# The Cub-e, a Novel Virtual 3D Display Device

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**Abstract**

We have designed, and are in the process of building, a visualisation device, the *Cub-e*. The Cub-e consists of six TFT screens, arranged in a perspex cube, with a StrongARM processor and batteries inside. It is a multipurpose device with applications including teleconferencing, interaction with virtual worlds, and games.

## 1 Introduction

The Cub-e is a cube with TFT displays on each of its 6 sides. This arrangement of screens allows the user to visualise objects that are "inside" the Cub-e. Motion, position and direction sensors inside the Cub-e allow user interaction with the Cub-e. The Cub-e is analogous to a VR-cave turned inside-out.

As an example of it's use, the Cub-e can show an animation of a lion simultaneously seen from different viewpoints (left, right, front, top, rear). When the Cub-e is rotated, the projections of the lion are changed; i.e. the lion stays in the same orientation relative to the physical world, but the projections on the Cub-e are updated.

The Cub-e is not just useful for visualising 3D objects. It can also be used as 6 synchronised 2D devices, or it can be used as a general output device, allowing a group of people to share a view on a virtual world (something which is difficult to achieve using a flat screen).

## 2 The Prototype Device

The prototype Cub-e that we are developing contains a wearable computer - an ADS Bitsy single board computer; accelerometers that detect pitch, roll and movement; an electronic compass to detect direction; a wireless network connection; and short range radio to detect other Cub-es and wearable computers [1] in the Cub-e's proximity. The Cub-e is powered by a Sony NP-F750 Li-Ion battery pack.

We are using quarter VGA TFT screens as square TFT screens are not readily available. Although the angles at which TFT screens can be viewed are not completely optimal, we expect that future screen technology will allow better viewing angles. Extensions that we envisage include audio I/O, and touch sensitive displays. We are experimenting with software written for MicroWindows running on a Linux platform.

# 3 Using the Cub-e

The Cub-e was originally conceived as a learning toy for young children. However, it quickly transpired that there are many potential uses for the Cub-e as a display device on the boundary of the physical and virtual world.

**Interaction with a virtual world** The object contained in the Cub-e can depend on where the Cub-e is, who is holding the Cub-e, or on the presence of other Cub-es. This way the Cub-e is a device that allows two-way interaction between a virtual world and a user. On one hand, the Cub-e displays an object from a virtual world; on the other hand, the user can move the Cub-e around in the physical world and thereby make changes to the virtual world. For example, when a Cub-e containing a cat and a Cub-e containing a mouse are brought close to each other in the he physical world, the behaviour of the two animals in the virtual world may change.

The binding between the object in virtual space and the Cub-e does not have to be permanent, and may again change based on the users activities, which is similar to the function of the wearable lens [2].

**Tele presence** The Cub-e can be used for tele presence, for example video conferencing, by displaying 5 projections of the persons involved on the Cub-e sides. Instead of projecting a single image on a wall, the Cub-e can be arranged anywhere, and can be viewed by people from all angles. The Cub-e is inherently suitable for use as a shared output device because there is information on more than just one side.

**Games** There are a large variety of games that can be developed for the Cub-e. Rubik's cube can be emulated on the Cub-e; one can develop a variant of the 15-puzzle with bits on all sides; or one can make a "virtual snow-dome". In the last application the user can put a model in the Cub-e (for example a 3D model of their house), which will be covered by snow by the virtual-snow-dome application. When the Cub-e is shaken, the Cub-e can will detect this using the motion sensors, and the snowflakes can be moved around.

The ability to carry a virtual object around in the physical world will probably give rise to several other applications that we have not yet foreseen. Indeed we expect the Cub-e to provide a platform which may initiate serendipitous events.

# References

[1] C. Randell and H. Muller. Context Awareness by Analysing Accelerometer Data. *The Fourth International Symposium on Wearable Computers*, 1(1):175–176, October 2000.

[2] C. Randell and H. Muller. The lens: a position based wearable output device. Technical Report 2001-LR-1, University of Bristol, Mar. 2001.