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A
Technical Seminar Report
(18EC8ICTHS)
on

Smart Dust using MEMS

Submitted in partial fulfillment of the requirement for the degree of

Bachelor of Engineering
in
Electronics & Communication Engineering
by

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Declaration

Certified that the UG TECHNICAL SEMINAR (18EC8ICTHS) work entitled, "SMART DUST USING MEMS"

is a bonafide work that was carried out by myself in partial fulfillment for the award of degree of Bachelor of Engineering in Electronics & Communication Engg. of the Visvesvaraya Technological University, Belagavi, Karnataka during the academic year 2021-22 and I am solely responsible for all the contents that has have been presented in it.

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Abstract

Smart dust is a tiny dust size device with extra-ordinary capabilities which combines sensing, computing, wireless communication capabilities and autonomous power supply within volume of only few millimeters and that too at low cost. These devices are proposed to be so small and light in weight that they can remain suspended in the environment like an ordinary dust particle. These properties of Smart Dust will render it useful in monitoring real world phenomenon without disturbing the original process to an observable extends. Presently the achievable size of Smart Dust is about 5mm cube, but it is expected that it will eventually be as small as pack of dust. Individual sensors of smart dust are often referred to as motes because of their small size. These devices are also known as MEMS, which stands for micro electro-mechanical sensors.

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CHAPTER 1

INTRODUCTION

"Smart Dust" is an emerging technology made up from tiny, wireless sensors called as Motes. Eventually these devices would be smart enough to talk with other sensors yet small enough to fit on a head of a pin. Berkeley's Smart Dust project, explores the limits on size and power consumption in autonomous sensor nodes. Size reduction is paramount, to make the nodes as inexpensive and easy to-deploy as possible. The research team is confident that they can incorporate the requisite sensing, communication, and computing hardware, along with a power supply, in a volume no more than a few cubic millimeters, while still achieving impressive performance in terms of sensor functionality and communications capability. The smart dust project envisions a complete sensor network node, including power supply, processor, sensors and communications mechanisms, in single cubic millimeters. The goal of the Smart Dust project is to build a millimeter scale sensing and communication platform for a massively distributed sensor network. This device will be around the size of a grain of sand and will contain sensors, computational ability, bi-directional wireless communications, and a power supply. Smart dust consists of series of circuit and micro-electro-mechanical systems (MEMS) designs to cast those functions into custom silicon. Micro-electro-mechanical-systems (MEMS) consist of extremely tiny mechanical elements, often integrated together with electronic circuitry.

CHAPTER 2

LITERATURE SURVEY

Sl No.	Title of the paper	Source	Findings
1	"Smart Dust- Communicating with a cubic millimeter computer"	IEEE Journal- Computer. January 2001.	Laser communication and Large Angle MEMS Beam Steering
2	"MEMS"	International Journal of Scientific Research in Computer Science, Engineering and Information Technology, Volume 4, Issue 5, August 2018	Sensor Networking of Smart Dust motes
3	"Design and Implementation of Optical Wireless Communications with Optically Powered Smart Dust Motes"	IEEE JOURNAL ON SELECTED AREAS IN COMMUNICATIONS, VOL. 27, NO. 9, December 2009	Wireless communication by integrating the communications modulator and Silicon to create a compact dust mote
4	"Smart Dust"	International Journal of Advanced Research in Computer and Communication Engineering, Vol. 5, Issue 6, June 2016	Communication between Sensor Networks using Smart Dust motes
5	INTERNET OF THINGS AND SMARTDUST: THE FUTURE OF WIRELESS NETWORK SENSORS	*International Journal of Information System and Engineering, Vol. 5 (No.1), April 2017*	Union of IoT and smart dust motes capable of bidirectional communication for monitoring and tracking

CHAPTER 3

PROBLEM STATEMENT

The smart dust project envisions a complete sensor network node, including power supply, processor, sensors and communications mechanisms, in single cubic millimeters. The goal of the Smart Dust project is to build a millimeterscale sensing and communication platform for a massively distributed sensor network. This device will be around the size of a grain of sand and will contain sensors, computational ability, bi-directional wireless communications, and a power supply.

The development and use of smart dust raises some problems and concerns for stake holder including: Privacy issues, Potential system security weaknesses, and Environmental impacts of Smart Dust – Motes' environmentally unfriendly components such as integrated circuit, battery, PCB and some motes draw on radioactive power sources.

CHAPTER 4

SCOPE AND OBJECTIVE

According to **UC Berkeley Professor Kris Pister** who is a key founder, Smart Dust integrated with superior computing efficiency, wireless radios, and sensing tech, will be quite a comprehensive solution to study the real time data concerning people, industries, cities as well as natural environment.

The objective of this seminar is to demonstrate a family of distributed sensor network systems with Smart Dust using MEMS where each system consists of one or more data receivers and hundreds of thousands of sensor nodes to be used for a wide range of applications.

CHAPTER 5

RECOMMENDED SOLUTION

- Smart dust requires mainly revolutionary advances in miniaturization, integration & energy management.
- Micro-Electro-Mechanical Systems (MEMS) is the integration of mechanical elements, sensors, actuators, and electronics on a common silicon substrate through microfabrication technology.
- While the electronics are fabricated using integrated circuit (IC) process sequences, the micromechanical components are fabricated using compatible "micromachining" processes.
- The advantage of this manufacturing process is not simply that small structures can be achieved but also that thousands or even millions of system elements can be fabricated simultaneously.
- Microelectronic integrated circuits can be thought of as the "brains" of a system and allow Microsystems to sense and control the environment.
- Historically, sensors and actuators are the most expensive and unreliable part of a sensor-actuator-electronics system. MEMS technology allows these complex electromechanical systems to be manufactured using batch fabrication techniques.
- Smart Dust consists of the following integrated into a single package: 1. MEMS sensors 2. MEMS beam steering mirror for active optical transmission 3. MEMS corner cube retro reflector for passive optical transmission 4. An optical receiver 5. Signal processing and control circuitry 6. A power source based on thick film batteries and solar cells. This remarkable package has the ability to sense and to communicate and to self-power.

Smart dust employs 2 types of transmission schemes:

Passive transmission: It uses corner cube retro reflector to transmit to base stations.

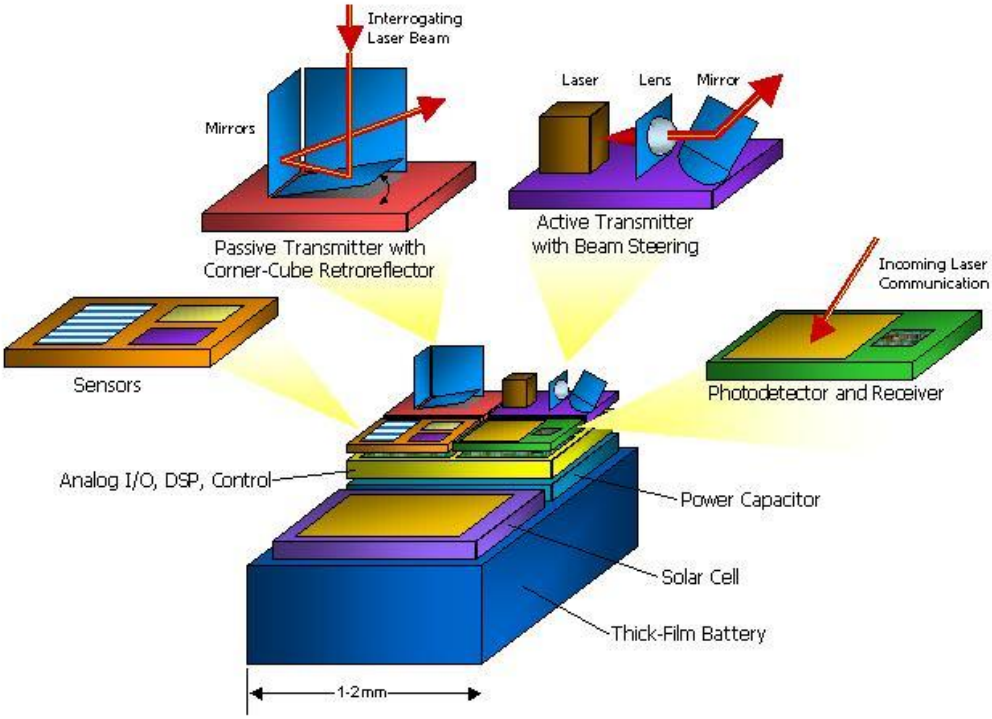
Active transmission: It uses a laser diode & steerable mirrors for mote to mote communication.

- The photo diode allows optical data reception.
- Signal processing & control circuitry consists of analog I/O, DSPs to control & process the incoming data.
- The power system consists of a thick film battery, a solar cell with a charge integrating capacitor for a period of darkness.

The Smart Dust mote is run by a microcontroller.

Periodically the microcontroller gets a reading from one of the sensors.

It also occasionally turns on the optical receiver to check for communication



CHAPTER 6

CONCLUSION

Smart dust is made up of thousands of sand-grain-sized sensors that can measure ambient light and temperature. Each of these sensors is called a "mote" which has wireless communications devices attached to them, and if you put a bunch of them near each other, they'll network themselves automatically.

Research in the wireless sensor network area is growing rapidly in both academic field and industry. Most major universities and many companies now have sensor networking projects, and some products are appearing on the market.

Innovative research includes short-range micro power radio, energy scavenging from thermal gradients and vibration, operating systems, networking and signal processing algorithms, and applications.

While the raw power of future computing environments will enable more massive and amazing hardware and software networks, a growing community will be pushing the limits on the lower end, building smaller hardware and writing.

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