# Real-World Object Capture in a Mixed Reality Environment

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## Background and Introduction

Mixed reality is an increasingly popular technology due to its nature of combining real and virtual objects and the ways this can enhance a user's interaction with the world. The Microsoft HoloLens is a standalone headset that allows for mixed reality application development but its ability to detect and track objects in space is relatively unexplored.

vuforia™ Microsoft HoloLens unity

The aim of the project was to evaluate the effectiveness of real-world object capture and real-time object manipulation in a mixed reality environment using Vuforia on the Microsoft HoloLens. The Vuforia SDK provides a variety of 2D and 3D targets that it stores in a database and references to allow detection and tracking of objects.

## Methodology

There were three principal stages to the development process. In the first stage Microsoft HoloLens was acquired, the required software downloaded and sample projects installed and explored.

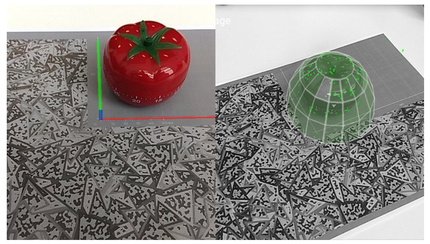
In the second stage the initial attempt to detect real-world objects was carried out. Vuforia's Object Recognition was chosen as the best targets to use to attempt this given the research done earlier. Vuforia's Object Scanner APK was installed on an Android device, an object was scanned in and made a target using Vuforia Target Manager. An application was built using Unity but no object detection occurred.

In the final stage Vuforia's Multi-Targets were explored instead. Images were taken of the multiple sides of a cuboid object and a target was created using Vuforia Target Manager. The new application still resulted in no successful detection. A change in environment then took place where the target creation and detection moved from a space with directional light to a more diffuse setting. A more detailed Multi-Target was then created and tested. However, this application was also unsuccessful. The development stage ended with no implementation iteration achieving successful object detection.

Project documentation and implementations available at:
https://github.com/beejpersson/Honours-Project

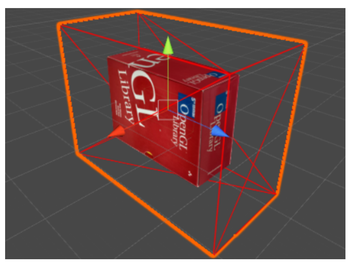
## Summary

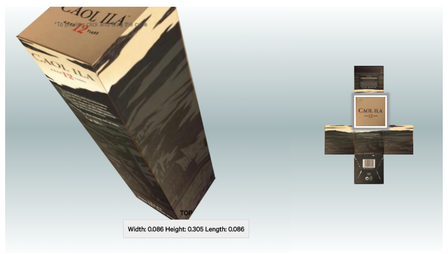
This project was an evaluation of the effectiveness of real-world object detection on the Microsoft HoloLens. It employed the use of the Vuforia SDK for its target tracking capabilities and Unity for building immersive, mixed reality applications.



Object Target creation: Pomodoro timer being scanned using Vuforia's Object Scanner for Android.

Multi-Target in Unity:
An OpenGL box as a Multi-Target with a surrounding wireframe box that would render when the object was detected.





Final Multi-Target: Vuforia Target Manager display of the multi-target and its 6 child image targets.

## Conclusions

This project was unable to implement any form of real-world object detection using Vuforia on the Microsoft HoloLens. The project did produce a number of other findings that can benefit future development. It did determine that Vuforia's Object Recognition feature is mostly unsupported on the HoloLens despite being part of Vuforia's HoloLens sample project. Successful object detection is usually a result of Vuforia's image detection capabilities, such as VuMarks and Multi-Target, masked as object detection by storing positional data of child targets relevant to the parent object target. The project also highlighted that the full functionality of Vuforia's tools are still in development and undergoing regular improvements. Much of the project's failures can be attributed to the difficulty when creating usable targets. There were many procedures to follow to reduce the chance that a target couldn't be detected with no indication as to what could be causing issues.

## Future Work

The primary goal for the future would be to produce a more professional object target creation environment. By building a scene with even surroundings and lighting using a setting similar to those used in photography studios, the target's specific recognition data would be better produced.

The next stage this project would have explored was Vuforia's other 3D targets. Model-Targets were previously dismissed due to lacking a 3D printer and that capturing a physical object that was simply a 3D print of the virtual model seemed initially less in line with the project's goals. VuMarks could also be explored. When using these the object geometry data can be retrieved from the database and used to produce same-size virtual content in the place of the real-world object on which the VuMark is placed. VuMarks should allow for better consistency with detection as well due to the more unique patterns they employ, similar to QR codes.

Once an object can be reliably recognised and a 3D render of that object put in its place, multiple simple post-processing effects could be applied to manipulate the object's appearance. Expanding on this, the tools to choose what manipulations are applied and having these manipulations occur in real-time on a variety of desired objects could be built. By providing this, the goal of producing a tool that allows a user to interact and manipulate their local space could be achieved.