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USING OF SMART DUST IN TRANSPORT SERVICES

Smart dust – концепція майбутнього, яка розглядає використання мікроскопічного устаткування на залізничному транспорті. Ця технологія найближчого майбутнього заснована на крихітних датчиках, здатних збирати, обробляти і передавати інформацію на підставі бездротового зв'язку.

Smart dust – концепция будущего, которая рассматривает использование микроскопического оборудования на железнодорожном транспорте. Эта технология ближайшего будущего основана на крошечных датчиках, способных собирать, обрабатывать и передавать информацию на основе беспроводной связи.

Smart dust utilization is futuristic concept that thinks over the use of microscopic equipment called «smart dust» on railway transport. It appears from the technology of near future, whose base should be tiny sensors able to collect, process and wirelessly transfer information.

Introduction

The main idea of this technology is the possibility in some space (for example inside the wagon) to recreate hundreds of tiny sensors that are designed to sense, measure and transmit data like temperature, humidity or the power of frequency of vibrations, so they would allow to detect some devices, people manners in some space or detail check given surrounding.

Definition of smart dust

Originally part of a larger project funded by the U. S. Department of Defense central research and development group, Defense Advanced Research Projects Agency (DARPA), the Santa Clara, Calif, – based chip making giant has worked with the University of California, Berkeley – Kris Pister and Randy H. Katz – to create cubic millimetre-sized sensors, or «motes». Micro-electromechanical sensor (MEMS), which is the base of smart dust, is called mot. First prototypes of mot were not like dust, their size were approximately 100 mm^3. So they were called macro motes. The technology was tested with the macro motes and is full functionally. Current motes are about 4 mm^3 and the goal for researchers is to get these chips down to 1 mm on a side, to be like the grain of sand though each would contains sensors, computing circuits, bidirectional wireless communications technology and a power supply. Motes would gather scads of data, run computations and communicate that information using two-way band radio between motes at distances approaching 250 meters.

Devices called smart dust are able to

- communicate wirelessly with surroundings,
- communicate wirelessly among each other,
- create distributed network.

The motes create together one big network, which is able to evaluate situation on high-level and then send processed analyses to information system.

Basic components of smart dust

Current motes are about 4 mm^3 and in this really small space are all devices, needed for its function. The basic components of the mot are sensors. They collect information about temperature, humidity, intensity of the light, vibrations and air pressure. In the future will be added another types like sensors for sound and video.

Microprocessor serves for processing of information obtained by sensors of the mot as well as by communication device. Memory SRAM saves the program for microprocessor and transferred or detected data. Communication with other motes or main device proceeds by sophisticated communication device. Device also need power supply and batteries.

Function and components of smart dust

Device is able to perform function, which is determined by types of sensors installed in it and by the type of program saved in the microcontroller. Mot is created to save the power. Mot is almost 99 % in stand-by mode and only 1 % of the time is performed its activity. Timer counts out time, which elapsed from particular activity of the mote. When the timer reaches zero value, it starts appropriate part of the mot. It could be communication channel, sensor, analog-digital converter or microprocessor. Given device after the end of its activity sets the timer to given value. This is the principle of the work of the mot. Device in stand-by mode obtains the energy. Sensors scan values of physical quantity from the space and send them to the anolog-digital converter, when they are converted to the digital form and saved to the memory SRAM. Microcontroller analyses them and defines, what to do with them: delete, archive or send a notice. Microcontroller can also receive through the communication channel new program, so it is possible to program the device for new type of tasks.

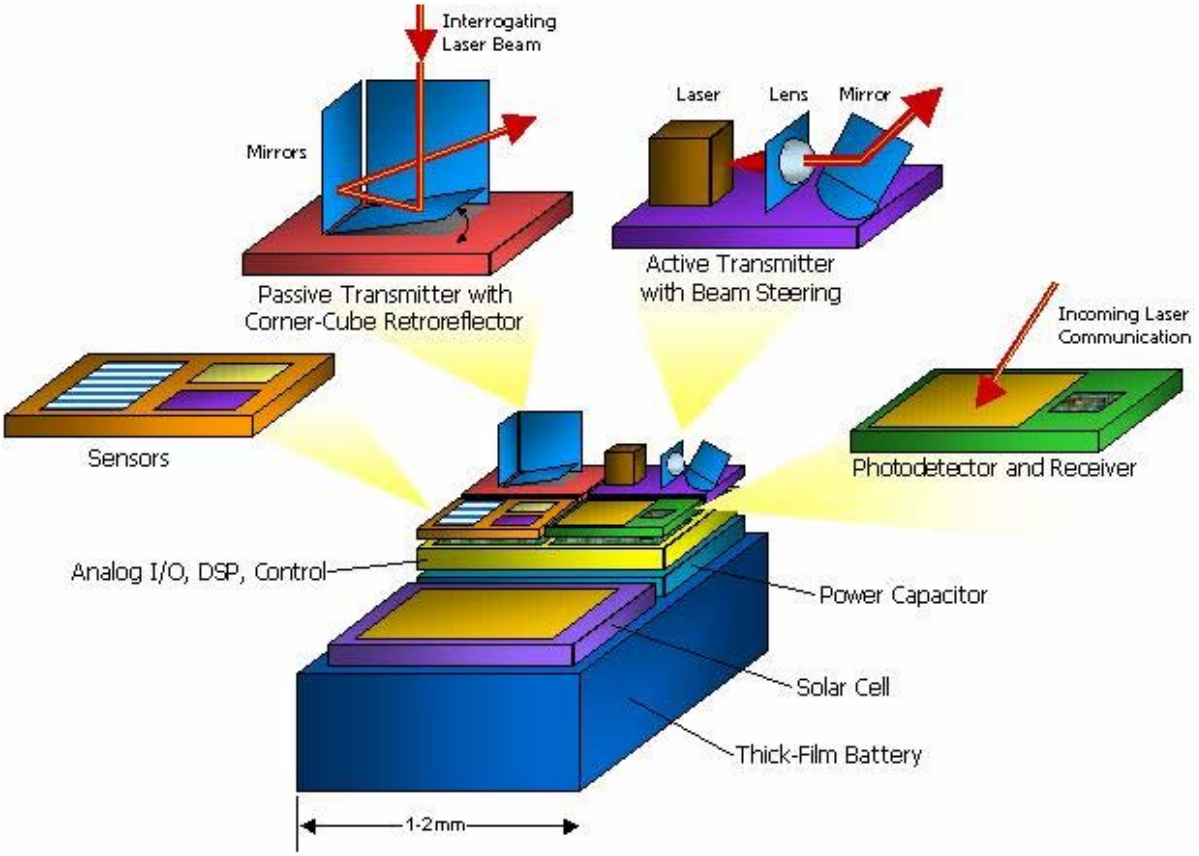

Fig. Multifunctional mote

Battery is able to save the energy with the grossness 1J for 1 mm^3. Because of the small size of the mot, its capacity is very small. Researches want to minimize power drain by particular components of the mot. Except the battery, other power source is solar collector, which is able to supply energy by sunlight but also in the room. Another way is a little bit unconventional: mot can supply energy from the change of air pressure from quake. Due to this fact, its lifetime can be several years.

Very interesting is communication channel. It can use for the data transport ray of light, because it's more useful than using of radio communication. Every mot has the light emitter, which has micro mechanic controlled mirror, so it can relay to arbitrary direction. Other communication device is passive, but his function is not only to receive but also to relay information. Major system relays towards mot a ray of light and mot modulate information to it and then, through the use of mirrors system reflects it back. Mirror system is made by three square mirrors placed to right-angel, so we can compare it to a corner of a room. Ray of light is that's why reflected to the same direction as it came from. By the minimal movements of one of the mirror is possible to modulate information to the ray. Such system of communication is very effective, whereas while using of macro motes were made 20 kilometres transfers.

Smart dust utilization

For the smart dust is in present a lot of potential commercial applications, so it can be used in different areas of our life. It can be also used in military sphere and in espionage. In the field of transport, logistic and forwarding, there are these applications:

– weather/seismological monitoring,
– using of sensors in the packing – for example at automatic stock-taking in a stock,
– monitoring of vehicle and commodity move,
– monitoring of vehicle parameters in all types of transport,
– monitoring of traffic at frequented communications,
– detection of errors at manufacturing via vibration trapping, which are outside the given range,

– monitoring of the clients in company,
– like a part of technology of so-called intelligent buildings – by simply addition to building coat – by means of smart dust would be possible to collect information about building state and manage it,
– monitoring of a power drain in companies, what could help to reform power sources management,
– monitoring of surrounding – for example smart dust can be pulverized round chemical and atom manufactures and its main task would be immediate to inform about possible accident.

Smart dust can be also used like protection against theft and forfeit and provision of security at stocking or transportation. It is very difficult to spring smart dust. It is possible to dust it over huge territory and observe movement of people, or focus on small space of bureau or stock. It is not required to install it, you can only dust it.

This concept applies and uses this system in railway transport.

Smart dust utilization in railway freight transport

Dust of smart dust (condition is: dusting in enclave) in:
– wagon,
– container,
– swap body.

It is thinking over the smart dust utilization mostly in dispatches, which involve increased attention-transportations on special conditions:
– transportation of easily spoiled goods,
– transportation of animals,
– transportation of dangerous commodity,
– transportation of valuable dispatches.

Smart dust utilization at transportation of easily spoiled goods

Easily spoiled goods are commodities, which go fast bad and which involve individual precautions during the railway carriage, to be sheltered from cold or warm impact. So the easily spoiled goods involve during the transportation icing, aerating, fumigation or other protection against cold or warm impact.

Smart dust has in wagon these functions:
– monitoring of humidity, temperature, vibrations, dustiness, aeration,
– distant regulation of temperature, humidity as necessary,
– protection of sending against abstraction,
– signalization of technical fault of refrigeration, freezing, or warming equipment,
– signalization of inconvenient conditions for given transportation.

Smart dust utilization at transportation of animals

Transportation of animals is specific, because it involves individual precautions of transportation.

Smart dust inspects setting of wagon, in which are animals transported:
– diagnostic of airing,
– monitoring of humidity and temperature,
– diagnostic of wagon sanctity during transportation,
– diagnostic of animal health,
– snapping of animal kill,
– signalization of setting defiance,
– distant regulation of temperature, humidity according to weather eventually as necessary.

Smart dust utilization at dangerous commodity transportation

It includes:
– monitoring of setting changes inside wagon,
– signalization of unexpected changes of settings, which could affect adversely transported dangerous commodity,
– monitoring of physical statements (temperature, humidity, vibrations), which could affect adversely to transported dangerous commodity,
– signalization of emergency conditions,
– diagnostic of wagon sanctity during transportation.

Smart dust utilization at valuable dispatches transportation

Valuable sending is sending, which has high financial value, eventually has other value (personal, artistic, historical etc.). Smart dust is there used for security, but also is able other monitoring if necessary.

Utilization:
– monitoring of setting inside of wagon, container or swap body,
– signalization at specific situation (damage of traffic or transportation vehicle),
– signalization of unexpected change of setting,
– in the case of a sending transported by specific conditions: monitoring of specific functions.

Conclusion

«Smart dust» devices are tiny wireless microelectromechanical sensors (MEMS) that can detect everything from light to vibrations. Thanks to recent breakthroughs in silicon and fabrication techniques, these «motes» could eventually be the size of a grain of sand, though each would contain sensors, computing circuits, bidirectional wireless

communications technology and a power supply. Motes would gather scads of data, run computations and communicate that information using two-way band radio between motes at distances approaching 300 metres. Potential commercial applications are varied, ranging from catching manufacturing defects by sensing out-of-range vibrations in industrial equipment to tracking patient movements in a hospital room. Huge range of smart dust utilization can be also in the railway transport.

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Submitted to the editorial board 18.02.05.