PROJECT PROPOSAL

GENERAL PROJECT INFORMATION

PROJECT NAME	COURSE PROFESSOR	PROJECT SPONSOR
Hybrid Drawing Solutions in AR: Bitmap-to-Vector Techniques on 3D Surfaces	Mirjana Prpa	Keith Lay

STUDENT	EMAIL	Expertise
Pengcheng Ding(Ding)	ding.pen@northeastern.edu	Unity, Animation, c#, 3D modeling
Yedian Cheng(Edie)	cheng.yed@northeastern.edu	Unity, 3D modeling

PROJECT OVERVIEW

RESEARCH PROBLEM	Current augmented reality (AR) tools for drawing on 3D objects are insufficient for engineering applications, particularly when scaling large-scale models using bitmap methods, which often results in significant distortion. This limitation hampers precision and efficiency, critical factors in engineering design workflows. We propose to address this gap by introducing advanced hybrid drawing capabilities. In our workflow, we added a vectorization process to convert the stroke data into more data-friendly and scalable vector data. Optimized bitmap drawings that would maintain clarity and precision regardless of scale, while the vectorization process would allow for quicker, more flexible sketching. These enhancements aim to enhance 3D drawing in virtual spaces, improving both the accuracy and speed of engineering designs, thus potentially transforming how professionals interact with AR technologies in the engineering field.
MOTIVATION	The engineering sector is increasingly adopting 3D scanning to generate 3D models, and collaborative efforts are shifting from traditional 2D blueprints to cooperative work on 3D models. There is a growing need for intuitive tools for drawing on 3D models, this ideal tool would be simple to use, enable fast drawing, and maintain clarity and detail when zoomed in, ensuring that the fidelity of the drawings is preserved in real-time.
RESEARCH GAP	Despite significant advancements in AR system visualization, precise applications for drawing in engineering contexts remain underdeveloped. Traditional use of drawing on object surfaces has primarily been confined to industrial design models or artistic creations, with actual sketching on rough 3D surfaces being relatively rare. Existing methods, which allow only pixel-by-pixel drawing on 3D surfaces, also tend to distort when models are scaled up and such pixelated lines do not meet the need for precision and cross-platform usability after export. These limitations do not meet our needs, as we need to mark faulty lines and ensure that drawings can be enlarged while keeping their accuracy and detail. Our research aims to address these deficiencies by introducing hybrid drawing capabilities: utilizing pixel-by-pixel methods for quick and easy initial drawing, followed by an optimized vectorization process to make the drawings scalable and enhance their accuracy and fidelity.

RESEARCH QUESTIONS	The identified gaps have driven the following research question we aim to investigate, **How to enable hybrid approach to drawing on 3D Surfaces that is quick but also scalable**?
PURPOSE OF PROJECT / STUDY	The goal of this project is to develop a tool that merges the benefits of bitmap and vector drawing methods. This tool will enable users to draw directly on 3D model surfaces and convert these drawings into vector format. This ensures scalability and data efficiency, maintaining image quality when models are scaled and reducing data size compared to traditional bitmap drawings.
Team Assignments	Pengcheng Ding: Takes charge of the overall development aspects of the project, leads the planning and execution of the software development lifecycle, and focuses on the development of the vectorization process, ensuring the tool's enhancements meet the project's objectives. Yedian Cheng: Concentrates on bitmap drawing implementation, and enhancing user interaction. Common Assignments: Having meetings with the project mentor and course instructor, interviewing the engineering team, documenting the entire project, focusing on tracking progress and writing the research paper, etc.
Novelty of the work	The novelty of our project relies on a hybrid drawing approach. In our project, users can quickly sketch freehand on 3D model surfaces, and these sketches are then converted to vector format. This combines the quick sketch capabilities of bitmap drawing with the scalability and data efficiency of vector drawing.

PROJECT SCOPE

WITHIN SCOPE	1. Develop an AR drawing system that allows users to sketch quickly in a freehand method and then vectorize the bitmap strokes into scalable, high-quality vector graphics.
OUTSIDE OF SCOPE	1. Development of new AR hardware or foundational operating systems. 2. Development of 3D model scanning or creation systems.

TENTATIVE SCHEDULE

KEY MILESTONE	START	FINISH
Form Project Team / Preliminary Review / Scope	09/05/2024	15/05/2024
Finalize Project Plan / Kick Off	12/06/2024	30/05/2024
Complete Literature Review & define Research Gap & Research Question	16/05/2024	06/06/2024
Build Prototype	06/06/2024	04/07/2024
Evaluate Prototype	06/06/2024	11/07/2024
Improvement Phase: Revise based on the Feedback	11/07/2024	25/07/2024
User Evaluation + Data Collection	25/07/2024	01/08/2024
Project Summary Report and Close Out	01/08/2024	13/08/2024