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SMART DUST

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ABSTRACT

With reduction in size of the sensors, complex networks can be implemented easily.This is based on MEMS technology(MicroElectroMechanical Systems).This minute(mm) sized sensor networks are called smart dust, they are light as dust particles and thus float on air.Smart dust combines sensing of various environmental parameters and enables wireless communication in cubic millimetre. It consists of mechanical elements integrated by electronic circuitry. The tiny sensors which are the major building blocks of smart dust are called 'motes'.

INTRODUCTION

Smart Dust is the future of quantified world.[1] Smart Dust, got its name because it changes the method by which we interact with the world. Smart Dust requires miniaturisation and integration so MEMS technology is used. Smart dust is fabricated using the same steps as that of chips used in computers. Using MEMS not only has an advantage that it will be small in size but also a large number of sensors can be manufactured at the same time. Micro-Electro-Mechanical Systems (MEMS) is the integration of mechanical elements, sensors, actuators, and electronics on a common silicon substrate through microfabrication technology.[2]Microfabrication differs from normal fabrication in the method of fabrication used. Normal fabrication uses IC process sequence and microfabrication uses micromachining process. The basic idea behind smart dust is to create an ad-hod wireless network.

THESIS:

Independent sensing and wireless ad-hoc communication technologyin cubic millimetre range.

OUTLINE:

This paper deals with the latest improvement in communication technology - Smart Dust. It provides an overview of how smart dust works and its pros and cons. The paper also tells how MEMS technology is used in it. Multifunctional mote which is used to implement smart dust is discussed here along with its components. The fabrication of smart dust is included (micro fabrication).

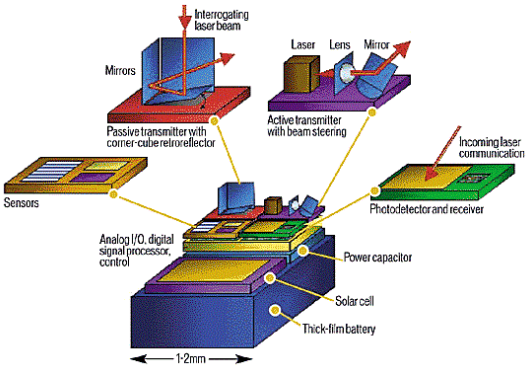
WHAT IS SMART DUST? :

Smart dust are tiny computers with sophisticated sensors which senses the environmental parameters such as temperature, humidity etc. It has the size of a rice grain now and it can again be reduced in size to a sand grain with upcoming technological improvements. With these smart dust even the air is said to be connected. The major component of smart dust is the multifunctional mote. A single smart dust mote typically contains a semiconductor laser diode and MEMS beam-steering mirror for active optical transmission; a MEMS corner cube retro reflector for passive optical transmission; an optical receiver, signal processing and control circuitry; and a power source based on thick-film batteries and solar cells.

[1]http://readwrite.com/2013/11/14/what-is-smartdust-what-is-smartdust-used-for

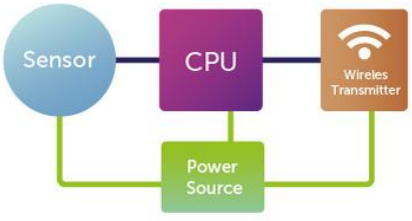
[2]https://www.mems-exchange.org/MEMS/what-is.html

Multifunctional Mote



These motes consists of inbuilt sensors, transmitters, receivers, charge inetgrating capacitors, power supplies such as batteries and solar cells. They are of millimeter range. An integrated circuit provides sensor-signal processing, communication, control, data storage, and energy management. A photodiode allows optical data reception. There are presently two transmission schemes: passive transmission using a corner-cube retro reflector, and active transmission using a laser diode and steerable mirrors.[3]A microcontroller runs the mote which is also the source of power supply to the mote. The sensor output (both physical and chemical parameters) is stored in the memory by these microcontrollers. It also turns on optical receiver to see if anyone is trying to communicate with it. This communication may include new programs or messages from other motes. In response to a message or upon its own initiative, the microcontroller will use the corner cube retro reflector or laser to transmit sensor data or a message to a base station or another mote.[4]

The mote consists of 4 parts:



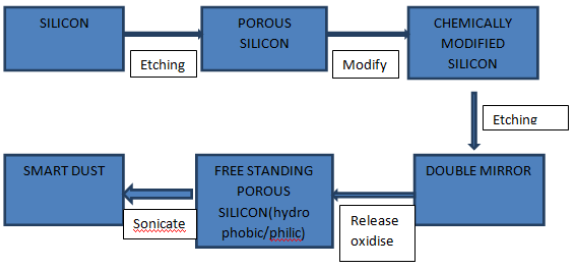
- Ambient sensor
- CPU
- Wireless transistor
- Power source

The sensor output is sent to the CPU and it is transmitted through Bluetooth, Wi-Fi etc.

The main limitation in the design of smart dust is the cubic millimetre volume . Since it does not have space for batteries and solar cells it must be off whenever it is not in use. Most of the time, the majority of the mote is powered off with only a clock and a few timers running. When a timer expires, it powers up a part of the mote to carry out a job, then powers off. A few of the timers control the sensors that measure one of a number of physical or chemical stimuli such as temperature, ambient light, vibration, acceleration, or air pressure.

Only single hop topology can be used as smart dusts are incapable of communicating with each other but can communicate only with base station. So line of sight communication is used.

METHOD OF FABRICATION OF SMART DUST:



First the silicon is etched chemically using electrochemical machining process. The second step involves chemically modifying the porous silicon photonic structure so that it will find and stick to the desired target.[5]The two steps (etch and modify) are repeated with a different colour and a different chemistry, yielding two-sided films. The films are broken up into particles about the size of a human hair. The particles seek out and attach themselves to an oil drop, presenting their red surface to the outside world and their green surface towards the inside of the drop.

MEMS TECHNOLOGY IN SMART DUST:

Microelectronic IC's are considered as the brains of systems, and helps microsystems to sense the environmental parameters. The sensors sense

[3]http://www.seminarsonly.com/electronics/Smart%20Dust.php
[4]https://www.classle.net/projects/node/406
[5]http://sailorgroup.ucsd.edu/research/highlights.html

chemical, mechanical and thermal parameters etc. Miniaturisation, integration and energy management are the main needs of smart dust. The output of the sensors are then processed and through some decision making steps direct the actuators to respond by moving, positioning, regulating, and filtering, thereby controlling the environment for some desired purpose.

CONCLUSION

Smart dust is thus a network of minute sensors which facilitates ad-hoc communication. Smart dusts possess various pros and cons. Using smart dust technology reduces the infrastructure cost, but increases the productivity. It also has many disadvantages such as if once a smart dust is implemented it is hard to retrieve it. Smart dusts are the best alternatives which are to be used in military applications in future. These floating smart dusts can also spy on our brain. In biological research, Smart Dust may be used to monitor the movements and internal processes of insects or other small animals.[6]

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