TableCity

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A City-building Sim for Augmented Reality

Figure 1: Close-up view of the virtual environment augmented into the real world

The Game

TableCity is a city-building simulation game developed for HTC VIVE Pro on unity. In this game, the player is tasked with creating a bustling city in an augmented reality (AR) environment while managing the city's various needs and resources.

The game uses a simple grid system for object placement. Roads provide the basis for the game's buildings, which must be placed adjacent to a road tile. HTC VIVE Pro's controllers provide the user with an easy and intuitive way of interacting with the game's environment in a point-and-click manner.

Residential buildings provide nearby industrial and entertainment buildings with the required customers and employees. Those buildings in turn provide the residents with happiness, which can increase population growth and income. The buildings require electricity and water to function, which are provided by the water towers and power plants that cost money to maintain.

Visual indicators provide information about the various buildings' statuses and unfulfilled needs to guide the player.

The assets used for this project were created entirely by the developers using GIMP 2 and Blender 2.81.

Development and Implementation

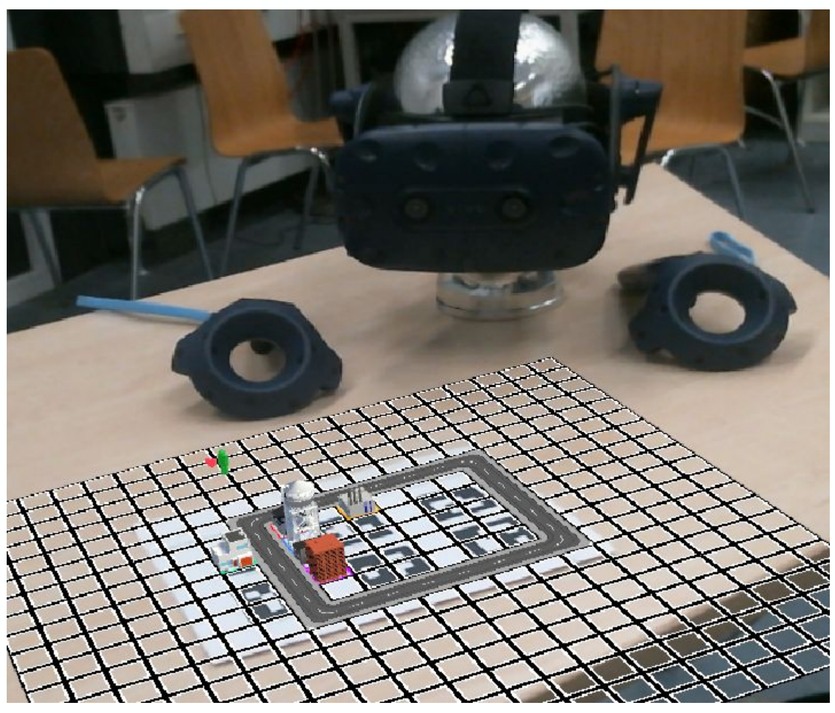

Figure 2: The game space is projected in the AR environment with the aid of ArUco markers.

Hardware & Software

HTC VIVE Pro, primarily a virtual reality (VR) headset, is equipped with two external cameras at 640 x 480 resolution which allows for AR applications. The video input from the resolution is projected onto the headset's two internal displays, providing the user with a low-resolution stereoscopic view of the real world while allowing virtual elements to be easily implemented on top of it. VIVE's SRWorks library provides Unity with prepared image mappings to undo the distortion of those external cameras at low latency to prevent motion sickness.

OpenCV is used in C#, Unity's primary scripting language, to allow for its ArUco implementation to infer the spatial relation between the camera and the markers in the real world.

The SteamVR library enables accurate tracking of the headset and the two controllers' location with the aid of two sensor base stations, meaning virtual objects can be permanently positioned in the AR environment without the need for constant calibrations. The game is primarily interacted through the use of the VIVE controllers that accompany the headset.

Tracking

TableCity relies on two tracking components to augment its city into reality: inside-out marker tracking and the outside-in tracking of the HTC VIVE Pro.

The first one uses OpenCV's ArUco to detect the marker corners which are then used to estimate the marker-camera relationship by solving the PnP problem.

Additionally, VIVE's tracking is used to get the position of the controllers and the head mounted display (HMD) which also gives us the position of the camera.

By combining the two, the game plane can still be displayed even when marker tracking is lost, by assuming static markers.

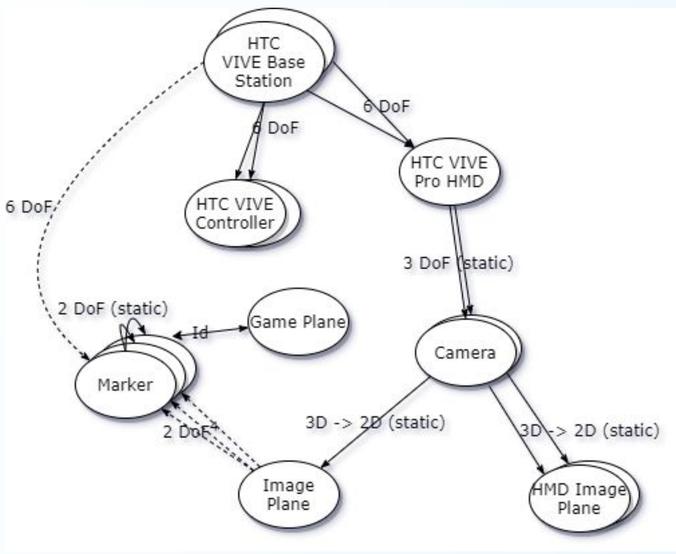

Figure 3: Spatial Relationship Graph (SRG) of TableCity

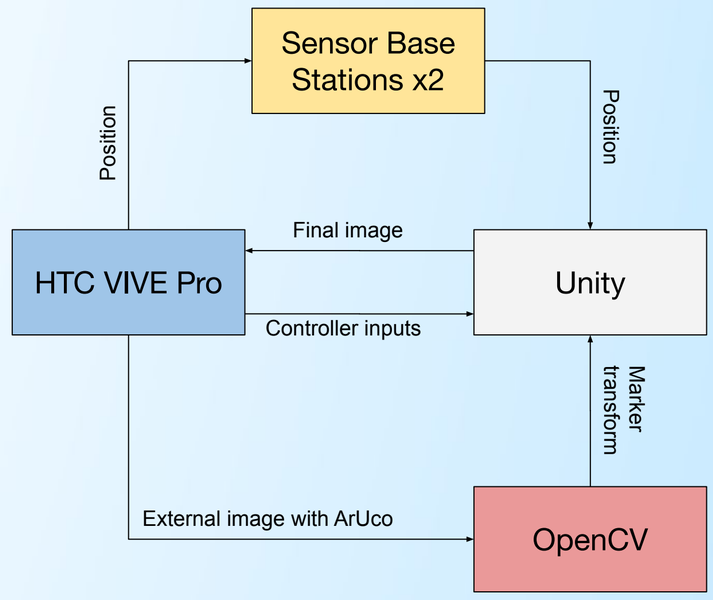

Figure 4: Hardware-software architecture of TableCity