual graffiti has not been attempted in the past. However, AR has been used in the past in “art invasions”; events during which users use an AR application to view art that would ordinarily not be displayed in public (usually in a prestigious art museum or institution). In 2010, the Dutch company Blippar Group sponsored one such event at the world-renowned Museum of Modern Art in New York City. Over 40 artists submitted their work which could be viewed using the popular AR app Layar alongside the physical works displayed at the MoMA. Contrary to popular belief, TJ is not lacking in artistic talent and expression and creativity have always been encouraged. While some of this was lost in renovation, TJ’s artistic spirit could be seen on the temporary walls that were erected around the school. These quickly filled up with drawings and messages and were a place for students to express themselves. As the school transitions into its new incarnation, it is difficult to find art outside of the art gallery. Using AR technology and the Tango, TJ students and other users will be able to have a permanent “art invasion” at TJ.

*Research Techniques/Methods:*

The development environment we will be using for the project is Android Studio. The Tango tablet is a mobile device and as a result, the application will be developed in the Android programming language. We will use the Tango Developer API to allow us to use the built-in Tango features in our project. Features provided by the API include motion tracking, area learning, and depth-perception. Motion tracking will be used to determine the position of the device in relation to the surrounding environment. It works like a mouse, but instead in 3d. It recognizes angles, directions, etc. Area learning builds on top of motion tracking and “remembers” motion and position instead of just tracking it. We will use this to build a “virtual room” and use that layout as the virtual canvas for our digital media. Area learning also improves the accuracy of motion tracking. Depth perception is the most important feature of the Tango and the Tango API. It will be used to improve the layout built by area learning and also allow us to implement Augmented Reality by realistically overlaying media onto images of real world surfaces.

For a larger scale implementation, we will use a database to store the layout data for multiple parts of the school as well as the “graffiti data” relating to the pictures we want to put on the walls. We are familiar with Firebase and may explore MongoDB as an alternative when we reach that point.

*Materials: equipment and cost*

We plan to use the Google Tango Tablet Development Kit for our application. The cost for this is $512 ordinarily but the lab already has one so we have no additional cost. QR Codes might be used and will be printed on paper and hung up in desired locations. As of now, we do not anticipate using QR codes.

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