Twist and Shout: Developing Interactive Annotation for 3D Printers

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Abstract. This short paper encompasses the birth of Project Anno. The researcher investigated the possibility of support for accurate annotation on the output of 3D scanners [14] to enhance the use of 3D printers [12] for use in 3D prototyping. As Project Anno is a work-in-progress, the current system aims to simulate accurate natural user interaction and expects to result in a user's physical movement and voice input being able to operate the system's annotation functions with some degree of precision, nicknamed as the "twist and shout" method by the researcher. In this interactive annotation environment, users can have a natural interactive experience by using their hands to practise accurate control of using the hand in place of a mouse. A description of the solution, closest related work, how Project Anno is novel, how Project Anno's design is iterated upon, and the usability evaluation method of Project Anno are discussed.

Keywords: 3D point clouds, 3D scanners, user annotation, natural user interaction, 3D printers, 3D prototyping.

1 Introduction

The idea of developing interactive annotation for 3D printers [12] was first conceived when the researcher came across the IEEE 3DUI 2014 Contest, where the problem description involves building a system that allows users to annotate 3D point clouds [13] from 3D scanners [14][8]. The challenge of this project is to enable support for accurate labeling of sets of points and authoring of overlapping hierarchies of annotations at varying scales [8]. This project endeavors to possess a set of tools that is versatile enough to meet this challenge. To incorporate annotation precision, the researcher considered the Adobe Illustrator Ruler and Guide [9] concept and the Scalable Vector Graphics [10] concept. As for interactivity, the Interactive Whiteboard [11] concept was considered. To promote Natural User Interaction [3], the Kinect for Windows [2] was considered. Similar examples applying the Interactive Whiteboard [11] concept and Natural User Interaction [3] include ShowMe Interactive Whiteboard [1], Touchless Touch [6], and Ubi Interactive [7]. In terms of 3D prototyping, 3D printing [12] was considered. These considerations contribute towards the solution for developing interactive annotation for 3D printers.

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2 Description of the Solution

Developing interactive annotation for 3D printers [12] was named Project Anno for ease of reference. At this stage of the current version of Project Anno, some constraints were involved. As an enthusiast researcher, budget was the largest constraint followed by development tools (directly related to budget) and manpower (one person involvement). Therefore, the development tools indicated are what the budget permits at this point in time. As for the manpower, the researcher hopes to form a collaboration team for future versions of Project Anno.

2.1 Hardware and Software

The current version of Project Anno was built using both hardware and software. The hardware used consists of two items. The first item is an ASUS All-in-one PC series. The second item is a Kinect for Windows sensor [2] which was used for the development of the user interaction [3].

Microsoft Windows 8.1 was used as the operating system for building Project Anno. Microsoft Visual Studio 2010 was used for coding the applications in C#/C++ to work with the Kinect for Windows sensor [2]. Kinect for Windows SDK v1.8 and Kinect for Windows Developer Toolkit v1.8 were used to build the user interaction [2-3]. Kinect for Windows Runtime v1.8 was used to enable end users to communicate with Project Anno [2]. DirectX SDK was used to enable the compilation of Direct3D-based functions in Project Anno. DirectX End-User Runtime was used to enable end users to operate Direct3D-based functions in Project Anno. XNA Game Studio 4.0 was used to support Kinect's ColorImageStream, DepthImageStream, and SkeletonStream to enable end users to have a natural interaction experience with Project Anno. Speech Platform SDK 11.0 was used to enable user speech recognition when interacting with Project Anno [2].

2.2 Application of Concepts

With reference to the considerations that contribute towards the solution for developing interactive annotation for 3D printers [12], the researcher applied the “snap to grid (snap to pixel)”, “snap-to-guide (smart guide)”, and “snap to point” from the Adobe Illustrator Ruler and Guide [9] concept, and the versatile “polygon” basic shape from the Scalable Vector Graphics [10] concept, to simulate the accurate annotation of sets of unstructured and unlabeled points at different scales while preserving the vector image shape generated by 3D scanners [14]. In terms of Natural User Interaction [3], the researcher applied motion sensing with the help of the Kinect for Windows [2] to simulate user interaction with the system using a user's physical movement and voice as input. To enhance 3D prototyping, the researcher applied the idea of 3D printing [12] as the final product of annotating 3D point clouds [13] generated by 3D scanners [14] to facilitate the decision-making process in diverse industries, for instance, architecture, construction, dental and medical, education, aerospace, engineering, geographic information systems etc.

2.3 Status Quo of Project Anno

As Project Anno is a work-in-progress, the current system enables users to have a natural interactive experience by using their hands to practise accurate control of using the hand in place of a mouse through a simple exercise routine. This simple exercise routine introduces natural user interaction as another way for human beings to manipulate a system's functions using their physical movement. The objective of this simple exercise routine is to complete all the tasks assigned within a set time frame without instructions. Project Anno expects to result in a user's physical movement and voice input being able to operate the system's annotation functions with some degree of precision. This method of natural user interaction is nicknamed “twist and shout” by the researcher.

2.4 System Architecture of Project Anno

The diagram illustrates Project Anno's system architecture (Fig. 1).

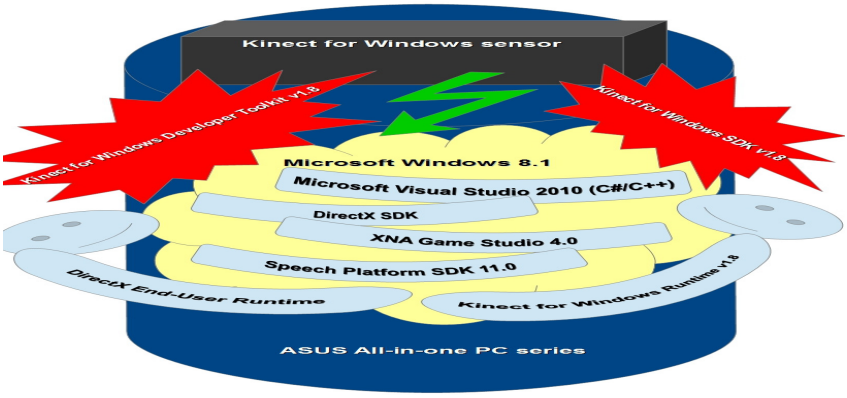

Fig. 1. Project Anno's System Architecture

3 Closest Related Work

The closest related work to Project Anno took some searches before making a final decision on three. There are several projects on interactive whiteboards using the keyboard and the mouse. There are few projects on interactive whiteboards using motion sensors. However, most include user annotations on documents.

3.1 ShowMe Interactive Whiteboard

One closest related work to Project Anno is the ShowMe Interactive Whiteboard [1]. ShowMe Interactive Whiteboard is an iOS application that has a number of features particularly useful for educators. The features include voice recording, assorted brush colors, pause and erase functions, image import from existing library, built-in camera,

and web search, upload and share recordings, embed recordings for sharing, unlimited lesson length, and student management using groups function [1].

3.2 Touchless Touch

Another closest related work to Project Anno is Touchless Touch [6]. Touchless Touch is a software that converts any surface into a multi-touch screen, including use as an interactive whiteboard, a standard of 128 touch points, operates with any surface size from 14" to more than 200" (requires more than one sensor), Windows 7 and Windows 8 native touch support, Kinect for Windows, Xbox 360 Kinect, and OpenNI/Prime Sense sensors support, unlimited free trial, and unlimited free upgrades/updates of the licensed software [6].

3.3 Ubi Interactive

Ubi Interactive [7] is another similar example. Ubi Interactive transforms any surface into a touch screen, with no complex setup, no user calibration, no need to develop special applications, simply connect the projector and Kinect to the Windows 8 PC and the Ubi software will callibrate automatically, supports input mode such as finger, hand, or Ubi pen on touch surface, supports touch points from 1-20, supports display size of up to 120", and a 30-day free trial version of the Ubi software [7].

4 How Project Anno Is Novel

Project Anno differs from the three closest related work mentioned in a number of ways. Project Anno aims to apply motion sensing, voice commands, and user annotations on 3D objects, unlike the closest related examples where multi-touch and user annotations are employed. Project Anno also aims to apply 3D scanning [14] capabilities to capture the 3D image before user annotations are carried out on the image and to record user annotations for future references or 3D printing [12]. Project Anno attempts to carry out annotations using a user's physical movement and voice input on the output of 3D scanners [14] to enhance the use of 3D printers [12] for use in 3D prototyping in diverse industries, using the "twist and shout" method nicknamed by the researcher. Project Anno strives to provide 3D scanning [14] and natural user annotation capabilities as a 2-in-1 package so that various industries can benefit from printing annotated versions of a 3D prototype to facilitate the decision-making process. Project Anno is compatible with a large display size when connected to a projector, a Kinect for Windows sensor [2], and a Windows 8 PC or laptop.

5 How Project Anno's Design Is Iterated Upon

A hybrid (Extreme and Scrum [4-5]) development methodology is adopted by the researcher in developing interactive annotation for 3D printers. The Extreme [4]

development methodology is employed because Project Anno requires frequent enhancements to system quality and user feedback on system responsiveness, in order to improve productivity, by using checkpoints to introduce new user requirements, to further enhance system efficiency. The Scrum [5] development methodology is also used because Project Anno needs an iterative and incremental approach to achieve an objective, that is to meet the challenge of this project, while being flexible enough to deliver promptly in response to new user requirements. This hybrid development methodology is named ExScrum development methodology (Fig. 2) by the researcher. The researcher will continue with this hybrid development methodology for building future versions of Project Anno.

Fig. 2. ExScrum Development Methodology

6 Usability Evaluation Method of Project Anno

Heuristic evaluation [15] is selected as the usability evaluation method for the development of Project Anno because it is a good way of examining the interface for big and small problems against a set of usability principles called “heuristics”, supplementing the method with severity ratings (frequency, impact, persistence) of small problems, by a small group of evaluators, possibly becoming users of Project Anno. To measure the usability of Project Anno, the current version of the system will be examined against the ten usability heuristics [16].

7 Conclusion

This paper explored developing interactive annotation for 3D printers [12]. Hardware and software, application of concepts, status quo of Project Anno, system architecture of Project Anno, ExScrum development methodology, and heuristic evaluation were discussed. The current version of Project Anno comprises a simple exercise routine that introduces natural user interaction as another way for human beings to manipulate a system's functions using their physical movement. Project Anno is still in its

infancy and development is continuing towards building a set of tools to carry out annotations using a user's physical movement and voice input, on the output of 3D scanners [14] to enhance the use of 3D printers [12] for use in 3D prototyping in diverse industries, using the “twist and shout” method of natural user interaction.

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