DViT™

Digital Vision Touch Technology

White Paper

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Contents

Summary

This paper describes digital vision touch (DViT) technology, a new technology developed by SMART Technologies Inc. It outlines existing touch systems and their limitations, such as dependence on special pen tools and restricted application to large-format, rear-projection displays. It describes how DViT technology works and explains how it overcomes the limitations of other systems by enabling both high image quality and intuitive use. Finally, it describes the initial products in which DViT technology is currently being used.

Introduction

From digital television to high-resolution projectors, we're constantly searching for superior image quality. As displays improve, images come to life with clarity and vivid colors. Adding touch control to a display makes images seem even more real and gives users an intuitive control over information that static displays lack. But touch control also brings challenges. It often requires a layered screen that can reduce the image quality, or it relies on special tools that can be lost or damaged or that need batteries which may run out of power. Scaling to different display sizes may also be difficult.

Digital vision touch (DViT) technology (several U.S. and foreign patents pending), developed by SMART Technologies Inc., breaks through these challenges with a new, unique system that overcomes the problems of existing touch technologies. DViT technology brings high-accuracy interactivity to a display without compromising usability or image quality.

Background: Touch Technologies

We encounter touch technology almost daily, whenever we use an interactive kiosk, a personal digital assistant or a bank machine. Touch control frees us from dependence on keyboards and makes it quick and easy for us to access and modify electronic information. Touch systems use technology designed to track contact on a surface and transmit that information to a computer.

Touch technology can be divided into two broad categories: passive and active. Passive systems do not require a special pointer to activate the touch surface, only the user's finger or any other pointing device. Active systems, on the other hand, require a special device to contact the touch surface, usually a unique, powered stylus.

Passive Touch Systems

Because they don't rely on special pointing devices, passive touch systems depend on technology in their surface area to register contact. Passive systems include:

- Analog Resistive (AR) – Two sheets coated with a resistive material are separated by an air gap. Pressure applied to the surface brings the sheets together and registers a contact point.
- Surface Acoustic Wave (SAW) – Transducers vibrate a glass surface to produce acoustic waves across the glass. Touch contact interrupts these waves, and reflectors along the border help determine the position of this contact point.
- Capacitive – Circuits at the corners of a charge-carrying glass panel register a current when a finger touches the surface. Frequency changes determine the position of the contact.
- Infrared Light-Emitting Diode (LED) – Infrared LED transmitters line two borders of a surface, while photoreceptor receivers line the other two borders. When an object comes between the transmitters and receivers, it breaks the infrared path and registers a contact point.

Passive touch systems are durable and do not require special tools that could be lost or broken, so they're often appropriate for high-traffic environments. Both AR and capacitive systems, for instance, are used in restaurants, and AR systems are often used in electronic and interactive whiteboards in schools.

There can, however, be disadvantages. Passive touch technology is not ideal for rear-projection displays because it compromises image quality. With SAW systems, the thick glass needed to conduct the sound waves produces a noticeable parallax in the image.

Capacitive and infrared LED systems have other drawbacks. With infrared LEDs, the physical size of the LEDs limits the number of photoreceptors and transmitters and therefore limits the resolution of the touch panel. Capacitive systems are sensitive to temperature and humidity and must be touched only by an ungloved finger, not a stylus or other tool, because they rely on physical capacitance. Moreover, neither capacitive nor infrared LED systems scale well to large sizes.

Active Touch Systems

Active systems don't always require a special touch surface, but they do require a special pointing device. Active touch technology includes:

- Electromagnetic – A digitizing screen communicates with a battery-powered pen or a pen containing a magnetic coil (a tuned resonant circuit).
- Ultrasonic and Infrared – Infrared sensors and ultrasonic technology track a battery-operated pen.
- Laser/Bar Code – A laser scans a surface and detects the reflective, bar-coded sleeve on a pen.

Electromagnetic systems produce high touch resolution, so they're suitable for the precise functions of such items as drawing pads. Moreover, electromagnetic technology can detect when the pen is touching the surface and when it's being held just slightly above, so it has the hovering capability of a computer mouse. Users can also rest their hands on an electromagnetic surface without interfering with the touch signal – all communication occurs between the pen and surface alone.

However, electromagnetic systems require a wire grid that makes them difficult to scale up for large plasma and rear-projection displays. The reliance on a pen tool can also be a problem for locations in which the pen might go missing.

Active systems are weakened by this dependence on a pen tool that could be lost or broken or that requires batteries which need replacing. Ultrasonic and laser systems have additional pen sensitivities because the user might inadvertently block the transmission. With ultrasonic systems, the user must hold the pen a certain way and exert enough pressure to produce sound waves. Laser technology relies on the pen's bar code, so if the user blocks this code – by putting a hand or finger over that portion of the pen, for instance – the signal will be lost.

Digital Vision Touch (DViT) Technology

DViT technology overcomes the limitations of traditional touch systems. Requiring neither a special touch screen nor a special pointer, it facilitates high image clarity and delivers high touch accuracy.

The Technology

The system is based on digital cameras. Four cameras, one in each corner, constantly scan the surface to detect a target object (Figure 1). When a camera detects a target, its processor identifies the affected pixel and calculates the angle at which it occurs.

Figure 1: DViT Technology Camera

The location of this contact cannot be determined from one angle alone. Therefore, each camera detects the target and calculates its own angle. SMART has developed mathematical formulas that automatically record the distance between two cameras and their viewing angles in relation to each other. With this information known, the technology can then triangulate the location of the contact point (Figure 2).

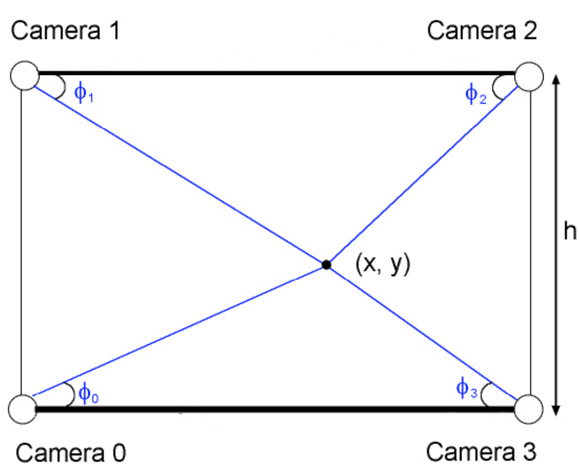

Figure 2: Camera Identification of a Contact Point

Mathematically, only two cameras are needed to calculate a contact point. But to ensure a robust system, DViT technology uses four cameras and has every camera pair report its triangulated result. The location of the contact point is sent to the user's computer. Users can navigate computer applications and Web sites, or write on the surface, and all information is transmitted to the computer as mouse clicks or electronic ink.

DViT technology enables two additional options. First, it's possible to detect both when an object contacts the surface and when it hovers above it. The cameras scan a layer of stacked pixels. If an object breaks into this pixel area, it registers with the cameras regardless of whether it has touched the surface. Second, DViT technology prevents a second object from interfering with the first. If two objects contact the touch surface, the cameras ignore the second object.

The Benefits

DViT technology is reliable and flexible and has numerous other benefits. When using a DViT-technology-enabled touch surface to control computer applications, mouse clicks and writing are very precise, even with the lightest touch. Touch accuracy is very high, because the specially designed cameras have a high frame rate (100 FPS) and support fast image-processing techniques.

DViT technology also has benefits for durability and image quality. It's durable because, unlike touch systems in which the technology resides in the screen material, the cameras and processors reside only in the corners, protected from day-to-day contact. In addition, it doesn't require a special pen or pointer that can be lost or broken. Since it doesn't require a layered touch screen, DViT technology also won't obscure the high-quality images of plasma and rear-projection displays.

This technology also has great potential for future touch systems. First, it's scalable to almost any practical size because the technology resides in the corners, not the surface area. Second, as digital cameras improve, so can DViT technology. In the future, it may even be possible to have simultaneous multiple touch and to distinguish between different pointers.

Comparison: DViT Technology and Other Touch Systems

DViT technology delivers all of the advantages of other touch systems while overcoming their limitations. It combines the intuitive and flexible attributes of passive systems with the precision of active systems. At the same time, it overcomes the problems of rear-projection image quality and pen dependency. Finally, it adds other advantages, such as scalability and hover capabilities, that give it much promise for the future (Figure 3).

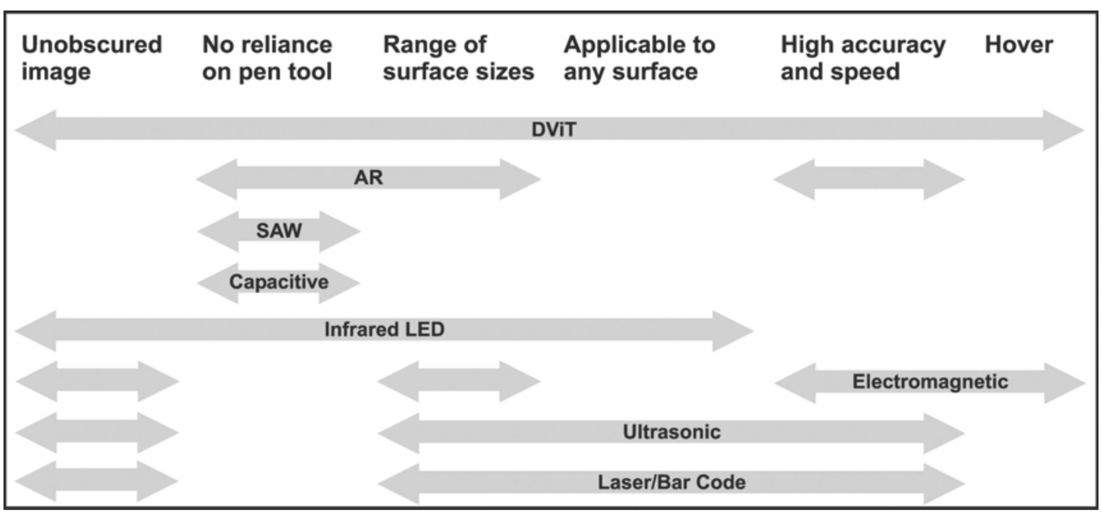

Figure 3: Touch Technologies Comparison

DViT Technology in SMART Products

SMART is using DViT technology in two products formerly dependent on analog resistive technology: the *Rear Projection* SMART Board™ 3000i and SMART Board *for Plasma Displays* interactive whiteboards. The 3000i consists of an interactive whiteboard and projector in a space-saving, mobile cabinet (Figure 4). The SMART Board *for Plasma Displays* interactive overlay gives a plasma display panel all the functionality of an interactive whiteboard (Figure 5).

Figure 4: *Rear Projection* SMART Board 3000i Interactive Whiteboard

Figure 5: SMART Board *for Plasma Displays* Interactive Overlay

With DViT technology, these products now have greatly improved image quality. The 3000i with DViT technology is 34 percent brighter than the former analog resistive model (lights-on measurements). The contrast ratio is over twice as good, registering an improvement of 136 percent. The overlay's brightness has increased by 21 percent and the contrast by 15 percent.

In addition, the products deliver high precision and remain easy to use. The cameras and processors reside in the corners and track all touch contact. The surface consists of an anti-reflection, anti-glare material that's durable, touch friendly and easy to clean. A user simply touches the surface with a finger to control computer applications, navigate Web sites, and write and edit notes (Figure 6). The products enable dynamic, easy-to-deliver presentations, and flexible, powerful collaboration sessions.

Figure 6: Touch Control

Conclusion

These applications of DViT technology are just the beginning. Interactive whiteboards have proven to be invaluable tools for such activities as:

- Collaborating on electronic documents
- Brainstorming and saving notes
- Teaching a class using software applications and Web sites
- Presenting reports, projects and plans

DViT technology will make touch systems suitable for an even wider range of locations and uses. Its durability and freedom from special tools make it appropriate for high-traffic areas such as kiosks, schools and convention centers. Its facilitation of high-quality image production makes it ideal for boardrooms and control centers where clarity is paramount.

SMART Technologies Inc. pioneered the first interactive whiteboard in 1991 and has led the industry ever since. DViT technology is the latest innovation in a line of products that provide intuitive use and keep the users' needs foremost in mind. The technology itself – however advanced and complex – works in the background, as a simple tool that meets people's needs.