In the name of God, the Almighty

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Title: **Wireless Sensing Networks**

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Abstract:

Sensing networks, contrary to traditional networks representing the connection between man and information bases, are directly connected to physical world. Such networks, as their name shows, by the use of their sensors sense the physical world and then transfer to the man the results of their findings as information from the region. A specific type of sensing networks, known as Sense/Work Networks, can make a decision and perform some operations using its environmental observations

Sensing network has redirected its attention from the concept of resource sharing in traditional networks into the concept of information gathering. These data include temperature, pressure, moisture, light, acceleration, magnetic and other supposed qualitative particular which are all related to environmental and physical elements. There are different applications supposed for these networks including medical, environmental, commercial and military studies.

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1- Introduction:

With the human inference that collective communities have more benefits than individual living, he tried to apply this logical and experimental inference in his product, that was computer. Then he referred to collective existence of computer as Network and the subject of network gradually set forth in different methods.

Current advances in integrated circuit technology in small size in one hand and development of wireless communication technology on the other hand made thepaved the way for wireless network to be designed. Now where the wireless network lack any stable network infrastructure and wireless nods can move dynamically, the network is known Ad Hoc. Sensing network is counted as Ad Hoc network with the difference that sensing network is capable to communicate with the environment and physical phenomenon.

Traditional network made the communication between men and information banks possible and they are general purpose while sensing networks are usually single purpose and dispatch relative information after observing their surrounding area. In other words if we omit the basic stations in mobile communication network (telephone) and consider each handset as a node in a manner that nodes are connected directly or through one or some middle nodes, the result would be something similar to wireless sensing network. Sensing network is consisted from many small nodes having wireless connection. Each node is working independently and free from human intervention and is physically very small in size. Despite the fact that this network follows traditional network protocols, it rewrite regular network protocols for its limitation and different applications. Such limitations are limitation in processing power, memory capacity, power supply, …. . Such problems have been the origin of many research subjects in this field.

Sensing network are a certain type of wireless networks which are counted as Ad Hoc networks for lack of central antenna. These networks, having effective communication between their components, have different structures and objectives. As well node specific particulars of the sensor indicate uncertainty in their exact localization. So approximate and certain localization is performed for them which is enough for applications considered for these networks.

Sensing network performance can be considered as an orderly arrangement of miniature airplanes, known as sensor, which carry data from sensing area and bring such data to us.

2- Primary concepts:

2-1 Sensor:

A small electronic part which may recognize an object, occurrence of a condition, or physical quantity and transform the result into electric signal. Then processors transform such electric signals into data which can be used by the man (Fig. 1)

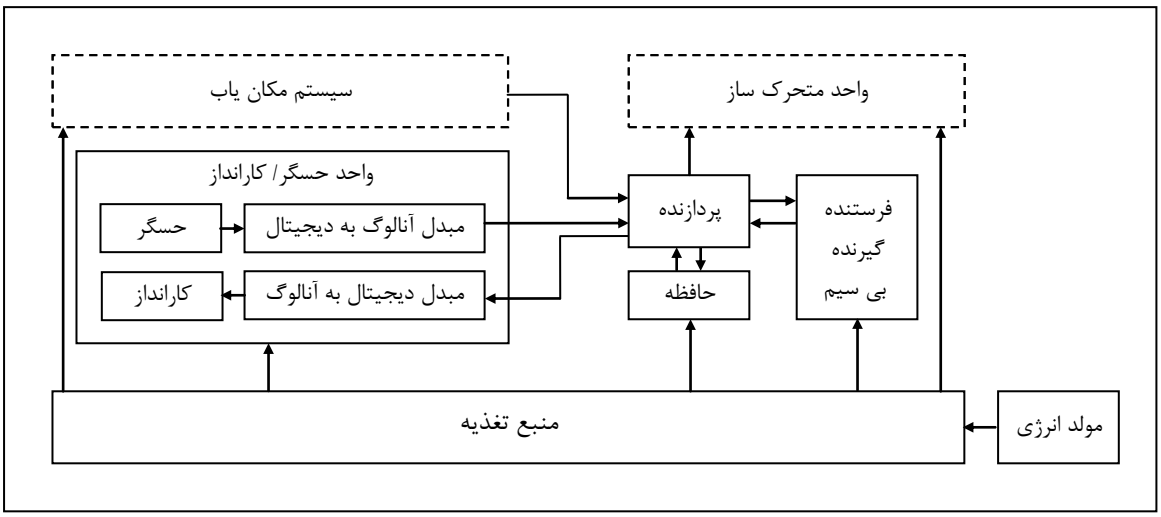

Fig.1 Internal structure of a sensing node

2-2 Types of sensor:

Sensor is divided in some types in terms of sensitivity toward specifications or environment conditions including temperature, pressure, moisture, light. Accelerometer and magnetometer. Sensor node include one of some sensors which receive analogue information from the sensor and send it to the processor in digital form, with the supposition that nodes are homogenous (having the same capacity in calculations, communication and energy).

2-3 Sensing network:

A network having some sensing nodes

2-4 Sink:

The node responsible for collection of data which supervise the network in whole.

2-5 Task Manager node:

A node through which the person is connected to the network as a user of network manager (fig.2).

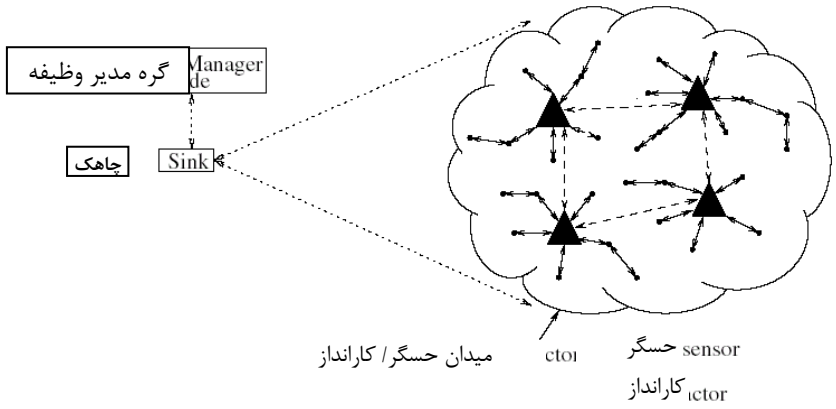

Fig. 2- General structure of sensing network

2-6 Energy source for the sensing node:

The source which supply the required energy for sensing node. To compensate limitations of energy source, which is usually supplied by an energy limited battery,

solar cells may be used. Sensing node should have low consumption. For instance a 1.2 V, 0.5 AH may be enough to supply the required energy for up to 9 months. It should be noted that in many cases, batteries can not be replaced so the battery life of a sensing node indicates useful life for the sensor.

2-7 Localizer:

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Identifies physical and geographical location of the node.

2-8 Safety and frequency interference:

Wireless sensing network connection make work easy for enemies. Using a single connecting frequency for the network in whole may make it vulnerable. Nodes close to the sink or center are depleted earlier for having more traffic. Shortage of energy may result in the condition in which the enemy place a node in the area and repeatedly and send alarming message for the entire network nodes which waste their energy.

2-9 Sensor nodes size:

Nodes should be small in size and volume, for instance in the size of a match or smaller up to 1 cm^2. The requirement of being small in sensing nodes is resulted from the fact that their consumption rate should be low enough and if necessary they should be suspended in the air with wind (Fig, 3).

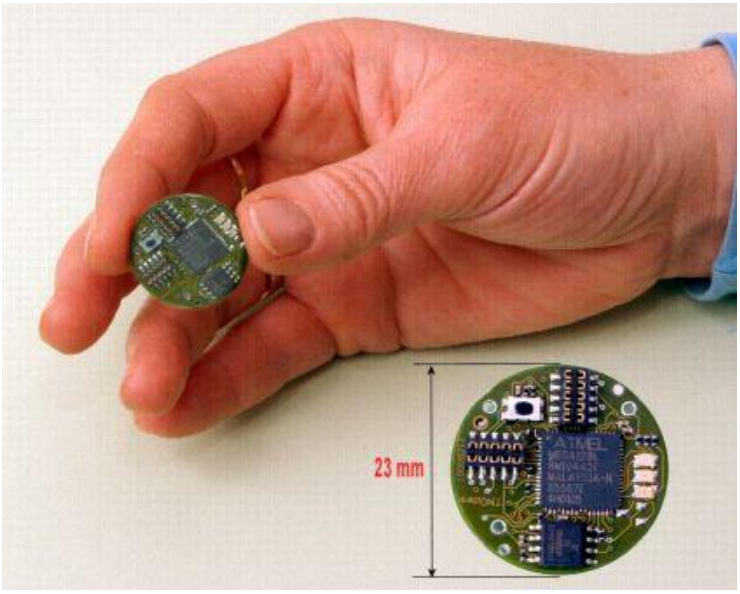

Fig. 3- Small size of sensing node

2-10 Hardware limitations and obstacles

Sensing nodes should be small, light, low in volume, economic, low price and environmentally friendly. VLSI or integrated circuits of high compaction and low consumption have significant role in decreasing hardware limitations or the sensing network. Of the relative challenges there are node multiplication in sensing network, their high density, possible failure and repeated topologic changes, using mass distribution and nodes being data oriented, having no identification number.

In addition there are some applications for the sensing network which requires many numbers of sensing nodes to be used, so in such cases the expenses for each node would be low (from few dollars to few cents depending on the application). As well sensors may remain for many years or even decades without their batteries being changed which remind the necessity of effective usage of battery and energy so that they do not require periodical replacement of batteries. Any way the network would require significant reorganization and human force.

Big networks having nodes with low power would have some problems especially there is the fact that rooting of such networks is generally performed without using common rooting tables. As well network division, maintenance, support and ability to preserve are among other challenges of such networks.

2-11 Topology:

Topology of sensing network is a graph while applicable algorithm would consider it as a covering tree. The connection between nods is that of mass distribution. Searching topology is among the specifications of such networks which challenge their security. The main stage in management of topology is primary commissioning of the network the nodes for which have had no primary connection with each other and with the first replacement and initiation they should be able to connect with each other. This means the possibility of new nodes membership and then omission of out of service nodes. Searching topology creates the ground to accept enemy nodes. As nodes are acting as rooter in addition to collection of information, they should perform good unless they are omitted and topology is corrected.

2-12 Reliability:

The problem is that we want to create a reliable network using unreliable components. So intelligent algorithms have been defined. Nodes failure as the result of natural factors such as earthquake, flood, radio disturbances should not affect the network performance since the problem make nodes center uncontrollable. To this end sensing network should enjoy self-organizing, self-treatment and self-optimization capabilities. However sensors life is short.

2-13 Scalability:

If the network can work with any number of nodes and any density and a sensing network can support thousands of nods with different distribution density, this indicates the network scalability.

2-14 Cost price:

As there are numerous number of nodes in sensing network, which in some cases even reach millions of nodes, their price should be economically justified. 50 cent increase in each node would mean approximate increase for $ 500 in the network in whole. As well for node distribution time, if we consider 30 seconds for each node to distribute and place them in the necessary region, we would require 8 man hour to develop and establish 1000 nodes in the network.

2-15 Environmental conditions:

In those environments where human can not attend for different reasons (weather, poisonous gases, arduousness, chemical environment, microbial, nuclear, ocean bottom, studies in the space, military locations, forest, …) but he requires to collect information about the environment, sensing network is used. To prevent corrosion and environmental destructive effects, the sensor node is sometimes placed in a container to be protected against moisture or unsuitable conditions.

2-16 Communicating media:

Radio waves, infrared radiation and light signal are among common communicating media among which radio communication is used more. It should be noted that infrared radiation is inexpensive and easier but it works in straight line.

2-17 A real sample:

Mica particle is a true sample of sensing network resulted from the works performed by researchers from Barkly University-USA. It has 8-bit processor of “tmel” type, 128 Kb of memory and 4 Kb of Ram (Random Access Memory) for data and 512 Kb flash memory as well as Risk instructions. It should not be forgotten that calculation

backup is performed without multiplication, shift, alternative length and turning operation. As well, it uses 916 MHZ radio waves of low usage and 40 k/Sec band width on individual, divided channel with limited range of 12 meter.

Radio wave would consume 408 MA when receiving, 12 MA when sending and 5 MA in standby status. Mica particle or smart dust was guided by Professor Pitster and Khan. They hope to make mica particle of few millimeter.

Fig 4- Mica Particle- From Barkly University work.

Mica particle is available in different sizes. The smallest particle is known as Smart Dust. Research plan on smart dust is guided by Professor Pitster and Khan who have reached a limit for the measure and consumption of power in autonomous sensing nodes. Decrease in size for making inexpensive nodes and their development is so important. The research group hope to make the necessary items for sensors, information transmission, hardware calculation along with power supply of few mm in size while keeping sensing and communication capabilities efficiently.

This few square millimeter node is known as smart dust which is the realm of impossible things. Its future samples can be so small to be suspended in the air, float,

and send sensed items for hours and days. Smart dust can send the information passively using a modern light reflection technology.

4- Conclusion:

The result from sensing network is that this gives a new concept from the networks which was not expressed before. So sensing network are in the first step in their progress and like many other modern sciences, we would witness significant progress in near future. Subjects such as node localizer, energy consumption, node maneuverability and their multiple uses are among the active discussion in this field. So it is hard to say which hardware or software may prevail in future but researches continue on sensing network and relative subjects.

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