

OPTIDOT AR: AN AUGMENTED REALITY EDUCATION APPLICATION

Chi Zhang, Yunfan Gong, Paul Jolly, Ali Vosoughi

Advisor: Zhen Bai

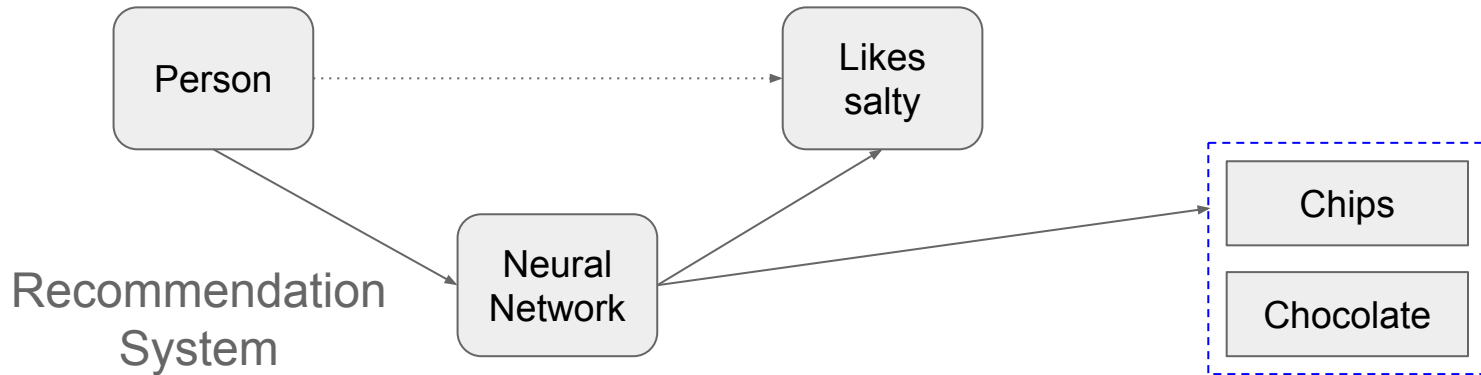
December 21, 2023

MOTIVATION BEHIND THIS PROJECT

- Artificial intelligence is everywhere (YouTube, TikTok, to name a few).
- AI literacy for **K-12** is important
- **Recommendation systems**, which are AI-based now, are feeding our opinions
- Knowing how they work is important
- Key method is to **learn basics** of neural network
- The basic element of neural network is dot product

WHY OPTICAL SYSTEM IS CHOSEN? (MOTIVATION OF OPTIDOT)

- Having a physical interaction brings their intelligence to physical world, and their recall is enhanced
- K-12 students by then already have knowledge of how optical systems work
- Why not build an optical neural network?
- Then it comes how to teach them recommendation system



OPTICAL NEURAL NETWORKS ARE NOT NEW! → 1991

Jpn. J. Appl. Phys. Vol. 31 (1992) pp. 1689–1693
Part 1, No. 5B, May 1992

Optical Learning Neural Network Using Selfoc Microlens Array

Yoshio HAYASAKI, Ichiro TOHYAMA, Toyohiko YATAGAI,
Masahiko MORI¹ and Satoshi ISHIHARA¹

Institute of Applied Physics, University of Tsukuba, Tsukuba, Ibaraki 305

¹*Electrotechnical Laboratory, Tsukuba, Ibaraki 305*

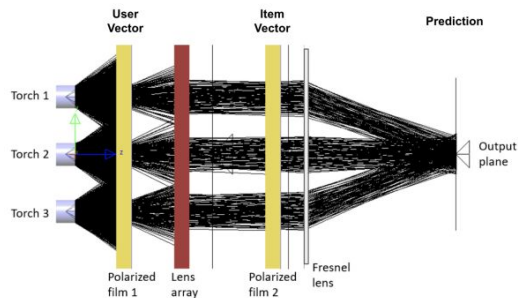
(Received December 2, 1991; accepted for publication January 18, 1992)

An optical network system with learning capabilities and a 2-D architecture is proposed. The 2-D architecture is implemented by a multiple imaging system of Selfoc microlens arrays, which enables us to develop a compact optical neural network system. Synaptic weights of neurons are memorized in a Pockels readout optical modulator, and the system obtains the learning capabilities. Experimental verification of multiple imaging and learning is presented. In the experiments, the neural network system stores the three patterns by an orthogonal learning method. The performance of the optical neural network system is estimated in terms of a point spread function of the Selfoc microlens.

KEYWORDS: optical neural network, optical computing, orthogonal learning, microlens

OPTIDOT HAS PREVIOUSLY BEEN SUCCESSFULLY IMPLEMENTED

- Using OptiDot as an AI-embedded **recommendation** system predicting how likely a user **likes** an item.



OptiDot: An Optical Interface for Children to Explore Dot Product and AI Recommendation

Anonymous submission

TEACHING NEURAL NETWORKS TO K-12 USING AR

Benefits can go beyond physical world: **making animations**

Neural networks

Students wearing AR glasses



ENGAGING K-12 IN RECOMMENDER SYSTEM NEURAL NETWORKS

Educational Game

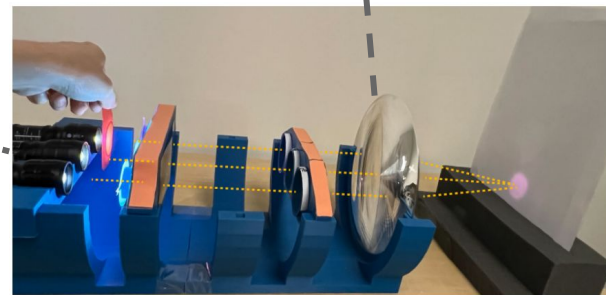
K-12 student thinks about eating one of the chocolate bars, cheesecake, and potato chips



Environment

Knobs

Lens



Device of Interest: **OptiDot**

OBJECTIVES OF THE PROJECT

- **Part 1:** A storyboard, which is an interactive and engaging **educational plan** that will achieve the learning goals
- **Part 2:** A **proof-of-concept AR environment** that will serve as a starting point for the full implementation of the educational plan

PART 1: STORYBOARD

(EDUCATIONAL PLAN)

"SNACK MASTER"

AN INTERACTIVE LEARNING GAME FOR K-12 AI LITERACY LEARNING

Context:

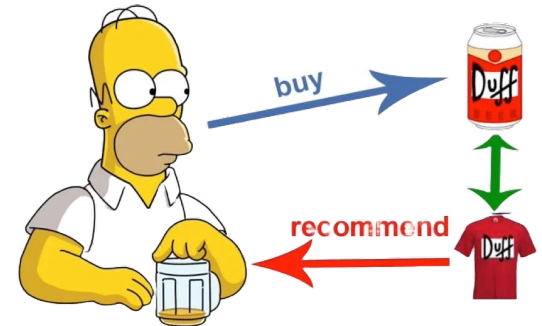
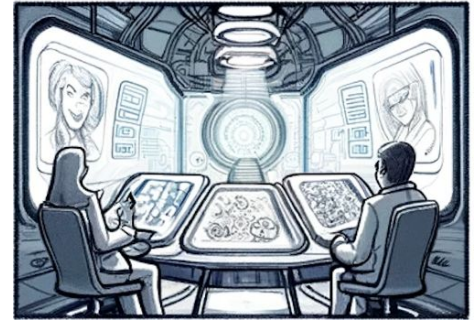
- Students **roleplay** “flavor scientists” in a futuristic food science lab
- Optidot is the cutting-edge equipment in the lab that is able to guess your snack preference

Big ideas:

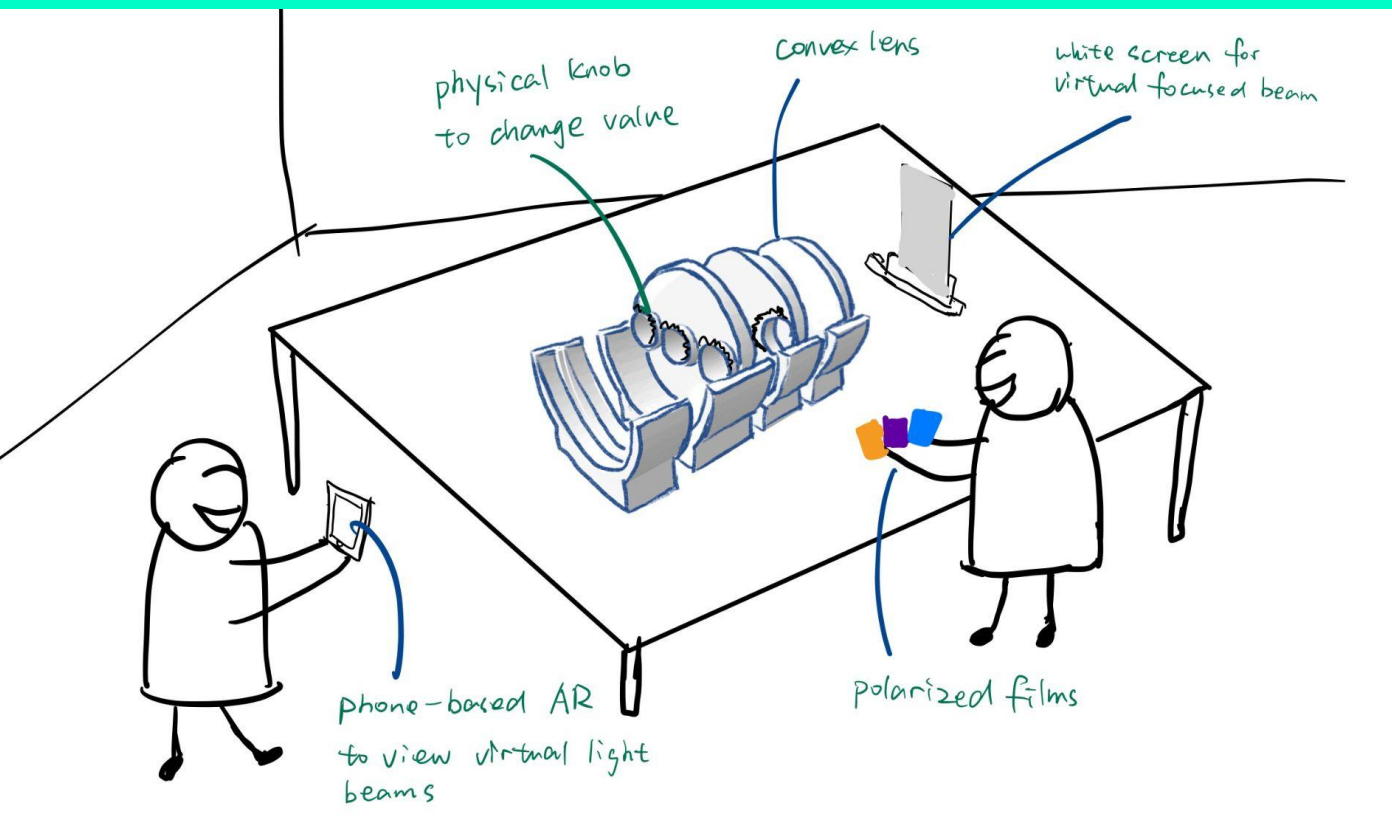
- Recognizing content-based recommendation systems in students’ daily use and understand the underlying mechanisms
- Applying data literacy, i.e., multivariate data vector, dot product

Three learning activities

- **[Implemented]** #1 Personal Preference Prediction
- [Plan for future] #2 Cheesecake challenge & #3 Chip Flip



GAME SETUP



Physical:

- the two sets of polarized films
- the physical knobs to input values

Virtual:

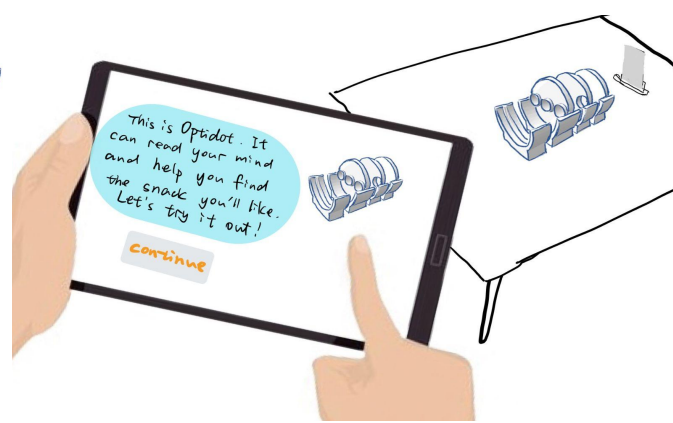
- convex lens
- projection screen
- light sources
- light beams

The first activity simulates the process of predicting students' favorite snack, and the goal is to understand data vectors and attribute weights.

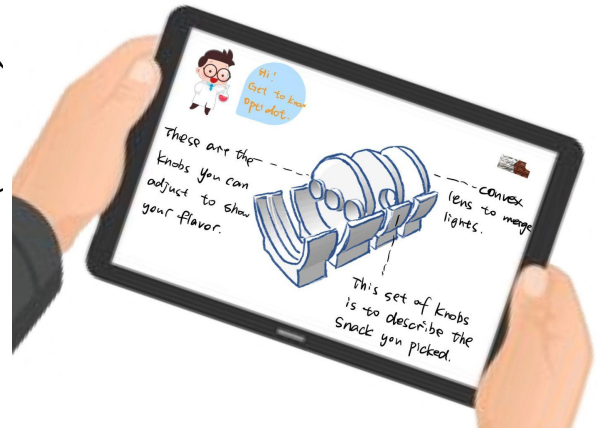
STEP-BY-STEP DESIGN OF LEARNING ACTIVITY #1



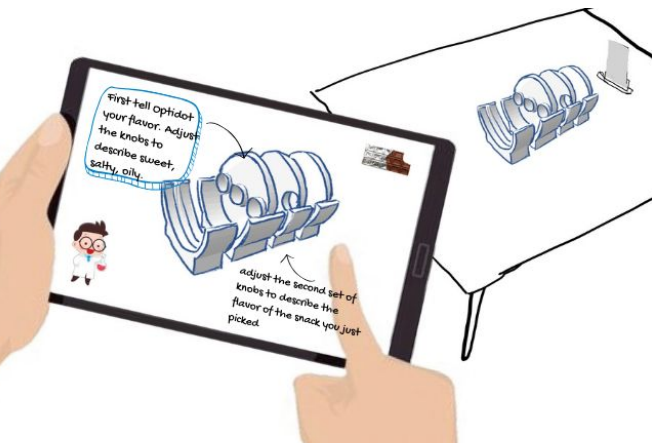
(1) Narrative introduction



(2) Intro to Optidot



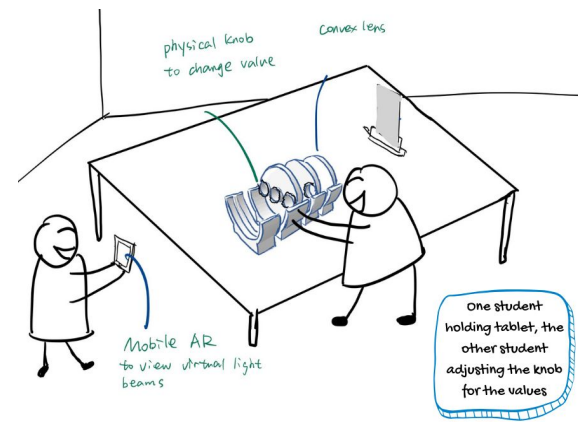
(3) Optidot features



(4) Initializing personal flavor



(5) Describing the snack



(6) Prediction and taste test

PART 2: PROTOTYPE APPLICATION

PART 2: PROTOTYPE APPLICATION

Minimum objectives:

- **Demonstrate the ability to overlay graphics or text** that is contingent on an imported 3D model (AR)
- Verify the ability to **maintain realistic rendering while viewing the scene from different viewpoints** (i.e., correctly rendering objects while walking around the scene).

Stretch Objectives:

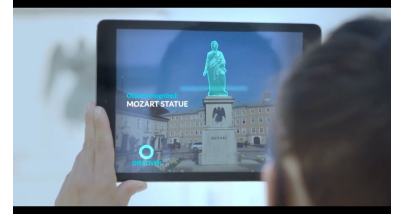
- **Add user interfaces** through which a user can adjust various parameters such as the intensities of the light by virtually rotating the films
- **Incorporate a correct optical model** that will update the output on the projection screen as the intensity of each light beam changes
- **Begin implementing components of game 1 in the educational plan**

Result:

- Implemented sample features and basic elements of educational storyboard
- Created a testable platform to obtain detailed understanding of usability/effectiveness
- Created an easily extendable AR development software pipeline

OBJECT TRACKING IN AR

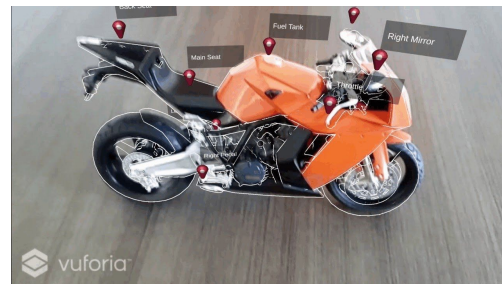
- Definition and purpose
 - Recognize and track 3D physical objects in real-time
 - Anchor virtual content to physical models via the AR interface
 - Enhance user perception by enabling AR interaction
- Various tracking technologies
 - Marker-based tracking
 - Model-based tracking
 - Hybrid tracking
 - Simultaneous localization and mapping (SLAM)
- Popular AR software development kits
 - ARkit (iOS) and ARCore (Android)
 - Vuforia Engine



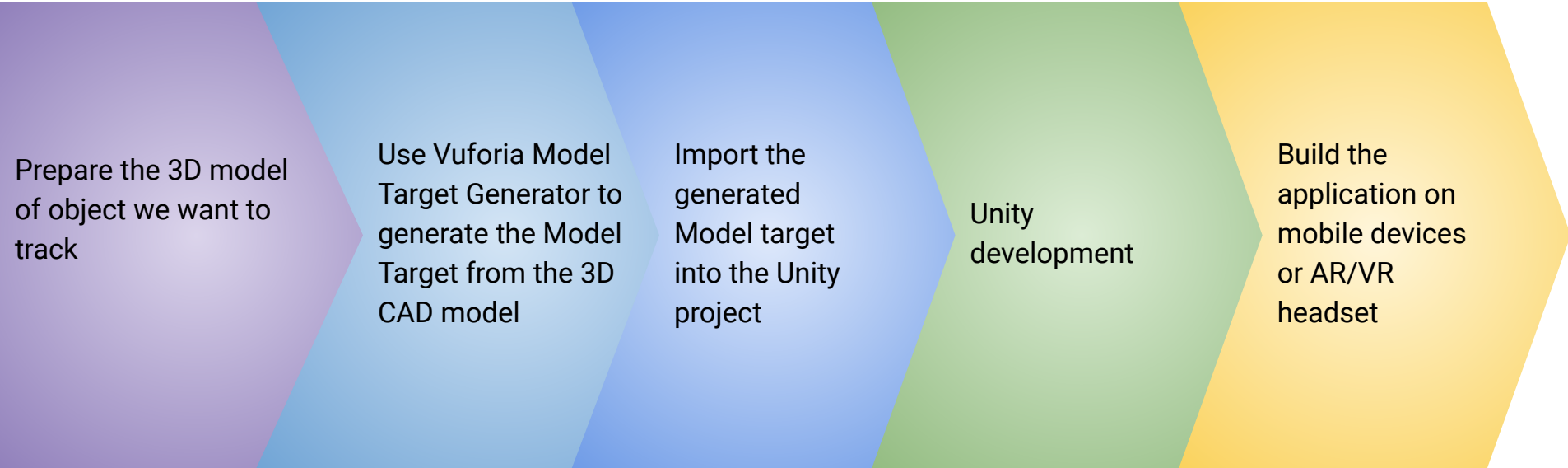
VUFORIA ENGINE

Most widely used AR development platform

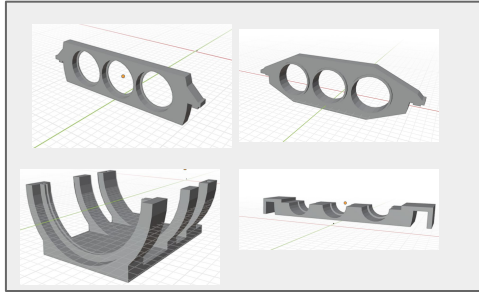
- Cross-platform compatibility
 - Android
 - iOS
 - Windows
 - Magic Leap OS
- Seamless integration with Unity
- Various tracking options
 - Image targets
 - Model targets
 - Multi targets
 - Cloud recognition



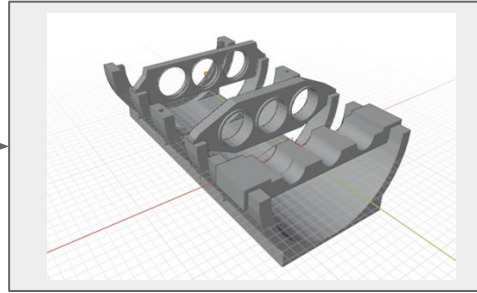
DEVELOPING AR APPLICATION WITH VUFORIA AND UNITY



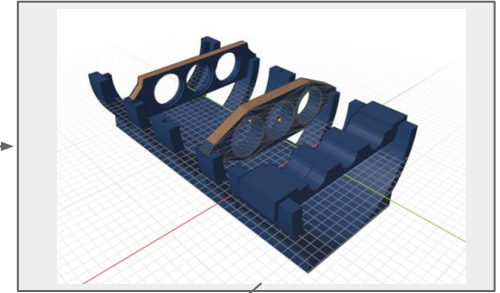
MODEL TARGET GENERATION



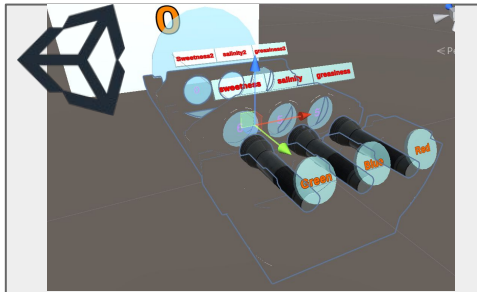
.STL files for the 3D-printed parts



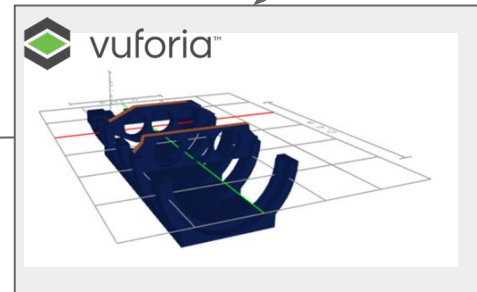
Import the 3D models and assemble them in Blender



Add colors and export the CAD model

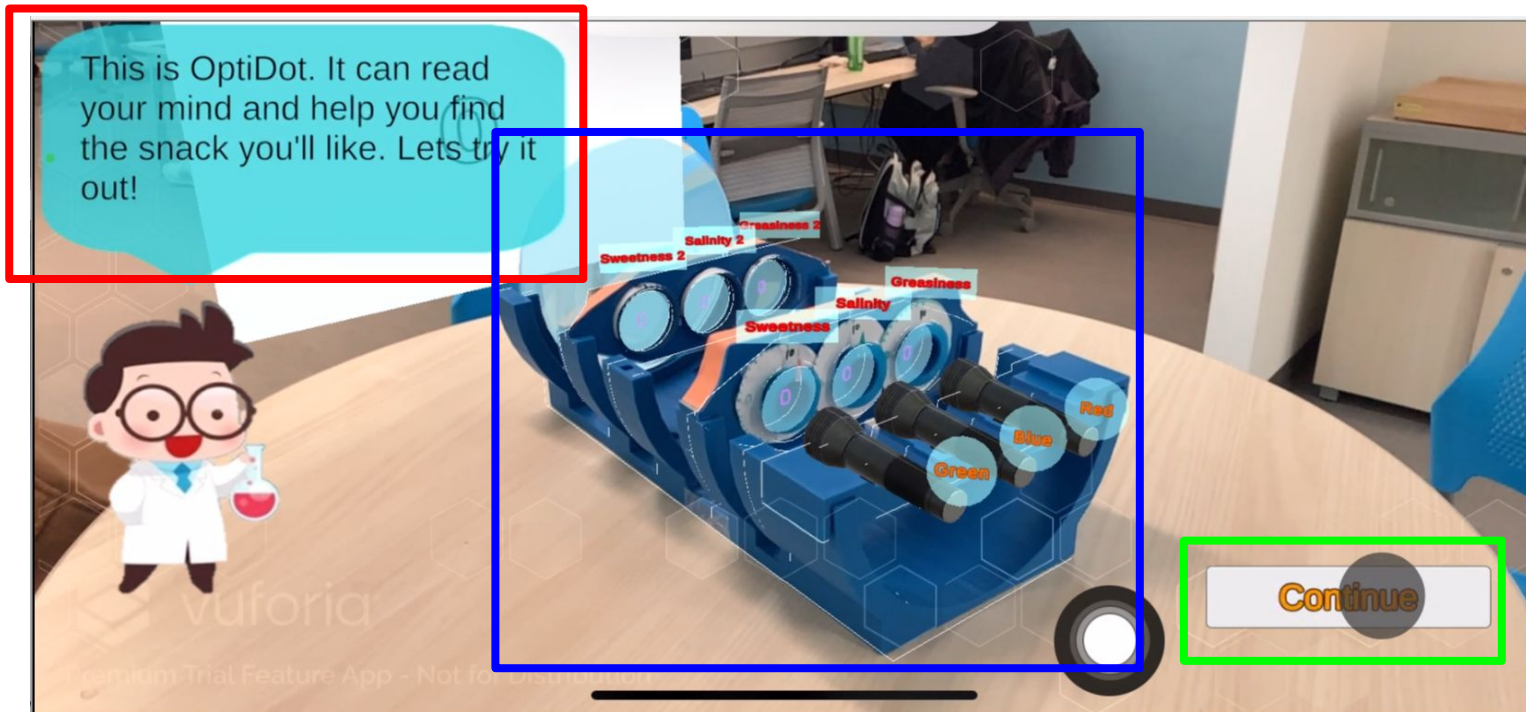


Include in the Unity project

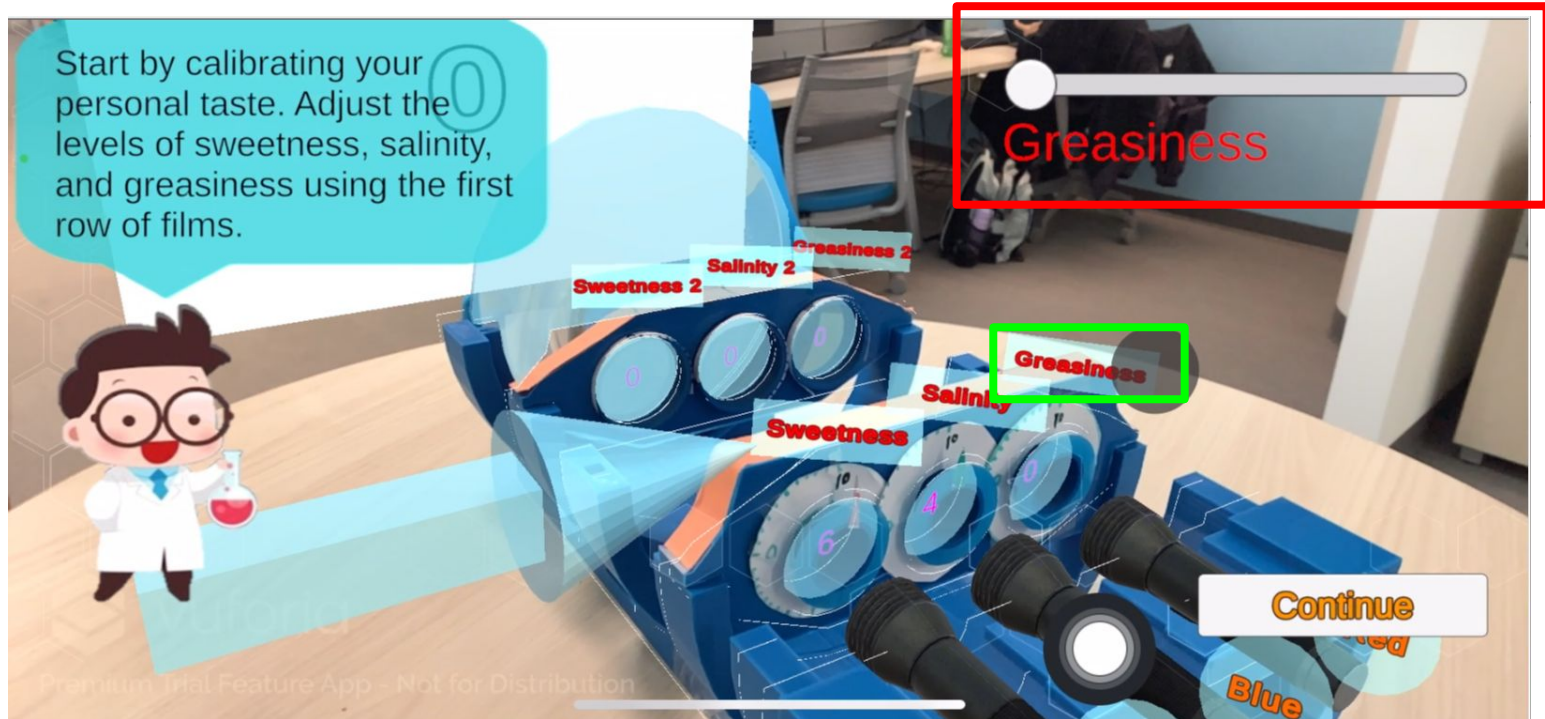


Generate the Model Target of OptiDot

GAME INTERFACE



USER INTERACTION



BUILDING THE MOBILE APPLICATION

- Very simple and straightforward!
- Followed the process of building an iOS application from Unity
 - Create Xcode project from Unity
 - Enable development on mobile device
 - Build application for target operating system and device using Xcode
- This process can be easily adapted for Android devices

The value and brightness of the number shown on the screen indicate how well each snack matches your personal taste.

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Crispiness 2

Start over



FUTURE WORK

- Complete the implementation of all three educational games as detailed by the storyboard
- Improve graphics and controls to make them more intuitive and aesthetically pleasing
- Perform field-tests to study game-play and interactions
- Human-computer interaction improvements
- Physical device improvements
 - Ex: physical buttons that interact with and control the augmented virtual world

QR CODE FOR VIDEO

Link for the project:

https://github.com/ChiZhang9797/AR_VR_practicum

