ESPi Patent Portfolio: The Master Key to True 3D User Input

Executive Summary

The ESPi patent portfolio covers optical methods for calculating the absolute 3D position and orientation (pose) of an object that a user moves freely in 3D space to generate input.

As computers become faster, smaller, and cheaper, user input devices will inevitably gain precision, resolution, and responsiveness. ESPi patents cover the fundamental 3D calculations and hardware solutions that enable input devices to reach these goals.

The next generation of input devices will provide a superior user experience that "feels like the real world". Game and TV controllers, medical devices, digital pens, and consumer goods not yet conceived will track natural human movement without the artificial constraints or compromises that today's devices must endure.

The ESPi patent portfolio is a cornerstone for supporting the development of next generation input devices that accurately capture natural motion in the real world.

Absolute 3D controller systems have existed for years. In fact, I couldn't fly my plane without one. So why are ESPi's claims special?

Of course, 3D equations of motion have been known for over 100 years. Our researchers' contribution was to adapt them for generating user input. Having started almost 10 years ago, ESPi is the first player to patent the six degrees of freedom calculations for absolute 3D tracking in conjunction with optical methods that employ an on-board optical sensor to generate user input.

Mathematically speaking, ESPi calculations are the same as those used by navigation systems. Persons skilled in the art will recognize that these equations are the only way to fully and accurately describe an object's movement in 3D space. The fundamental rules of 3D geometry preclude any other approach.

The Wii is pretty good, and it doesn't calculate in true 3D (it doesn't track six degrees of freedom in stable coordinates). Why is accuracy important?

The Wii and other state-of-the-art user input devices that employ inertial sensors and limited optics (IR LEDs) so far have not implemented true 3D algorithms. Instead, such devices make compromises to avoid performing the full calculations required to recover the user's precise 3D motions. The result is a loss of information, gradual drift, and accumulating position and orientation errors.

To the user, the device appears to gradually go "off track". In fact, a smart user can actually "cheat" in the motions he or she uses, as they don't accurately mimic the real

world. Gamers easily sense such lack of the "real world feel". In games and applications that require correspondence to the real world, such shortcomings are deal breakers.

My application works with a 2D display. Why do I need input that reports all six degrees of freedom?

Errors in capturing and translating 3D pose are inherited even when working with 2D applications. For example, the Wii, or LG's "magic wand" TV control drift even when interacting with 2D displays or 2D gaming environments.

When unconstrained movement in 3D is translated to 2D, information is lost – it's like watching a 3D object move by looking at its shadow. Applications must work around this loss of 3D information by adding clunky re-calibrations, simplifications or buttons. Special steps must be taken to avoid "aliasing" problems (e.g., when different 3D poses produce the same 2D projection) and to ensure motion continuity. Recovering all six degrees of freedom (true 3D) from the start obviates such problems and eliminates the need for cumbersome workarounds.

Another common workaround is to constrain the range of motion of the input device and thus avoid having to calculate its natural three-dimensional movement. These workarounds are found in devices such as joysticks or trackballs. However, the marketplace is rewarding devices that don't limit movement. User interface developers will inevitably continue to avoid artificial and unnecessary limitations in future devices.

What are the benefits to using ESPi's hardware and methods?

- **Capture the natural direction of progress.** For today's user input devices to improve, they must be calibrated to present an accurate relationship to the real world. Calibrating relative motion sensors with on-board optical units will necessarily use ESPi's calculations.
- **Strategic advantage**. As computing power becomes faster, smaller, and cheaper, reaching high accuracy becomes cost efficient. Input devices will add resolution, speed, and precision. ESPi's patents cover on-board optics hardware and corresponding calculations that make ultimate precision possible.
- **Competitive advantage.** Users will experience full 3D precision as a responsive, natural feeling input device that accurately captures their unconstrained movement. Lifelike interactions between players (ESPi technology supports multi-player games) will add a quantum leap to the gaming world. Medical applications will benefit. This highest-achievable quality experience made possible by ESPi's methods will be a market advantage to early adopters.
- **Broad applications.** ESPi patents are not limited to any specific industry or purpose. They apply to any type of user input device with on-board optics that can be held or attached to the user's body. A partial list of potential implementations includes: digital pen, stylus, wand, 3D mouse/pointer, 3D smart phone input functionality, 3D digitizer, scalpel, human motion tracker for dancers, athletes, animation, biometrics, multi-player games, etc.

Why did ESPi choose optics?

ESPi uses on-board optics to recover the absolute position and orientation of the device being tracked. It's the approach commonly used in computer vision and robotics. Those fields have proven that optical methods are particularly simple, cost effective, and highly accurate.

Simple. Many of ESPi's algorithms require no additional equipment in the environment. They can work passively with existing visible features (e.g., edges of known objects). Competing solutions such as those using acoustics, magnetic fields and more general radio frequency (RF) signals, have the disadvantage that they require off-board units such as emitters or coils to be mounted at known locations in the workspace.

Cost Effective. Optical devices are cost effective and are rapidly becoming ubiquitous. On-board cameras are present in many consumer electronics products, including smart phones. Of those, even mid-range units have sufficient resolution and processing capability to implement ESPi's optical navigation algorithms for recovery of 3D position and orientation.

Highly Accurate. Compared to competing solutions using acoustics, magnetic fields and more general radio frequency (RF) signals, optics deploy short wavelength radiation. This choice endows them with the highest spatial resolution capabilities for pose recovery. In addition, optical radiation has low latency – travelling at the speed of light – and is relatively immune to environmental noise and interference.

What's the advantage to on-board versus off-board sensors?

ESPi's on-board sensor solution is more efficient, low cost, and has a much higher 3D resolution capability than approaches with off-board sensors.

Resolving an object's movement from on-board the object is a simpler problem than resolving the same movement from a remote location. Off-board sensors, such as those used by Microsoft's Kinect or Sony's Move, even when supported with reflected IR radiation, require more power, more resources, and more processing than an ESPi navigation solution. In addition, systems with off-board sensors cannot match the level of spatial resolution achievable with an on-board sensor.

What type of Intellectual Property Rights (IPRs) does ESPi own?

ESPi owns patents broadly classified as *essential patents* and *implementation patents*:

- The essential U.S. patents cover the core apparatus and methods for six degrees of freedom 3D interfaces with on-board optical sensors and have international counterparts in Europe and Asia. These IPRs are basically impossible to design around by third parties due to their early priority dates and broad claims built on the foundations of optical 3D pose recovery with on-board sensors.
- The implementation patents address preferred embodiments of the technology in terms of advantageous hardware, firmware and software choices. Specific hardware platforms include wands, remote controls, smart phones, and tablets.

The ESPi portfolio of patents offers the powerful raw ingredient of absolute 3D motion tracking for user input.

ESPi researchers also possess technical know-how gained from developing a breadboard prototype and several alpha units. We can directly apply this experience to ensure effective beta design and successful productization.

Where can your vision take it?

For more information email info@4espi.com