An Interactive Table Supporting Mobile Phone Interaction and 3D Content

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Abstract
Due to the small user interfaces (UI) and screen displays of mobile phones it is inconvenient for multiple users to access and view content on phones simultaneously. As such, integrating multi-touch interactive tables with users' interactions with the content on their phones can be seen as one approach to augment their experience of viewing that content which becomes as a result unlimited to single phone, or single user anymore. In this paper we show a system that implements this augmented integration through utilising Bluetooth, NFC (Near Field Communication), and 3D graphics, which is aimed for medical students.

Keywords
Mobile phones, interactive tables, 3D graphics, content sharing.

ACM Classification Keywords
H.5.2 Information Interfaces and Presentation: User Interfaces – *Input devices and strategies; Prototyping.*

Introduction
Mobile phones are personal devices that hold various personal content such as photos, videos, contacts, etc. Viewing this content on the small screen display of phones is acceptable for a single user and for assuring

the privacy of browsing. However, when it comes to sharing the viewing with other users simultaneously, the limited phone UI and display fail to deliver acceptable user experiences as those in single-user scenarios. The small screen allows for two or three users to have a clear view of the displayed material without the hassle experienced when trying to locate and move more viewers around the phone to have direct line-of-sight to its screen.

Several approaches and technologies have emerged to overcome this over-the-shoulder form of interaction. The most noticeable is the use of projectors, whether built-in or externally attached, to allow the projection of content onto any surface [2], allowing thus a multi-user access. Another solution relies on pairing the phone with a public display to present the content to be shared [1]. Both applications however encounter the limitation of having only one user in control of the interaction with the displayed content.

A more conceivable approach is based on integrating the mobile phone with a multi-touch interactive table [3] which receives the content from the phone and lays it on the surface for multiple users to view and interact with; hence, removing the burden of the limited access. The research conducted here focuses on this integration and it utilises Bluetooth, NFC, 3D content and 3D manipulation to facilitate it for a group learning interactive experience in the medical domain.

The next section gives an overview of the system presented in this paper followed by a discussion of its implementation. After that the experiments conducted on the system and the possible future work are both covered before we draw our conclusion.

System Rationale

The system presented here demonstrates how mobile phones and interactive tables can cooperatively work together for more collaborative interaction experience for medical students with medical content on their phones. Unlike most existing systems, it manipulates 3D content rather than 2D ones. The student basically carries this content on her phone and shares it with others over the table to promote a group discussion. She does so by touching an NFC tag on the table with her NFC-enabled phone to identify the Bluetooth address of the server to connect to. Once identified and connected the server receives and displays the transmitted 3D content on the surface of the table, as demonstrated in figure 1. Here a detailed anatomical model of the upper leg muscle and bone construction segmented from MRI scan data has been used. Students are capable then of manipulating the model and its components through different 2D gestures on the table. They can move, rotate, zoom in/out, enable/disable its parts, and change their transparency.

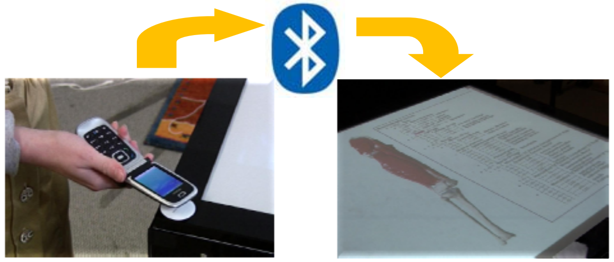


figure 1. Overall work flow of the system.

The OSG (Open Scene Graph) graphics library has been used to implement the viewer that renders these 3D models and facilitates its manipulations. This library handles windows-based single-input events through one mouse pointer. It cannot handle multiple input pointers and this is not useful when it comes to interacting with multi-touch tables. This limitation has been resolved here through the use of the TUIO [4] open-source framework as shall be detailed next.

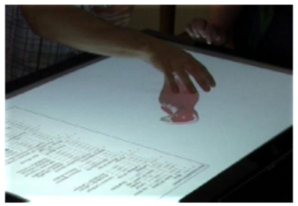
Implementation

In this section we illustrate how the three components of the system, interactive tables, mobile phones and 3D graphics, have been implemented to deliver the integrated interactive experience for medical students.

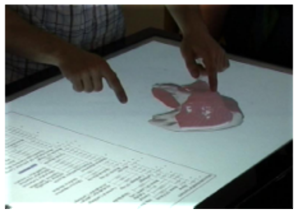
Interactive Table

The integral component of the system is the multi-touch interactive table which is basically a composition of various technologies (infrared light, infrared camera, and projector) integrated together in one box and coordinated through computer-vision software [6].

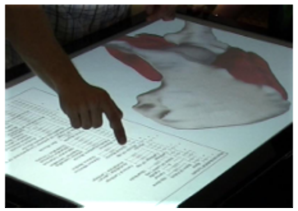
a. Moving – five fingers



b. Rotating – four fingers



c. Zooming– two fingers



d. Selecting – one finger

figure 2. The different interaction forms with the table.

The table uses the Windows operating system and inherently supports single-pointer events. Many solutions have been introduced to overcome this limitation and the TUIO framework is one example. It defines a protocol and an API for tangible multi-touch interfaces which have been integrated into OSG to translate multiple touches on the table surface to corresponding single-pointer events that it handles. In this case, moving five fingers along the surface of the table triggers the "move" action of the 3D model as in figure 2.a. Moving four fingers will rotate the model in the appropriate rotation angle, figure 2.b. And dragging two fingers towards each other zooms out the model and dragging them apart zooms in, figure 2.c.

Mobile Phone

A Java ME application has been implemented to handle the detection of and the connection to the server. Both NFC and Bluetooth have been utilized to accomplish this. NFC is a short-range high-frequency wireless technology which utilizes touch as a way of interaction between two phone terminals, or between a phone and an NFC tag [5]. The system here adopts the second case where a student touches an NFC tag on the table with her NFC phone to identify the Bluetooth address of the server. Then the mobile application initiates the authorized Bluetooth connection and sends the 3D model across in XML format which is then parsed and rendered by the 3D viewer.

3D Models

The transferred model is a 3D model of the upper leg muscle and bone construction and it is part of the "3D Anatomical Human" project [7] whose purpose is to study the anatomical and functional aspect of the musculoskeletal system. A medical student can interact with the model's different parts by touching them directly on the table. She can tap the muscle or bone of interest on the 3D model and see its corresponding name on a side menu that is displayed along with the model on the table. In addition, the user can disable parts of the 3D model in order to help her closely diagnose specific bones or muscles. And she can even control the transparency of any of its parts to allow a see-through experience. Both these actions are triggered when one finger touches the surface of the table as figure 2.d above shows.

User Experience and Future Work

From the preliminary tests conducted during development and shooting the video for the demo application presented here it was evident that interacting with 3D models on a wide scale display directly without any intermediary peripherals (e.g. mouse, keyboard, joystick, etc.) has appealed to users. They found the 2D gestures that simulate the 3D manipulations easy to apply.

More dedicated user trials with medical students, and maybe doctors, are planned to be performed. This is expected to give more specialised recommendations regarding the content to be displayed and even the way of manipulating it on the table to suit the way doctors interact with anatomical material during their practices.

A further work will be carried out to allow multiple users to upload content onto the table simultaneously. This could facilitate an interchange of knowledge within the formed group. And the table would be sensitive to the location of those multiple users around it and thus display content in the appropriate orientation.

Conclusion

The novelty of the presented research here lays first in the usage of NFC for establishing a connection between a mobile phone and a multi-touch table and secondly in the mapping of 2D finger gestures for interactions to 3D manipulations. This is used for integrating mobile phones and tables which can open new doors for collaborative interactions that can engage multiple users at a time in various domains such as education, entertainment and even commerce. Adding 3D graphics enhances their experience even further which helps in creating an immersive group learning experience.

Acknowledgement

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