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Evolving Constraints in Military Applications using Wireless Sensor Networks

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***Abstract*— WSNs consist of a large number of small sensor nodes. These nodes are very cheap in terms of cost. In military operations, there is always a threat of being attacked by enemies. So, the use of these cheap sensor nodes will help to reduce the loss. In this paper, we analyze the existing literature of using WSNs for military applications. We will discuss the available scenarios of using sensor nodes in the military uses. Provided suitable sensors the system can detect identify and classify threads based on the count, number, type weather it is armored vehicles or men in foot, type and amount of weapons they carry, etc., can be detected in advance. This system provides reliable real time war picture and better situational awareness. This will further help to improve the troop readiness and decrease the reaction time. Added using the data collected tactical planning for deploying troops effectively can be done. In case of civil applications economic zones like oil fields, gold mines, can be protected from intruders and attackers. Industrial complex and production facility can be protected with minimized man power and improved efficiency. Basic criteria are which had to be taken into account while deploying wireless sensors for such applications has been discussed. Particularly locating the intruder with respect to the distance from the sensor node to the target in terms of latitude and longitudinal coordinates are discussed here.**

***Index Terms*— Radar signals, quantization error, friend identification, power management, perimeter defense.**

I. INTRODUCTION

There are different types of sensors available like temperature sensor, humidity sensor, multimedia sensor and others. Due to these variant sensors, WSNs got applications in different fields such as environment monitoring, agriculture monitoring, industrial monitoring, health monitoring, home applications and military operations. Sensor Networks were initially designed for military operations and surveillance [1-4]. WSNs have been emerged as an excellent tool for military applications involving intrusion detection, various parameter monitoring, information gathering and, smart logistics support in an unknown deployed area [5, 6]. These networks can provide different services to military and air force like information collection, battlefield surveillance and attack detection [7-11]. Because of their capabilities of real time transmission, WSNs play an important role in military operations. These networks offer several advantages over traditional sensor devices such as fault tolerance, robustness and low budget deployment. Recent trends and advancement of technologies in the area of micro-electronics has lead to the creation of the Micro-Electro-Mechanical Systems, commonly referred to as MEMS [3]. MEMS had overcome the limitations of system on chip technology by providing sensing capabilities of physical parameters and control of the real world through actuators instead of just performing logical operations. Not only MEMS which took advancement in silicon valley, RF technology and digital circuits has also evolved for long distance low power applications and digital circuits have shrinked the circuitry into a single chip and minimized the fabrication cost and time, the sequence of process like sensing, processing, communication and integration lead towards advancement in WSN. Device which used to perform such sensing operations in its range is called as motes which come as a prototype or a commercial product. In this paper wireless mote is used for border surveillance, detection and tracking of enemies in hostile environment to secure our main land. Surveillance needs capabilities to detect, track, identify and classify enemies and priorities them according to the thread.

Normally surveillance needs high degree of stealth in order to avoid detection. Placing our soldiers along the border directly leads to their life thread and the solution is to place wireless sensor motes along the borders to listen to the ground. The problem with wireless sensor network is power backup. Energy efficient algorithms have to be deployed to tackle this problem which improves their endurance capability. The main objective of this paper is to discuss how to detect, classify, and track intruders in border to protect our perimeter. A field deployed wireless sensor must have the ability to detect the presence, count, location, track, and identify the intruders.

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II. ISSUES IN COMBAT SYSTEM

A. Field noise

Sensors mainly convert one form of energy signal into other, mostly an analog signal to digital for error free transmission. On the other hand digital systems also have their own problems to tackle. But the worst enemy for any electronic system is its noise. It may be from outside environment of natural noise or an internal noise of system noise. Since our high precision sensor system works on small rate of sample mostly small amount of photons in case of optical sensors and electrons in case of low power circuits [4]. Other than this, in the process of conversion of signals to digital, quantization, aliasing, and bit error rate (BER) after analog to digital conversion (ADC) will also affect the system performance.

B. Field variation

Field of environment taken for study will not remain so for a long period. The nature of the environment may change in course due to climatic conditions which will affect the vision of the system. For example, infrared sensors may get affected due to heat source emitted from vehicles, flame, explosion in its area, activities of our soldiers and it can't be reliable. Radar signals get affected by moisture and mist [4]. Computer vision may get affected due to improper illumination and shadow formation.

C. Background signals

Separating target from background environment is a major issue. The same issue is faced by computer vision in separating target from background in off-laboratory condition. In Some sensing methods like within range systems like RADAR, LIDAR, SONAR can easily be fooled by noise and multipath interference.

III. DESIGN CONSIDERATIONS

A. Presence

Decision has to be taken "Is there any human beings are present". During this process of detecting the presence the system must not miss took outside environmental components as a human being. In a scenario, if enemy soldiers are airdropped into our territory and if the use dummies among those (i.e., some dead bodies are airdropped system will mistook them as soldiers) which is a serious issue. Presence has to be justified with no chance if error so that the system can be made system proof.

B. Count

Number of enemy soldiers are intruders present into our territory has to be identified accurately so as precise and valuable intelligence can be provided to our soldiers regarding the hostile environment. Counter measures can be taken accordingly are our tactics can be planned accordingly.

C. Location

Locating targets is very much important to provide surprise attacks on enemy so as we can get him in situation, no idea what is happening. In some scenario locating target is very much important so that we can eliminate thread situation with indirect fire support elements like mortar, artillery shells, and even unguided are guided rockets like Pinnak and Hellfire.

D. Tracking

Course of the enemy or intruder may change in time and it has to be checked continuously so called a task known as tracking. It is same as locating. But it is repeated continuously over time for a long duration. Tracked data has to be continuously updated with our soldier to improve the reliability of the intelligence.

IV. DESIGN REQUIREMENTS

A. Physical attributions

In most scenarios the sensor nodes are hand deployed and transported to the field via vehicles or by the soldier in his back pack which means the sensor must be small in size and weight [5]. In some occasions the sensors may be air dropped using transport aircrafts or UAV's in the sense the sensor node has to be ruggedized.

B. Self-formation

Deployed sensor nodes must identify its friend with in its range and network itself to transfer data using hopping techniques as like ad-hoc, because of power constrain. It is needed the sensor to be static because some nodes can get displaced due to physical influential factors and the node has to reconfigure with the network. If any sensor node fails reconfiguration has to be done without human intervention.

C. Data flow

During the early stages of the concept of WSN technology particularly during the period of first generation sensor network one way communication is much more enough [27-29]. But advancement of technology lead us into a new phase of second generation sensor network where in some scenarios the commander has to take control of the sensor node where we need duplexed communication techniques say to steer electro optical sensors like CC TV [20-26].

D. Coverage and network size

Coverage in the sense the sensing area of the node. Military standard sensor must require an appreciable sensing area and the network size says about the number of nodes which can be connected with the network. The network must have the property of robustness, self-healing and configurable.

E. Life of the sensor

Some operations last for weeks and some for month's even years. In such case the sensor must last long to provide intelligence of the war picture particularly one placed in hostile environment. If the sensors are deployed for protection of home land and strategic locations it is possible to change the power source which further improves the life of the sensor [33]. In some modes the sensor need not to function to its full effect and there some power saving

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algorithms are deployed to save more power thus to improve life.

F. Stealthy characteristics

Now-a-days stealthy is not only for human eyes. Stealth is to cover from every illuminative characteristic. Means also from electronic and electromagnetic signature. Deployed node must emit very tiny electronic signature.

G. Reliability

Data gathered must be reliable for the commander to take split seconds decision. The network must provide necessary security to avoid eaves dropping, tampering and interception.

H. Denial of service

In any instant of physical attack on the sensor nodes it must be capable of reporting it back to the command center by using some switch mechanism.

I. Tamper proof

Any single data present in the sensor may leads to compensate national security if it gets in the hands of third party. So that the node must be tamper proof to secure the data within it.

J. Cost

One of the deciding factors for implementation of any project in real time is the overall cost of the system in terms of implementation and maintenance. So this factor has to be taken into account during pre and post development of the product by implementing latest technology.

IV. OPERATIONAL FLOW

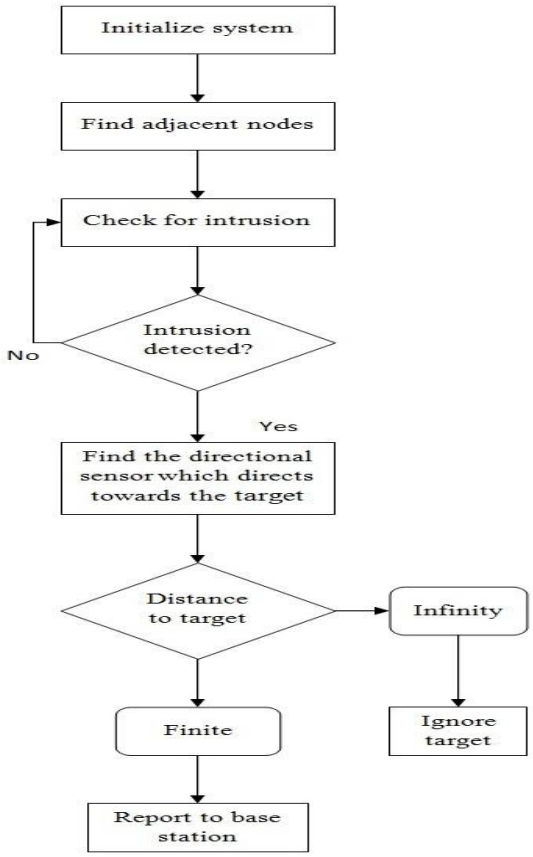

Figure 1: Flow chart of the methodology

The above mentioned flow chart clearly explains the operational method of the system. In the system if the distance to the target was found as infinity, the target was ignored. Because no target can be infinite and infinity cannot be measured. The range to be measured can also be pre-defined, i.e., the threshold value can be set, which is based on the level of noise. Say if a signal with output voltage is found as 8V and it can be ignored if output above the range of 6V is found as noise [30-32].

V. CONCLUSION

Implementing such self-forming sensors will reduce the deployment and maintenance cost which also helps us to provide better situational awareness and troop readiness in case of military scenarios. In civil application perimeter can be managed effectively using such wireless sensors. In future the same will be done in hardware and real time operational issues will be discussed.

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