

# 360<sup>2</sup>: Turning an Ordinary Rotating Metal Disk into a Unique Interactive Exhibit

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**360<sup>2</sup> is an interactive system that allows exploration of digital representations of real artifacts through physical and multi-touch interaction with a double rotating gimbal (i.e., a disk that the user can freely rotate around two axes). While the user manipulates the disk, the system uses a projector to augment a display upon it. User input is supported both through fingertip contact (i.e., multi-touch) and disk rotation in both axes. In addition to the disk, a secondary projection surface is provided for additional information, upon which multi-touch gestures are supported.**

A key innovation of the 360<sup>2</sup> system [1] is the fact that both the metal disk and the secondary projection surface do not integrate any technological element. This is achieved by a computer vision system that employs a depth camera that is hidden above the installation. Using the depth images, the system estimates the disk's orientation, and detects and localizes fingertip contact with the disk [2]. This information is employed for supporting user interaction, but also for appropriately warping the projected visual content so that it appears undistorted on the disk's surface. The 360<sup>2</sup> system was developed in the context of the "Ambient Intelligence Programme" of the Institute of Computer Science of the Foundation for Research and Technology – Hellas (FORTH-ICS).

Three different applications of the system are currently available:

## 1. Stater 360<sup>2</sup>

This application allows users to "take into their hands" coins at a large scale.

*Figure 1: Installation of Stater 360<sup>2</sup> at the Archaeological Museum of Thessaloniki, Greece.*



Whilst in an idle state, a collection of coins is presented on the disk's surface. If a user rotates the disk, the coins slide and collide following the disk's motion and tilt, as if they were real objects. When a coin is selected it grows until it covers the whole surface of the disk (Figure 1). The user can access the other side of the coin simply by rotating it. Furthermore, by touching the coin's surface, a menu offering four choices becomes available: a) access a magni-

fying glass that can be freely dragged over the coin's surface; b) see a map on which the coin's place of origin is highlighted; c) read textual information about the current side of the coin; d) shrink the coin back to its original size, revealing the whole collection again. On the secondary projection surface detailed information about the coin's place of origin is offered, along with buttons for language selection. Stater 360<sup>2</sup> is currently being exhibited



*Figure 2: Installation of Phaistos Disk 360<sup>2</sup> at the information office of the Municipality of Heraklion in Crete, Greece.*



*Figure 3: Installation of Artefact 360<sup>2</sup> at the premises of ICS-FORTH.*

as part of the exhibition entitled “The Europe of Greece - Colonies and Coins from the Alpha Bank Collection” at the Archaeological Museum of Thessaloniki.

## 2. Phaistos Disk 360<sup>2</sup>

This version of the system (Figure 2) was developed for, and is installed at, the information office of the Municipality of Heraklion in Crete. City visitors can interact with a large-scale digital recreation of the Phaistos Disc, one of the most famous archaeological findings in Crete. The original clay disc, dating back to c. 1700 BC., is 16 cm in diameter and its two sides bear a total of 242 enigmatic signs in an unknown language. The system installation comprises a metal disk manufactured to offer a feeling of clay. Users can flip the disk to see its back side or rotate its surface to have a better view of the symbols which are arranged in spiral format. A touch on the disk can provide information about each side. Furthermore, a magnifying glass is available and a study tool, allowing to access information about individual or

groups of symbols. Except for language selection, the secondary projection surface provides access to alternative rendering of the disk’s surface.

## 3. Artifact 360<sup>2</sup>

Artifact 360<sup>2</sup> supports the exploration of artifacts in 360 degrees (Figure 3). By rotating the disk around the vertical axis, the user can see 360 different views of the artifact, as if the actual object was placed behind the disk’s surface, thus creating a 3D visualization effect. By tilting the disk surface, the user can access alternative lighting settings, revealing different details of the artifact. When the user touches the metal surface, hotspot areas of the current view are presented. Upon touching a hotspot, related information is presented. Additionally, using two fingers, the user can magnify different parts of the presented image.

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## References:

- [1] P. Koutlemanis, et al.: “A Steerable Multitouch Display for Surface Computing and its Evaluation”, Int. Journal on Artificial Intelligence Tools, Vol. 22, No. 6, 1360016, World Scientific Publishing Company, 2013.  
 [2] X. Zabulis, P. Koutlemanis, D. Grammenos: “Augmented multitouch interaction upon a 2-DOF rotating disk”, in Advances in Visual Computing, Springer, LNCS Vol. 7431, pp. 642-653, 2012.

## Links:

- [1] <http://www.ics.forth.gr/ami>  
 [2] Youtube video: <http://youtu.be/ltobJ-RBgao>

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# LecceAR: An Augmented Reality App for Cultural Heritage

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**Augmented Reality (AR) - the augmentation of a physical world’s view with digital media - has recently gained popularity thanks to the increasing computational power and diffusion of mobile devices such as tablets, and smartphones. These developments allow many practical applications of AR technology, especially in the cultural heritage domain. LecceAR is an advanced app that allows tourists to view rich 3D reconstructions of cultural heritage sites within the city of Lecce in Italy.**

LecceAR is an iOS app for markerless AR that will be exhibited at the MUST museum in Lecce, Italy. The app shows a rich 3D reconstruction of the Lecce Roman amphitheatre, which is only partially unearthed (see Figure 1). The use of state-of-the-art algorithms in computer graphics and computer vision allows an ancient theatre to be viewed and explored in real-time.

LecceAR is the result of a joint collaboration between different institutes of the Italian National Research Council (CNR). In fact, it was developed by the Visual Computing Laboratory (ISTI-CNR), NeMIS (ISTI-CNR), and IBAM-CNR, as a deliverable for the Italian

project “DiCeT: Living Lab di Cultura e Tecnologia” (PON04a2\_D). This project began in early 2013 and has been showcased, including LecceAR, at the MUST museum in Lecce during an exhibition in September 2015.

Although commercial AR frameworks exist and provide compelling prices, they usually have low quality rendering engines. For example, they may have limits in the number of triangles to be rendered for a 3D object, and on customization of the final visualization. These are key issues especially in the cultural heritage domain, which requires large 3D models that are typically the output of a 3D scanning cam-

paign. Therefore, we opted to develop a from-scratch app to have enough flexibility and the capability to render large and complex 3D models.

LecceAR was developed using standard computer vision and graphics libraries; i.e. OpenCV and OpenGL. The app comprises two modules: a matching and tracking module, and a renderer.

The first module, ‘MaTrack’, processes frames coming from the device’s camera in order to establish whether or not they contain a known target image. If a frame contains a target, the module computes a geometric transformation mapping the target onto the video