# Mobile Collaborative Augmented Reality with Real-time AR/VR switching


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## 1. Introduction

The recent boom in computing capabilities of mobile devices has led to the introduction of Virtual Reality into the mobile ecosystem. We demonstrate a framework for the Samsung Gear VR headset that allows developers to create a totally immersive AR & VR experience with no need for interfacing with external devices or cables thereby making it a truly autonomous mobile VR experience. The significant benefits of this system over existing ones are - a fully hands free experience where hands could be used for gesture based input, the ability to use the Head Mounted Display (HMD) sensor for improved head and positional tracking and automatic peer to peer network creation for communication between phones. The most important factor in our system is to provide an intuitive way to interact with virtual objects in AR and VR. And users should be able to switch from AR to VR world and vice versa seamlessly.

## 2. System Description

We built a simple game of AR/VR Chess to demonstrate the system. Two users view a natural marker on which the virtual chessboard is displayed when viewed through the Gear VR with the mobile device docked into it. The moves made by one user in the system are visible to the other player upon completion. The marker may be a common marker for the two players or the system may also be extended to allow remote players to have their own marker on which the chess board is displayed. In either case, the game state is transmitted via a peer to peer network. This can be considered as the simplest form of remote collaboration.

**AR/VR World:** In the general case, the chess board may be replaced by any arbitrary 3D model whose state can be modified by the collaborators. The world around this model of interest can be switched to either reality (the augmented reality case) or fantasy (the virtual reality case). In the AR case, because of limitations of a single camera, only the 3d geometry has depth perception while 3D depth is perceivable completely when a switch to a VR environment is made.

**AR-VR Switch:** The user may switch between AR & VR by simply long pressing on the integrated touchpad in the Gear VR. Relative position of the chessboard is maintained same so that the switch from AR to VR is smooth. For the transition from AR to VR be smooth, the camera matrix in AR and in VR should be different.

**Interaction:** We came up with an intuitive scheme for selection and interaction to move the pieces on the chessboard based on gaze based selection. We gaze at a chess piece and tap on the touchpad to select it and do the same gesture for moving it to new location. We use Gear VR's sensor values for getting the gaze location.

## 3. System Design

The system combines multiple experiences into a single application. We built a lightweight application framework suitable for mobile devices for integrating collaborative augmented reality and virtual reality.



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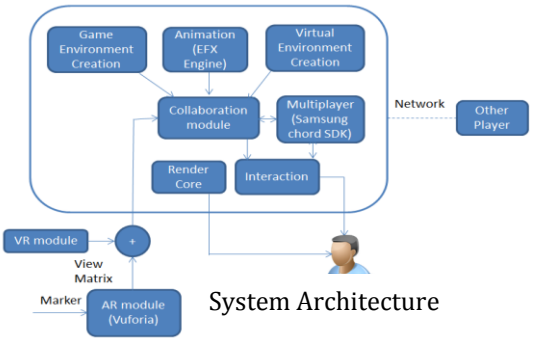

System Architecture

Initial marker tracking for AR is achieved with Qualcomm Vuforia. This extracts the projection and view matrices that allow the creation of a world to match the camera view. The VR module simulates a virtual environment based on the state information from the AR module, to maintain the relative position during AR-VR switch. Animation, model loading and associated bits are handled by the Animation and Effects Engine [VIPIN PATEL ET AL]. The collaboration module is the core of the system that enables hands free interaction. It interacts with all the other modules that handle animation, interaction, networking and game logic. Interaction among the players such as moves and animations are communicated across networks using the multiplayer module built on the publicly available Chord SDK.

| Features | Our Mobile Collaborative Augmented Reality System | Collaborative Augmented reality [1] | Mobile Collaborative Augmented Reality: the Augmented Stroll [2] | Interaction in a Collaborative Augmented Reality Environment[3] |
|---|---|---|---|---|
| Hands free interaction in 3D | ✓ | × | × | × |
| HMD tracking with high accuracy | ✓ | × | × | × |
| Real time AR/VR switching | ✓ | ✓ | × | × |
| Light weight framework for mobile | ✓ | × | ✓ | × |

## 4. Conclusions

We demonstrated a framework for the Samsung Gear VR headset that allows developers to create a totally immersive AR & VR experience with no need for interfacing with external devices or cables thereby making it a truly autonomous mobile VR experience. We also showed the possibility of in place switching between AR & VR while maintaining the state of the world.

## References:


MARK BILLINGHURST, HIROKAZU KATO, Collaborative augmented reality in *Communications of the ACM* - Volume 45 Issue 7, July 2002, pp 64-70.

PHILIPPE RENEVIER, LAURENCE NIGAY, Mobile Collaborative Augmented Reality: The Augmented Stroll in *Engineering for Human-Computer Interaction, Lecture Notes in Computer Science* Volume 2254, 2001, pages 299-316.

HOLGER T. REGENBRECHT, MICHAEL T. WAGNER, Interaction in a collaborative augmented reality environment : *CHI '02 Extended Abstracts on Human Factors in Computing Systems*, pages 504-505.

VIPIN PATEL ET AL, A 3D animation and effects framework for mobile devices in *ACM SIGGRAPH 2014 Posters*. *Article No. 1*