

Latest Technologies in Surface Computing

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Abstract: *The name Surface comes from "surface computing" and Microsoft envisions the coffee-table machine as the first of many such devices. Surface computing uses a blend of wireless protocols, special machine-readable tags and shape recognition to seamlessly merge the real and the virtual world — an idea the Milan team refers to as "blended reality." The table can be built with a variety of wireless transceivers, including Bluetooth, Wi-Fi and (eventually) radio frequency identification (RFID) and is designed to sync instantly with any device that touches its surface. It supports multiple touch points – Microsoft says "dozens and dozens" -- as well as multiple users simultaneously, so more than one person could be using it at once, or one person could be doing multiple tasks. The term "surface" describes how it's used. There is no keyboard or mouse. All interactions with the computer are done via touching the surface of the computer's screen with hands or brushes, or via wireless interaction with devices such as Smartphone's, digital cameras or Microsoft's Zune music player. Because of the cameras, the device can also recognize physical objects; for instance credit cards or hotel "loyalty" cards. For instance, a user could set a digital camera down on the tabletop and wirelessly transfer pictures into folders on Surface's hard drive. Or setting a music player down would let a user drag songs from his or her home music collection directly into the player, or between two players, using a finger – or transfer mapping information for the location of restaurant where you just made reservations through a Surface tabletop over to a smartphone just before you walk out the door.*

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1. Introduction

Over the past couple of years, a new class of interactive device has begun to emerge, what can best be described as "surface computing". Two examples are illustrated in this report. They are Surface Table top, Perceptive Pixel. The Surface table top typically incorporates a rear-projection display coupled with an optical system to capture touch points by detecting shadows from below. Different approaches to doing the detection have been used, but most employ some form of IR illumination coupled with IR cameras. With today's camera and signal-processing capability, reliable, responsive and accurate multi-touch capabilities can be achieved. The multi-touch pioneer and his company, Perceptive Pixel, have devoted the better part of two years for building an entirely new multi-touch framework from the ground up. Instead of simply mapping multi-touch technology to familiar interfaces and devices, Han's goal is far more sweeping. Because they are new to most, the tendency in seeing these systems is to assume that they are all more-or-less alike. Well, in a way that is true. But on the other hand, that is perhaps no more so than to say that all ICs are more-or-less alike, since they are black plastic things with feet like centipedes which contain a bunch of transistors and other stuff. In short, the more that you know, the more you can differentiate. But even looking at the two systems in the photo, there is evidence of really significant difference. The really significant difference is that one is vertical and the other is horizontal. Why is this significant? Well, this is one of those questions perhaps best answered by a child in kindergarten. They will tell you that if you put a glass of water on the vertical one, it will fall to the floor, leading to a bout of sitting in the corner. On the other hand, it is perfectly safe to put things on a table. They will stay there.

2. What is Surface Computing?

Surface computing is a new way of working with computers that moves beyond the traditional mouse-and-keyboard experience. It is a natural user interface that allows people to interact with digital content the same way they have interacted with everyday items such as photos, paintbrushes and music their entire life: with their hands, with gestures and by putting real-world objects on the surface. Surface computing is a completely using your hands or placing other unique everyday objects on the surface – such as an item you're going to purchase at a retail store or a paint brush – you can interact with, share and collaborate like you've never done before. Imagine you're out at a restaurant with friends and you each place your beverage on the table – and all kinds of information appears by your glass, such as wine pairings with a restaurant's menu. Then, with the flick of your finger, you order dessert and split the bill. We really see this as broadening content opportunities and delivery systems. Surface computing is a powerful movement. In fact, it's as significant as the move from DOS [Disk Operating System] to GUI [Graphic User Interface]. Our research shows that many people are intimidated and isolated by today's technology. Many features available in mobile phones, PCs and other electronic devices like digital cameras aren't even used because the technology is intimidating. Surface computing breaks down those traditional barriers to technology so that people can interact with all kinds of digital content in a more intuitive, engaging and efficient manner. It's about technology adapting to the user, rather than the user adapting to the technology. Bringing this kind of natural user interface innovation to the computing space is what Surface Computing is all about.

3. Hardware Design

By late 2004, the software development platform of Surface was well-established and attention turned to the form factor. A number of different experimental prototypes were built including "the tub" model, which was encased in a rounded plastic shell, a desk-height model with a square top and cloth-covered sides, and even a bar-height model that could be used while standing. After extensive testing and user research, the final hardware design (seen today) was finalized in 2005. Also in 2005, Wilson and Bathiche introduced the concept of surface computing in a paper for Gates' twice-yearly "Think Week," a time Gates takes to evaluate new ideas and technologies for the company.

4. From Prototype to Product

The very next phase of the development of Surface focused on the concept to product. Although much of what would later ship as Surface was determined, there was significant work to be done to develop a market-ready product that could be scaled to mass production. In early 2006, Pete Thompson joined the group as general manager, tasked with driving end-to-end business and growing development and marketing. Under his leadership, the group has grown to more than 100 employees. Today Surface has become the market-ready product once only envisioned by the group, a 30-inch display in a table-like form factor that is easy for individuals or small groups to use effectively. The translucent surface lets people communicate with Surface using touch, natural hand gestures and physical objects placed on the surface. Years in the making, Microsoft Surface is now poised to transform the way people dine, entertain and live.

5. Key Attributes

Surface computing features four key attributes:

5.1 Direct Interaction

Users can actually "grab" digital information with their hands and interact with content through touch and gesture, without the use of a mouse or keyboard.

5.2 Multi-touch Contact

Surface computing recognizes many points of contact simultaneously, not just from one finger as with a typical touch screen, but up to dozens and dozens of items at once.

5.3 Multi-User Experience

The horizontal form factor makes it easy for several people to gather around surface computers together, providing a collaborative, face-to-face computing experience.

5.4 Object Recognition

Users can place physical objects on the surface to trigger different types of digital responses, including the transfer of digital content.

6. Technology behind Surface Computing

Microsoft Surface uses cameras to sense objects, hand gestures and touch. This user input is then processed and

displayed using rear projection. Specifically: Microsoft Surface uses a rear projection system that displays an image onto the underside of a thin diffuser. Objects such as fingers are visible through the diffuser by series of infrared-sensitive cameras, positioned underneath the display. An image processing system processes the camera images to detect custom tags, fingers and other objects such as paint brushes when touching the display. The objects recognized with this system are given to applications running in the computer so that they can react to shapes, 2D tags, movements and touch. The key components of surface computing are a "multi touch" screen. The idea that has been floating around the research community since the 1980s and is swiftly becoming new product interface — Apple's new iPhone has multi touch scrolling and picture manipulation. Multi-touch devices accept input from multiple fingers and multiple users simultaneously, allowing for complex gestures, including grabbing, stretching, swiveling and sliding virtual objects across the table. And the added advantage of a horizontal screen, so several people can gather around and use it together. Its interface is the exact opposite of the personal computer: cooperative, hands-on, and designed for public spaces.

7. Microsoft Surface Overview

Microsoft Surface turns an ordinary tabletop into a vibrant, interactive computing experience. The product provides effortless interaction with digital content through natural gestures, touch and physical objects. In Essence, it's a surface that comes to life for exploring, learning, sharing, creating, buying and much more. Currently available in select restaurants, hotels, retail establishments and public entertainment venues, this experience will transform the way people shop, dine, entertain and live. Surface is a 30" display in a table like form factor that's easy for individuals or small groups to interact with in a way that feels familiar, just like in the real world. Surface can simultaneously recognize dozens and dozens of movements such as touch, gestures and actual unique objects that have identification tags similar to bar codes. Surface computing breaks down traditional barriers between people and technology, changing the way people interact with all kinds of everyday content, from photos to maps to menus. The intuitive user interface works without a traditional mouse or keyboard, allowing people to interact with content and information by using their hands and natural movements. Users are able to access information either on their own or collaboratively with their friends and families, unlike any experience available today.

7.1 Hardware

Essentially, Microsoft Surface is a computer embedded in a medium-sized table, with a large, flat display on top that is touch-sensitive. The software reacts to the touch of any object, including human fingers, and can track the presence and movement of many different objects at the same time. In addition to sensing touch, the Microsoft Surface unit can detect objects that are labeled with small "domino" stickers, and in the future, it will identify devices via radio-frequency identification (RFID) tags. The demonstration unit I used was housed in an attractive glass table about three feet high, with a solid base that hides a fairly standard computer equipped

with an Intel Core 2 Duo processor, an AMI BIOS, 2 GB of RAM, and Windows Vista. The team lead would not divulge which graphics card was inside, but they said that it was a moderately-powerful graphics card from either AMD/ATI or NVIDIA.

7.1.1 Screen

A diffuser turns the Surface's acrylic tabletop into a large horizontal "multi-touch" screen, capable of processing multiple inputs from multiple users. The Surface can also recognize objects by their shapes or by reading coded "domino" tags.

7.1.2 Infrared

Surface's "machine vision" operates in the near-infrared spectrum, using an 850-nanometer-wavelength LED light source aimed at the screen. When objects touch the tabletop, the light reflects back and is picked up by multiple infrared cameras with a net resolution of 1280 x 960.

7.1.3 CPU

Surface uses many of the same components found in everyday desktop computers — a Core 2 Duo processor, 2GB of RAM and a 256MB graphics card. Wireless communication with devices on the surface is handled using Wi-Fi and Bluetooth antennas (future versions may incorporate RFID or Near Field Communications). The underlying operating system is a modified version of Microsoft Vista.

7.1.4 Projector

Microsoft's Surface uses the same DLP light engine found in many rear-projection HDTVs. The footprint of the visible light screen, at 1024 x 768 pixels, is actually smaller than the invisible overlapping infrared projection to allow for better recognition at the edges of the screen.

7.2 System Software

Microsoft Surface works much like another Microsoft product, Media Center, in that the main application runs on top of Windows and takes over the whole screen. Like Media Center, it is designed to be difficult to exit the application without using a mouse or keyboard. I asked if the Surface team considered allowing the user to drop into Windows mode while retaining the touch functionality, but they felt that the product worked better if it stayed in this mode.

The various demonstration programs are accessed from a main menu, which scrolls left and right in an endless loop. The user moves the selection by swiping back and forth and selects an application with a single tap. This works reasonably well and feels quite natural. When an application is selected, a swirly purple ring appears in the center of the screen to indicate that the program is loading. There were eight different programs available: Water, Video Puzzle, Paint, Music, Casino, a T-Mobile demonstration app, and Dining. Much of the software was written using Microsoft's WPF (Windows Presentation Foundation), though the XNA development toolkit, a framework originally created for writing PC and Xbox 360 games, is also supported. XNA allows programmers to use managed code written in C# to manipulate various DirectX features; managed code frees the programmer from worrying about handling memory,

allocating and discarding memory automatically. This approach has allowed Microsoft and its partners to write impressive-looking demonstration programs for Surface more quickly than would otherwise be possible.

8. Applications

Applications like Water, Paint, Video Puzzle, Photos are designed for the Surface.

9. Surface Computing in Future

Although surface computing is a new experience for consumers, over time Microsoft believes there will be a whole range of surface computing devices and the technology will become pervasive in people's lives in a variety of environments. As form factors continue to evolve, surface computing will be in any number of environments like schools, businesses, homes and in any number of form factors like part of the countertop, the wall or the refrigerator.

10. Conclusion

Some people will look at Surface and claim that it does nothing that hasn't been tried before: computers with touch screens have been around for years and have already found niches in ATMs, ticket ordering machines, and restaurant point-of-sale devices. This view largely misses the point of the product. Like most projects, Surface takes existing technology and presents it in a new way. It isn't simply a touch screen, but more of a touch-grab-move-slide-resize-and-place-objects-on-top-of-screen and this opens up new possibilities that weren't there before. Playing with the unit felt a bit like being in the movie *Minority Report* (In a good way), but it also felt like a more natural and enjoyable method of doing certain computing tasks. Sharing and looking at family photos, for example, is more fun on Surface than on any other device. The retail applications, particularly the dining application, show how businesses could use the technology to really stand out from competitors, though one wonders how diners will react when their table locks up and needs a reboot. Many people who viewed the early Xerox PARC demonstrations of the GUI came out of that experience knowing that every computer would work that way someday, and they were right. Playing with Surface, one gets the sense that although not every computer will work like this someday, many of them will. More importantly, computers running Surface-like software will end up in places that never had computers before, and the potential applications are exciting. Imagine a multiplayer real-time strategy game where you and another human opponent can move units around as quickly as you can point to them or perhaps an educational environment, where university students could assemble and disassemble anything from molecules to sky scrapers quickly and easily.

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