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Certain Investigations on Military Applications of Wireless Sensor Networks

Mr. S. Pragadeswaran, Ms. S. Madhumitha and Dr. S. Gopinath
Assistant Professor, Department of Electronics and Communication Engineering
Karpagam Institute of Technology, Coimbatore, India

Abstract: *Now a day's Wireless Sensor Network (WSN) tends to attracts scientific community and its applications become the topic for many studies. This has been made possible by availability; especially in sensors have gotten smaller, cheaper and smarter in recent years. In order to form a network, these sensors are equipped with wireless interfaces by which they can communicate with each other. The use of and the ability to organise these sensors into networks have revealed several research challenges and have highlighted new approaches to deal with those problems. The goal of this article is to provide an up-to-date overview of both traditional and most modern WSN military applications and, hopefully, not only to allow this scientific field to be understood, but also to encourage the perception of new applications. The key categories of Wireless Sensor Networks applications are identified and characteristic examples of the applications are identified in order to achieve this objective.*

Keywords: Wireless Sensor networks, Sensors and Military Applications.

I. Introduction

In recent times, wireless sensor networks (WSNs) have received much interest, particularly with the proliferation of technology for micro-electro-mechanical systems (MEMS) that have encouraged the development of smart sensors. With restricted processing and computing resources, these sensors are small, and compared to conventional sensors, they are cheap. These sensor nodes can sense, calculate and collect environmental information and can relay information based on certain local decision processes and transmit the user's info.

Cooperation and synergy of sensing, collection, processing, and the next step in leveraging the inheritance of this modern technology is contact and intervention. Both in the theory and in practise, the possibilities and challenges posed by this sector are widely recognised and several research teams and businesses are interested in developing and implementing units that embody these four attributes. Such instruments, which are either developed as prototypes or as commercial products, are typically referred to as motes. A mote is an autonomous, portable computer, a sensor unit that also has the capability of processing and communicating wirelessly. In spite of the autonomy they are presently, the great power of motes is that they can form networks and work together according to different models and architecture[1].

These networks, known as wireless sensor networks, have been the subject of significant research efforts in the fields of communication, electronics and control. In this paper, we try to survey and classify the various applications using wireless sensors or networks of wireless sensors into suitable categories. As the continuing interest in this research area is strong, we believe that documenting these recent applications and trends would be useful, particularly from the point of view of new applications or related research problems.

II. Existing Sensor Network Applications

Sensor networks may consist of several different sensor types, such as seismic, magnetic, thermal, visual, infrared, acoustic and low sampling rate sensors.

Radar, which can detect a broad range of environmental conditions [19] Temperature, The moisture, Movement of cars, State of Lightning, The Pressure, Makeup for soil, Levels of Noise, The existence or lack of entities of such types, For continuous sensing, event identification, event ID, position sensing, and local control of actuators, sensor nodes can be used. Many new application areas are promised by the micro-sensing and wireless communication principle of these nodes.

While the number of wireless implementations sensors is amazing, there is no exact norm to describe a "mote". "The word "mote" means a platform of limited scale, no absolute separation, however, can be achieved. Already recognised applications can be, regardless of the exact type of platform, categorized under several general headings: military applications, control of the environment, industrial or human-centered applications and robotics applications.

III. Military Applications

It is possible to classify WSN applications into two categories: one is monitoring application and the other one is tracking application (See fig.1)

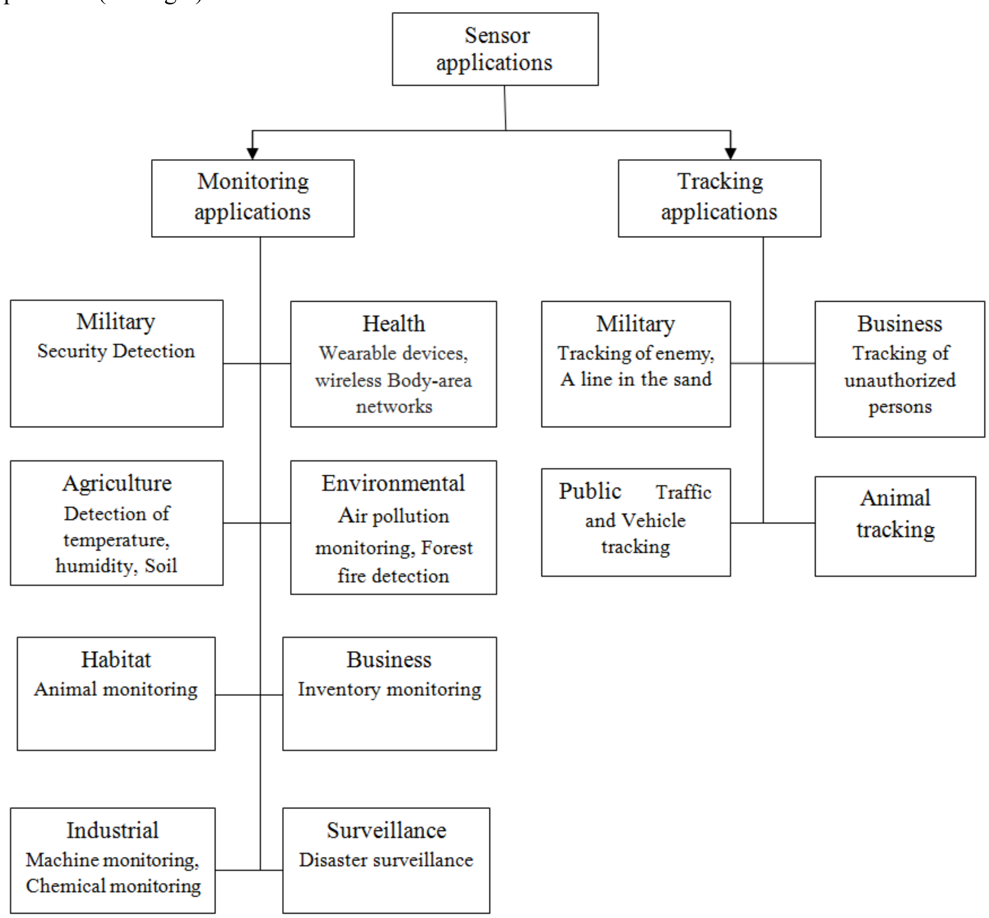

Figure 1: Possible categories of WSN applications

A big application field for the wireless sensor network is military defence. The wireless sensor network's key roles are to track enemy movements and organise the army's operations. In the region we want to track, the motes will be deployed and a base station will be there to manage the motes and to collect and process the information from different motes.

The motes are linked to sensors to monitor the atmosphere for the detection of enemy movement and to coordinate our side's military activity. Sensor-related motes can search for unique events and send the base station periodic messages. Motes will automatically transmit messages to the base station in the case of suspicious activities. The base station receives the data from different motes and takes the required measures, such as informing the command in charge of that region or giving messages to the motes surrounding that area. The base station will be positioned in a safe location, and without deploying the army, we can deploy the motes in the area we want to track. There are some drawbacks that make us protect the network in traditional ways, such as cryptography, such as power and low computation. So, to make the system safer, we have considered the case of an unmanned vehicle. The expensive sensors can be connected to the vehicle and other equipment such as the camera. The vehicle detects the data and directly sends it to the Base Station. The Base Station is going to collect the signals from nearby motes and from the base station, the vehicles include a driver mote. It can be used on both sides to track movements. By obtaining the data from driver mote, the military movements from our side can be very well organised. Knowledge on the enemy's movements will allow us to plan our next step. If any essential data about intrusion is sent by the sensors, the vehicle can then be relocated for a thorough examination to that location.

In military command, control, communications, computing, information, surveillance, reconnaissance and targeting (C4ISRT) systems, wireless sensor networks can be an integral part. The expeditious deployment, sensor networks' self-organization and fault tolerance characteristics make them a very sophisticated sensing tool for military C4ISRT. Since sensor networks are focused on dense deployment of sensor networks. Monitoring friendly troops, weapons and ammunition; battlefield surveillance; reconnaissance of opposing forces and terrain; targeting; war damage assessment; and identification and reconnaissance of nuclear, biological and chemical (NBC) threats are some of the military applications of sensor networks.

3.1 Friendly Powers Monitoring, Supplies and Ammunition

Leaders and commanders, with the use of sensor networks, can continuously monitor the position of friendly forces, the condition and availability of equipment and ammunition on the battlefield. Any soldier, vehicle, equipment and essential ammunition can be attached with small sensors that report the status. In sink nodes, these reports are compiled and sent to the troop leaders. Data can also be forwarded to the upper levels of the hierarchy of commands while being aggregated at each level with data from other units.

3.2 Battlefield Surveillance

The sensor nodes of the WSN may be deployed in applications of this kind on a battlefield close to the routes that enemy forces may use. The main benefit given is that the WSN can not only be positioned randomly, but can also operate without continuous attendance and maintenance being needed. In most situations, the terrain of the battlefield differs completely. This plays an important role for the sensor nodes, both in terms of coverage and energy consumption. Some of these apps are given below.

The use of WSN technology for ground surveillance is discussed in [3]. The authors explicitly propose a system consisting of low-cost common nodes capable of sensing magnetic and acoustic signals produced by different moving target objects. Based on the spatial variations of the signal, the device attempts to classify and categorise different targets, such as vehicles and troop movements.

A submarine Anti-Submarine Warfare (ASW) detection system is introduced in [4]. The system is made up of cheap multi-sensing units that combine active and passive sonars. A large number of sensors, which are deployed in littoral waters according to a particular pattern and ocean depth, can be scaled to the system. These sensing units use their passive sonar to locate a diesel-electric submarine and to confirm their target with their active sonar. By using an alarm signal containing its ID code, the unit which has confirmed a target notifies its neighbouring sensing units. A warning is triggered if the units send multiple alarm signals within a predefined period of time. In addition, due to the very low range of the active sonar (50 m), the system can acquire a low False Alarm Rate (FAR) that solves the acoustic multipath issue of traditional sonobuoys.

3.3. Combat Monitoring

The firing of guns, mortars, artillery and other weapons produces sound, heat, and vibrations within a battlefield. With the use of WSNs, this information can be registered and gives an expectation of the enemy's position. This application form is illustrated below. The use of acoustic sensor arrays suspended below tethered aerostats for the identification and localization of moving vehicles, transient mortar signals, artillery, small arms fire, and source location is provided in [5].

In combination with an acoustic vector sensor, a specialised detection device may be used to intensify the probability of locating the hazard by means of the shock wave produced by the supersonic bullet and the muzzle blast generated by the pistol [6].

The authors of [7] define a framework for real-time health monitoring of soldiers consisting of interconnected Body Sensor Networks (BSNs), a sub-family of WSNs. A BSN incorporating different physiological and biomedical sensors is a key component of this device.

These sensors are an accelerometer, an EEG simulator, and a SpO2 sensor that can be embedded within each soldier's advanced fighting helmet. In real time, they monitor different health status information, such as blood pressure, oxygen saturation, and heart rate. Different strategies may be applied by using the collected data to train soldiers more effectively and prepare them more properly for future engagements.

3.4 Multi- Vehicle Tracking

In the sense of a follow-up game, multi-vehicle tracking. There are two teams that are competitive: the pursuers and the evaders. A third part is a network of sensors that is used to help pursuers find their adversaries. The sensor network tells the pursuers about the relative locations and movements of the enemy units. Thus, the network of sensors enhances the "vision" of the pursuer team and reveals their competitors.

3.5 A Line in the Sand

It refers to the deployment of 90 nodes capable of detecting metallic objects. The ultimate aim was to track and identify moving objects with significant metallic content, and to track vehicles and armed soldiers in particular. The machine has overlooked other beings (e.g., civilians).

The second-generation Mica2 motes attached to a multi-purpose acoustic sensor board are sensors in the PinPtr system. Three acoustic channels and a Xilinx Spartan are used to build each multi-purpose acoustic sensor surface. II FPGA. Mica2 motes run on an operating system platform for TinyOS[21] that manages scheduling of activities, radio contact, time, I/O processing, etc.

3.6 Aerostat Acoustic Payload for Transient and Helicopter Detection

The Army Research Laboratory (ARL) has performed experiments to identify and limit transitory movements from mortars, large guns and small arms releases using acoustic sensor displays suspended under attached aerostats. For tie evasion, the same aerostat and unattended ground sensor UGS joint effort can track adjacent helicopters in 3d [8].

3.7 A Novel Shoe Scanner using Quadruple Resonance Sensor Open-access

At the GE Protection San Diego Centre of Excellence, a new shoe scanner was built using Quadruple Resonance (QR) to discern explosives contained in shoes[9]. With an open-access frame and filtering chamber, the shoe scanner was developed that allows travellers to stand in a normal position in the system during the checking process[10].

Advances in sea mine detection group filter applications, Omni Bird a miniature PTZ NIR sensor system for autonomous day/night UCAV operations, Low-cost acoustic sensors for littoral anti-submarine warfare (ASW) are also seen in [11].

3.8 Advances in Group Filter Applications to Sea Mine Detection

In the underwater environment, it is extremely difficult to distinguish questions that vary in scale, form, and introduction from daily occurrence and man-made disorder.

The Naval Surface Warfare Centre Panama City (NSWC PC) uses the unmanned underwater vehicle (UUV) sensor frameworks defined by high sensor information rates and restricted preparation capabilities to output the sonar image and characterise the image characteristics, geometrically characterised structures with introductions, and confined ghastly data into various orthogonal parts Or highlight the picture's sub-spaces [18].

3.9 Self-Healing Land Mines (SHLM)

A network supporting the autonomous antitank landmine system is defined in [12]. Each antitank mine monitors the state of its neighbour, senses threats to itself and reacts by moving autonomously to those threats. Sensing is based on a distributed acoustic location system and accelerometer sensors that are self-contained. The roadmap for the next generation SHLM system implementation was given in [13].

3.10 Aerostat Acoustic Payload for Transient Detection (AAP)

To detect and localise transient signals from mortars, artillery and small arms fire, acoustic sensor arrays suspended below tethered aerostats are used. The airborne acoustic sensor array measures a transient azimuth and elevation to the originating transient, and shows a collocated imager immediately.

Aerostat arrays can be supplemented by unattended ground sensor (UGS) systems Providing additional solution vectors for the 3D triangulation of a source position from many ground-based acoustic arrays[14]. A new generation of acoustic vector sensors measures the pressure and velocity of the particles in all three directions, thus directly measuring the position of the source [15].

3.11 Soldier detection and tracking (SDT)

Unattended acoustic and seismic protection when defending military sites or structures. Sensors are planned to survey particular points by detecting approaching individual enemy soldiers[16]. A human tracking programme utilises a mixture of acoustic sensors and still cameras for daylight. The near integration between the acoustic and visual modalities resulted in the activation of the camera only at the right time and place. Only those images which are compatible with the acoustically generated tracks are transmitted by the network, providing a very high hit rate [17].

IV. Conclusion

It is evident from the discussion above that WSNs play an important role in military operations. With the aid of these networks, it is possible to track not only the sensitive areas, but also, because of its modular existence, it can be extended over time to the surrounding areas according to the requirements. In addition, the rest of the network can continue to detect whether any node has been disabled due to its fault tolerance characteristic. The rest of the network would not be affected by a single sensor or a group of sensors being impaired.

The casualty rate would be minimised by the use of wireless sensor networks (WSNs). Normally, these networks are deployed in dangerous and sensitive areas where, in the event of their involvement, there is often a clear danger to soldiers. Due to their easily accessible and inexpensive nature, the damage to sensor nodes in that scenario is not visible. Wireless Sensor Networks (WSNs) have a broad range of applications for military purposes, as we discussed earlier, but there should be a number of more applications possible in military operations, taking into account the significance and sensitive nature of defence and security. This calls for further analysis in this area.

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