BRAINY GRIT NETWORK FOR PRUDENT BORDER SPYING SYSTEM

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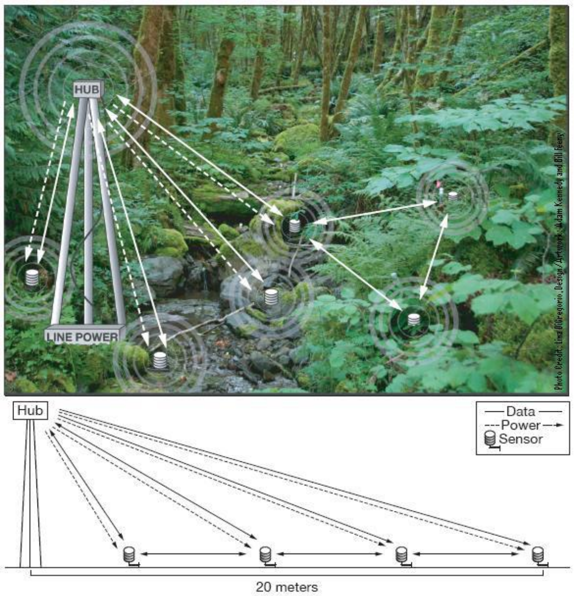
Abstract The project aim is to design a next generation intelligent ultra small dust like wireless sensor motes which has multiple onboard sensors and a processor, which has the ability to detect an enemy intrusion across borders and battlefields. Thousands of these smart dust motes can be deployed within a large area in a few hours by one or two men. The motes can form a network on its own among them, are small in size, rapidly deployable, have wireless connection to outside world. They detect the intrusion and classify it into vehicles or individuals and groups. Onboard hardware include a variety of sensors for vibration, magnetic, acoustic and thermal signature recognition, a microcontroller for processing these sensor values and a radio transceiver for communication over a wireless network. The system process the sensor readings, classify the targets and the tracking history can be viewed in the display attached in the central monitoring unit. The central monitoring node acts as the parent node in a peer to peer wireless network model. The dust motes communicate with central parent node using wireless radio network.

Keywords: MEMS, brainy grit motes

Wireless sensor network

I. Introduction The greatest threat to national security is "Terrorism", infiltrating through borders. In critical border areas, regular forces or even satellites cannot monitor the intruding terrorists, as the area monitored is quite large and complex. This paper proposes an innovative and effective solution to this problem by designing a next generation, intelligent, ultra-small, dust like, wireless sensor motes with multiple onboard sensors and a processor for detecting enemy intrusion across borders and battlefields. As the project is conceptualized on „smart dust technology, a brief elucidation of smart dust definition is provided. Smart dusts are dust size devices which are light in weight [1]. Each smart dust mote can be considered as a tiny computer with one or more sensors, on-board power supply, a communication system and a controller. It can communicate with other smart dust devices using the wireless radio network. The battery life of a smart dust mote can vary from a few hours to ten years depending on the size and capability of the device. A common mote communication scheme uses radio frequency signals to communicate over relatively short distances. This allows designers to minimize mote size and reduce power consumption. When communicating, the devices pass each message to a neighboring mote, which, in turn, passes the message onto a neighboring mote, and so on, until the message reaches the destination ie the central monitoring mote. The networks of motes continue to perform even if some of its communication paths fail to operate. And once a mote is placed in an existing network, it adapts to blend in with the other nodes to form a larger network; and when a mote fails, the other devices in the network take over its load.Fig. 1 show smart dusts deployed in a forest



In real time, thousands of such moves are deployed in the field for detecting intrusion but in the project we are employing only two smart dust sensor motes and a single monitoring mote on an experimental basis. There are several existing border surveillance systems or methods in use today [2]. The most popular methods are flying aircraft, deploying armed forces and ground surveillance using RADARS. The drawbacks of these systems are discussed here ;*(a) Flying aircraft:* the aircraft is usually run only for limited hours or for one or two days. *(b) Deploying armed forces:* it is very difficult for the armed forces to monitor a large area with great precision. Also, it is very unsafe and risky for the forces to remain at difficult terrains such as dense forests, snow covered or mountain areas for days where bad weather conditions prevail. *(c) Ground surveillance using RADAR:* No single RADAR can fulfill all border surveillance requirements with single RADAR equipment. There is search RADAR that does the search function and once the search is done we would need the track RADAR for the tracking. There is also complex RADAR equipment that could integrate two or more RADAR functions in one RADAR instrument. RADAR as a whole is very huge and bulky. RADAR‟s are very much visible owing to its big size and hence, it is subject to enemy detection. Due to the RADAR‟s bulkiness we would require one or two men to carry it to the place of deployment or it is mounted on an armed vehicle. The smart dust concept may be implemented in border surveillance applications in an effective and efficient way to solve many of these problems as we shall see in the coming sections.

Related Work on border surveillance

There are several works carried out in the area of border surveillance. As an example, the study conducted by T.J.Nohara explains the use of commercial approach to the deployment of radar surveillance [3]. The literature says, "surveillance solutions must be multi-mission suitable, scalable, flexible, maintainable, upgradeable, interoperable, shareable, and affordable", which is very true when it comes to border surveillance and other security systems. Smart dust system satisfies the above mentioned features and its compact size is an added advantage when deployed in the battlefields. To give another example, the work done by C.Neumann and his colleagues explains about the protection of our borderlines as well as military camps using Radar surveillance methods [4]. The challenges of remote border monitoring have been detailed in the work conducted by P.Pratap and his colleagues[5]. The paper discusses three major issues to be addressed to build an effective ground surveillance system and the issues are „providing reliable and efficient power‟, „providing adequate and timely maintenance to minimize downtime‟ and „networking systems for effective data transmission‟. Concluding, the work says that a system that overcomes these challenges will provide a "cost-effective solution requiring minimal support infrastructure solution to meet border monitoring and protection needs." Smart dust system ensures that it meets these challenges, to be discussed in the following sections. Numerous other works were carried out in designing border surveillance systems and also improving on the existing methodologies. Most of the works carried out was about improving on the existing Radar technologies, using unmanned air vehicles and fiber optic sensing [3][4][6][7].This paper proposes a system based on smart dusts for border surveillance applications that can help solve many of the challenges posed by conventional systems especially concerned to power consumption, maintainability, safety and coverage. The system structure of the smart dust networks is presented in the next section followed by the hardware and software design in the third and fourth sections. The third section also details about the components used and it's set up. The software design section also includes a high level flow chart for the system and the forthcoming section describe the output obtained when the system was put under test. The final section describes the features, few concerns and some enhancements of the proposed project.

II. System Structure

The project aims to develop a system of two motes that communicates with a central monitoring mote. The system structure can be broadly classified into two- sawdust mote circuit and the central monitoring mote circuit. The block diagram for the smart dust network is shown in Fig. 2. The system consists of the following components:

a) Microcontroller: 64-bit pica microcontroller 16f877a to control the smart dust mote.

*b) Communication: (zigbee)/*IEEE 802.15.4 wireless protocol, for communication between motes.

c) Thermal sensor: Enhanced PIR sensor, to sense the acoustic sound signals.

d) Vibration sensor: 3-axis MEMS accelerometer, to sense the acoustic sound signals.

e) Temperature sensor: sense the environment temperature

f) Magnetic sensor: Intruders carrying weapons and moving in vehicles can be identified using their magnetic signature in this AMR Magnetic sensor.

Each smart dust mote consists of a variety of sensors like magnetic, thermal, and acoustic and vibration sensors for detecting the respective signatures. The controller present in the dust mote processes these values and sends them over the wireless network using IEEE802.15.4 protocol. The structure designed for a smart dust mote is shown in Fig transmitting mote

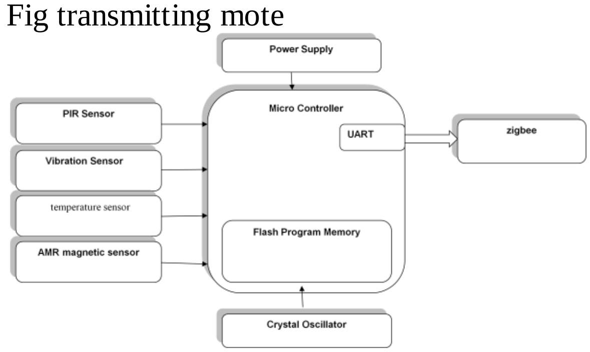
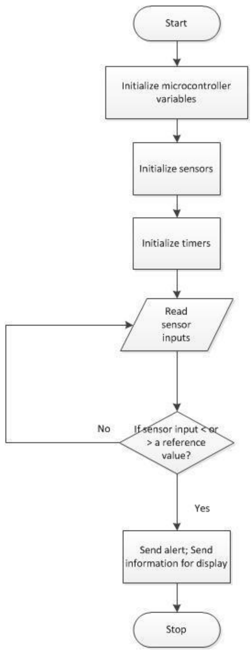


Fig receiving mote

Flowchart:



VII. Conclusion

The proposed system of smartdusts for border surveillance applications was designed, developed and tested in the laboratory. Few suggestions for the betterment of the project would be to make a distinction between animals or humans that is intruding based on the comparison of temperatures. PIR sensor can make out the difference in the body temperatures or the heat from animal and human bodies. Another major point of apprehension would be the availability of the smartdust chips.Smartdust motes are not yet available on a large scale and even if they do most of the motes are of the size of a deck of cards. We could hope for the future motes to be of dust size at the same time available at a reasonable rate.The key downsides of using smartdust networks in border surveillance is the pollution it causes because once deployed the smartdust mote remain in the soil for years. Therefore, let us hope for greener smartdust mote circuits to be developed on a large scale. Also, solar powered batteries can be of great benefit to the smartdust circuits as the circuits once deployed must remain in soil for years without maintenance. Another area of enhancement that we could suggest is that the smartdust motes could be made to give details such as the position of the intrusion and the weather conditions at the place of intrusion.

References

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