Smart Dust Technology

Smart dust is an emerging technology with a huge potential for becoming an internationally successful commercial venture. Now is the best time to invest in smart dust – right at the point at which the scientific community is close to perfecting the technology and its applications but its potential has not yet been realized by the capitalist market.

Fundamental Concept

Smart dust is a theoretical concept of a tiny wireless sensor network, made up of microelectromechanical sensors (called MEMS), robots, or devices, usually referred to as motes, that have self-contained sensing, computation, communication and power[1].

According to the smart dust project design created by a team of UC Berkeley researchers[2], within each of these motes is an integrated package of "MEMS sensors, a semiconductor laser diode and MEMS beam-steering mirror for active optical transmission, a MEMS corner-cube retroreflector for passive optical transmission, an optical receiver, signalprocessing and control circuitry, and a power source based on thick-film batteries and solar cells."

The intent is that these motes will eventually become the size of a grain of sand or a dust particle, hence the name "smart dust", but the technology still has a long way to go to achieve its target size. In current sensor technology, the sensors are about the size of a bottle cap or small coin. As with most electronic devices or technologies, the biggest challenges in achieving actual smart dust are the power consumption issues and making the batteries small enough. Although there is a lot of work being done on solar cells to keep the motes self-sustaining, the components are just not small enough yet to actually be considered smart dust. However, if Moore's Law holds true for smart dust technology, continuous improvements will be made to the circuit design and packaging of motes that will allow them to keep consistently shrinking in size and power consumption while growing in their sensor and/or computing capabilities.

Smart dust technology relies on a line-of-sight path in order for the sensor networks to operate. Given that smart dust has yet to be realized, scientists can only speculate on what the actual range of operation will be or how distance will affect performance; however, many researchers are confident that as long as line-of-sight is maintained, the motes could communicate over several kilometers.

Applications

A smart dust network consisting of spatially distributed autonomous motes could be used to monitor and measure things like temperature, sound, vibration, pressure, and environmental pollutants. The development of wireless sensor networks was first motivated by their military applications, such as using sensor networks for battlefield surveillance. One can easily imagine the advantage of a government agency that could covertly spread motes from a plane over enemy

[1] Smart Dust definition found at Wikipedia.
[2] UC Berkeley smart dust project researchers: Joseph Kahn, Randy Katz, & Kristofer Pister. Mote component description taken from their "Emerging Challenges: Mobile Networking for Smart Dust" paper.

territory. For civilian applications, a wide variety of smart dust applications are possible, such as agricultural, industrial, environmental, or healthcare monitoring, home automation, and traffic control uses.

Once the technology reaches the point where motes are actually the size of dust particles, the possible applications are endless – motes could be mixed into paint to apply to the walls of your home or be woven into clothing fabric. Smart dust, once fully realized and the motes become cost-effective to manufacture, is a technology that could conceivably be integrated into most commercial products.

Future Implications

There has been a lot debate on the future implications of nanotechnology as a whole. While smart dust has the potential to create many new materials and devices with a vast range of applications, especially in the fields of medicine, electronics and energy production, like any nanotechnology, smart dust also raises many of the same issues, including concerns about the toxicity and environmental impact of nanomaterials, and the potential effects on global economics. On the fringe, there has been speculation about technologies like smart dust ultimately leading to various doomsday scenarios. Apparently, the concern is that once we create self-sustaining machines, we will lose control of them and they will take over the world and destroy life as we know it.

It's doubtful that smart dust technology could cause any real environmental hazards and even more doubtful that motes will lead to the end of life on our planet. The benefits of smart dust technology far outweigh any of the potential risks and the people who invest in it early on will undoubtedly reap the rewards of their wise decision.

References

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