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# Combining the virtual and physical interaction environment

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## 1 Introduction: What does the future look like?

Mark Weiser famously proclaimed a possible future in his 1991 paper ‘A computer for the 21st century’ [1] in which he discusses a world filled with connected devices able to “weave themselves into the fabric of everyday life until they are indistinguishable from it”[1].

We now stand at point in history where ubiquitous computing (ubicomp) can be said to be closer to a reality than ever before. However the definition ubicomp and the proximate future continue to be redefined and evolve as technology and society adapt to new technological paradigm shifts. For example one could argue that the continuing efforts to define and standardize the ‘Internet of Things’ (IoT) appears to be fast becoming the current media-term for Weiser’s original vision.

Alongside these developments a new era of portable, wearable devices harnessing continuing advancements in mobile technology and sensor refinement, promise to revolutionize how we might interact with the wider digitally connected world. These have now evolved to a point where a potentially viable ‘invisible’ computing experience can be integrated into truly mobile multifunction devices.

This paper serves as the introductory part in an investigation into both the metaphysical and cybernetic considerations that influence the potential design of a graphic user interface, which the author has entitled the ‘Xuni Augmented Reality’ interface. By combining the use of a number of devices including a VR headset, a depth sensing camera, alongside a smartphone ‘hub’, it is envisaged that an individual user wearing these devices might be able to operate a mobile, highly responsive and practical ‘mixed reality’ user interface [2], [3].

## 2 Method

### 2.1 Investigation

The hybrid augmented reality system investigation, which the author has entitled ‘Xuni AR’ (Xuni), makes use various devices in concert, functioning together to operate a theoretical interface through ‘a symphony of interaction between multiple smart mobile devices.’ [4]. The purpose of the experiments was to:

- Investigate the likelihood of generating real-time environment data to be used within a Xuni AR interface using a depth sensor.
- Investigate the potential to rapidly integrate low-density meshes into a 3D graphics engine and HMD (Head Mounted Display) related enviornment.

**Compatibility Test One – Processing for Kinect software.** Given the lower level language access Processing for Kinect provides, a greater amount of control over individual Kinect sensor functionality could be implemented. If the Kinect continues to be used the Processing integration may be extended in future testing, if Unity® software proves to be unsuitable for use in this project over the longer term.

**Compatibility Test Two – Skanect software.** 'Skanect' environment capture software was used to create a three dimensional mesh of a physical environment. By capturing depth and point information using the Kinect sensor a high-density 50,000-point mesh was calculated. Skanect is compatible with a portable depth sensor, the 'Structure Sensor', which allows for much higher fidelity and near-real-time dense-mesh generation and analysis, also seen in the Microsoft Kinect Fusion application.

**Compatibility Test Three - Virtual-Reality-Glasses Testing.** As AR glasses were unavailable, a VR device was used. The Oculus Rift DK2 display integrates numerous sensors including a Gyroscope, Accelerometer and Magnetometer calculating momentum and rotation tracking. Oculus Rift also has the provision for an additional input on the HMD itself which could convert the VR HMD into a 'video see-through' AR device. A low-density replica environment of the Creative Arts Building (CAB), University of Huddersfield was integrated into a Unity3D scene file to simulate a real world location using resolution parameters gathered from the earlier Skanect testing.

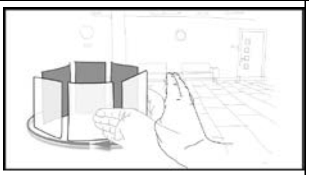
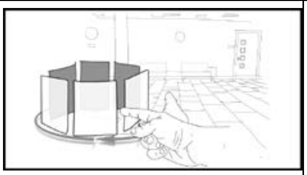
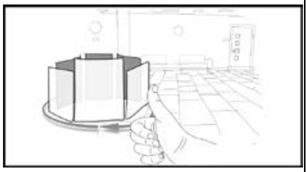
**Summary of Investigation phase.** The Oculus Rift experiments indicate the viability of efficiently combining with the Kinect Sensor depth based data experiments. It can be surmised therefore that designing an interface framework, which assumes the use of a depth aware AR environment could be efficiently generated.

### 2.2 Visualization

This section discusses the considerations for Augmented Reality interface design; the requirement for design research related to Human Computer Interaction (HCI), User Interface design (UI), User Experience Design (UXD) and gesture recognition; and documenting the process of creating a pre-rendered visualization.

The possibility exists, given the additional sensor arrangement included with many commercial depth sensors including the Kinect tested here, that the CG interface might be able to use color data gathered from the physical space to influence the color, lighting and texture of the CG objects. In attempting to visualize how the Xuni AR system might look, an short animation based on findings taken in the invention phase alongside references to other AR and user interface designs was created.

**Table 1.** Gestures referenced from 'User-defined gestures for augmented reality' [5]

| | | |
|---|---|---|
|  |  |  |
| **Fig. 1.** Browsing: Next (using all 4 fingers) | **Fig. 2.** Browsing: Next Item (Index finger) | **Fig. 3.** Editing – Accept: Thumb Up |

**Gesture Recognition.** The design for the Xuni AR system incorporates the use of a pair of 'smart-armbands' to detect and automate control of content displayed on the AR HMD. The armbands integrate a collection of battery operated electromyographic (EMG) sensors in conjunction with other built-in orientation based sensors [6]. They use these sensors to accurately read changes in arm muscle tension, orientation and acceleration. The armbands detect of all this data and match this to a pre-defined set of gestures using specially designed algorithms to filter out random noise. These pre-defined gestures could be amended or added to using developer created API's. Incorporating these factors into the design of the Xuni AR system would allow for measured responsive motion feedback through the AR HMD display.

Gesture recognition taxonomy was implemented referencing the work of HitLabNZ, University of Christchurch, NZ. Their study 'User-defined gestures for augmented reality' [5] records extensive blind testing of various hand poses or 'tasks' that might be implemented within an AR related interface. Using this information three distinct tasks were implemented in the Xuni system animation shown in Table 1.

**Resulting Interface for Xuni AR.** The animation demonstrating a basic Xuni AR interface combines the Xuni system features with the various conventions from the research gathered and illustrates how such an interface might look from a users point of view. To replicate depth-based data, three-dimensional point data was gathered by use of video motion tracking software. This generated a virtual camera that calculated its


**Fig. 4.** 'Browsing: Next' computer graphic simulation.


**Fig. 5.** 'Edit: Accept' computer graphic simulation.

position relative to other scene objects in virtual volume of space. The resulting reference points were then exported to Cinema4D scene file to be time matched with the animated CG interface objects.

**Summary of Visualization Phase.** As this project continues AR interface research and design will continue to inform and amend the prototype draft shown here, with real-time graphic techniques employed to replicate some of the features shown.

## 3 Discussion and Conclusions

The compatibility testing and basic implementation of this Xuni AR service indicate that such a system should be viable given the correct combination of inputs. However the amalgamation of these devices requires careful thought into the means by which they can be fully harnessed to exploit their individual characteristics in search of a truly immersive and productive whole. Alongside the many technical hurdles that need to be overcome in getting the a Xuni styled interface to work properly, challenges still remain in terms of common gestural interface taxonomy and user experience design. The device needs to not just work, it needs to 'disappear' if it is to be truly effective in its operational goals. With this in mind, further analysis into the metaphysical embodiment of a mixed reality interface and its requirement for representational user interaction is now required.

These will inform future research into mixed reality user experience.

## 4 References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