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A REVIEW ON BIO-INSPIRED HYBRID WIRELESS SENSOR NETWORK IN AREA SURVEILLANCE SYSTEM

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ABSTRACT

Area Surveillance System (ASS) have gained an increasing importance over last few years due to its multiple applications like under water pipelines monitoring, electricity transmission lines monitoring, public action monitoring, home security, in agriculture like water level, humidity, temperature, crop monitoring and many more. Hybrid Wireless Sensor Network (HWSN) is combination of Static WSN (SWSN) and Mobile WSN (MWSN) which plays an important role in ASS to gather data for monitoring and controlling. Complex tasks can be solved using self organization by interacting locally with individual agents without any external interference. In ASS, finding a target in unknown location is also a complex system. So, self organized Mobile Sensor Node (MSN) can be used to locate target. The main objective of this survey is to summarize the existing techniques of nature based self organization to route the MSN to locate target in ASS.

1. INTRODUCTION

A WSN based system is used in both military and civilian application in Area Surveillance. ASS can be used for the monitoring and controlling borderline area, road traffic, homeland, forest fire etc. Depending on the application and mission needs, ASS in general needs to use different kinds of sensor nodes like Static Sensor Node (SSN) and MSN, which gather Varity of raw data that are then merged and refined. As the result of this process, higher level information about a given phenomena is generated and then analyzed. However, the ability of a WSN to successfully perform this work depends on the cooperation among the different kinds of sensor nodes, mobility of nodes, self configuration of nodes available in the network, so that they can effectively contribute to the achievement of a common goal. ASS can be categorized according to the localization of sensor nodes. It is as follows:-

- Fixed/Static location of Sensor Nodes
- Movable/Mobile location of Sensor Nodes
- Both Fixed and Movable /Hybrid location of Sensor Nodes

In some systems sensor's location are fixed like in Traffic monitoring, Home or institution monitoring, crop monitoring etc. In such system first appropriate locations are identified in such a way that minimum number of sensor will require to cover entire area. Due to fixed location the network topology is same for whole network.

There are some systems which require movable sensors like wild life monitoring, electrical transmission line monitoring, finding explosive material in border line etc. In these system sensors are carried by robots or moving trolley to sense information. Due to the movability network topology is not same.

In some cases both fixed and movable sensors are required. If surveillance area is too large and it is not possible to cover entire area with static sensors, then we can identify some important locations to place fixed sensors and remaining area can be covered by movable sensors. Like police force operations, they use to find sensitive areas in city so that some police force will cover that area and rest of the area they covers by patrolling. Ex. In border line Control, probable entry points of intruder can be covered by static sensors and remaining area can be controlled be MSN.

2. SELF ORGANIZATION

The concept of self-organization was first proposed by the cyberneticist W. Ross Ashby [1] in the 1940s and developed among others by his colleague Heinz von Foerster [2]. During the 1960s and 1970s, the idea was picked up by physicists and chemists studying phase transitions and other phenomena of spontaneous ordering of molecules and particles. These include Ilya Prigogine [3], who received a Nobel Prize for his investigation of self-organizing "dissipative structures", and Hermann Haken [4], who dubbed his approach "synergetic". In the 1980s, this tradition cross-fertilized with the emerging mathematics of non-linear dynamics and chaos, producing an investigation of complex systems that is mostly quantitative, mathematical, and practiced by physicists. However, the same period saw the appearance of a parallel tradition of "complex adaptive systems" [5], associated with the newly founded Santa Fe Institute for the sciences of complexity, that is closer in spirit to the cybernetic roots of the field. Building on the work of John Holland, Stuart Kauffman, Robert Axelrod, Brian Arthur and other SFI associates, this approach is more qualitative and rooted in computer simulation. It took its inspiration more from biology and the social sciences than from physics and chemistry, thus helping to create the new disciplines of artificial life and social simulation. The remainder of this paper will mostly focus on this second, simulation based tradition, because it is most applicable to the intrinsically social and cognitive processes that produce the systems studied by information science. Although the other, mathematical tradition sometimes uses the term "complex systems" to characterize itself, the labels of "non-linear systems" or "chaos theory" seem more appropriate, given that this tradition is still rooted in the Newtonian assumption that apparently complex behavior can be reduced to simple, deterministic dynamics—an assumption which may be applicable to the weather, but not to the evolution of a real-world social system. Extending both traditions, the turn of the century witnessed a surging popularity of research into complex networks. This was inspired mostly by the growth of the worldwide web and the models proposed by Watts and Strogatz [6], and Barabasi and Albert [7].

The system which is not solvable by any straight forward mathematical solution & whose output is unpredictable due to unpredictable behavior of its agents is called complex system. Multi-agents of complex system generally interact nonlinearly with each other like insects, animals, body cells etc. Due to non linear behavior these systems are unpredictable and uncontrollable. Initially these systems are predictable but after some time instance these may be predictable, neutral or unpredictable.

In complex systems most of the agents communicates locally. If less number of agents involved in system then its behavior is controllable & predictable. But if more number of agents are involved then its behavior is uncontrollable & unpredictable. Ex. Nature based problems like land sliding, fire in forest, waves in sea, wind storm, flood in river, avalanche in snow & air borne or viral diseases.

There are mainly four properties of complex system-

- Positive Feedback
- Negative Feedback
- Amplification
- Multiple Interactions

Self-organization can be defined as the spontaneous emergence of global structure out of local interactions. "Spontaneous" means that no internal or external agent is in control of the process: for a large enough system, any individual agent can be eliminated or replaced without damaging the resulting structure. The process is truly collective, i.e. parallel and distributed over all the agents. This makes the resulting organization intrinsically robust and resistant to damage and perturbations. As noted, the components or agents of a complex system initially interact only locally, i.e. with their immediate neighbors. The actions of remote agents are initially independent of each other: there is no correlation between the activity in one region and the activity in another one. However, because all components are directly or indirectly connected, changes propagate so that far-away regions eventually are influenced by what happens here and now. Because of the complex interplay of positive and negative feedbacks, this remote influence is very difficult to predict and may initially appear chaotic. Summary of self organization is shown in Table 1.

Table 1: Summary of Self Organization

Abstract Features	Description
Self Organization [1],[2]	It is a process in which system changes its behavior & output by interacting locally with its agents without any external control.
Emergence [5]	It is a phenomenon where it reaches to unexpected state by interacting multiple self organized agents.
Self Organized System [6],[7]	In changing environment when self organization & emergence is applied to function then system is called Self organized system
Benefits	Increase of Robustness, Adaption, Scalability and Local communication.
Limitation	Possibility of occurrence of opposing action so lack of guarantee for finding optimum solution.
Application	Distributed Network routing, localization of Wireless Sensors, Network Security etc.

3. SELF ORGANIZATION FOR AREA SURVEILLANCE

These properties can be seen in self organizing system so it is hypothesized that self organization & local Interaction can find the solution on complex system such as ASS. For example: In real life if there are some terrorists camps (Target) in forest. Forest is few hundred square kilometers (working space). We don't know the exact location of target. Target changes their locations frequently. In such situation we have to send one or more Army troops in searching operation. Every troops individuals (Agent) search target individually. If target found they will inform to each other locally otherwise they move randomly or preplanned path in a group. This operation will continue till target is achieved.

If we want to perform same operation with computerized devices then we can use MSN which will be equipped with sensor to identify target & capable to interact with each other i.e. self organized MSN. So ASS is a complex system. Due to its non linear behavior self organization can give better solution to find target

Self organization is the one of the most important topics in the present scenario of the surveillance. In the surveillance and the path finding the self organization of the sensor nodes in the wireless sensor network plays a very important role. Moreover, embedded web servers [8] [9] can be used to connect the physical world of sensors and actuators to the virtual world of information utilities and services. Consequently, a flurry of research activity has recently commenced in the sensor network domain, especially in wireless ad-hoc sensor networks.

Following are the some of the importance need of self organization of sensor nodes in the wireless sensor networking for surveillance.

3.1 Coverage Problem

Coverage problem is the one of the most important reason of the requirement of the self organization. In the ASS the sensor nodes need to cover the as much as possible area to find or to locate the object. Sensor nodes are generating response for the other nodes in network if they are in the coverage area of the network [10]. One of the fundamental issues that arise in sensor networks, in addition to location calculation, tracking, and deployment, is coverage. Due to the large variety of sensors and applications, coverage is subject to a wide range of interpretations. In general, coverage can be considered as the measure of quality of service of a sensor network.

Furthermore, coverage formulations can try to find weak points in a sensor field and suggest future deployment or reconfiguration schemes for improving the overall quality of service. In most sensor networks, two seemingly contradictory, yet related viewpoints of coverage exist: worst and best case coverage. In worst-case coverage, attempts are made to quantify the quality of service by finding areas of lower observe ability from sensor nodes and detecting breach regions. In best-case coverage, finding areas of high observe ability from sensors and identifying the best support and guidance regions are of primary concern.

3.2 Realization of False Tolerance

False tolerance is other important issue occurred in the surveillance in the wireless sensor networking which needs the self organization. False tolerance occurred because of the nonlinear placement of the sensor nodes in the wireless sensor network. Nodes are move in the different direction in the coverage network to locate the object in the surveillance area. These nodes are try to reach the object by generating the signals to the other nodes in the network. The tolerance generated by the nodes helps the other nodes to find the path of the node near to the object. Self organization helps to arrange the nodes in the network to reduce the false tolerance [11].

3.3 Target Motion Prediction

Search and rescue has been commonly classified according to the environment within which it takes place and the nature of the target's motion. Urban SAR (USAR) refers to activities amid collapsed structures and is concerned with locating stationary survivors within a bounded environment [12] [13]. Marine applications address search in potentially boundless environments, typically precluding consideration of terrain-difficulty issues [14], [15]. Wilderness SAR (WiSAR) refers to locating lost persons moving in unbounded inland environments with varying and often complex terrains [16], [17]. This presents rescuers with a significantly different problem than that for the two aforementioned applications. The main challenge is to locate a moving unobservable (i.e., non-trackable) target, whose state at any given time is unknown, but can be predicted through the use of probabilistic information. As part of our continuing research efforts on multi-robot coordination (MRC) for autonomous WiSAR, Self organization helps to predict the location of the object by arranging the nodes continuously by itself in the wireless sensor network.

3.4 Greedy Geographic Routing

Sensor/ad hoc networks. In this paradigm, it is assumed that every node knows its own location in the plane, and the source of a message knows the location of the destination through a location service system. The message is expected to proceed in a greedy manner—it is always forwarded to a node that is closest to the destination among the forwarder's neighbors. Such a greedy strategy, were it to succeed, can often produce a low-stretch path [18]. One of the major advantages of such a method is that it is low-state, in that every node only needs to remember the location information of its immediate neighbors, thus fitting in the resource-constrained environment of a sensor network.

Unfortunately, greedy routing alone does not guarantee successful delivery of messages in a practical network due to the existence of local minima, where a node does not have a neighbor closer than itself to the destination. This problem can be solved by self organization of the sensor nodes in the wireless sensor network

3.5 Path Planning

Path planning is the one of the most important aspect of the surveillance of the object in the particular territory. Shortest path finding to locate the object in the wireless network is very important to improve the energy consumption in the network because the sensor nodes had the limited amount of energy for operation. The main problem with the path planning is the how can each sensor node plan its trajectory such that it explores the environment and gathers as much information as possible regarding target locations, while maintaining the required connectivity to the other sensor nodes in the wireless network.

To solve this problem self organization of sensor nodes can be very handily. Author Alireza Ghaffarkhah uses the concept of self organization in his paper path planning for networked robotic surveillance to find the shortest path of the object in by using the multiple robots as the mobile nodes. In his paper author consider a robotic surveillance problem in which team of mobile robots are deployed in remote area to detect multiple static objects. After finding objects they informs to base station. Author also studied minimization of object detection probability. They shows how this type of design is possible by co-optimization of sensing (information gathering) and communication (information exchange) when motion planning. Author started by considering the case where the robots need to constantly update the remote station on the locations of the targets as they learn about the environment. For this case, he proposes a communication-constrained motion planning approach for the robots. On the next case he considers where the remote station only needs to be informed of the locations of the targets at the end of a given operation time [19].

4. NATURE BASED SYSTEMS FOR AREA SURVEILLANCE SYSTEM

To solve the complex problem of surveillance area many different systems are proposed by the different researchers. Some of the important systems of the area surveillance are discussed in the section. Nature based systems are classified into: (classification shown into Fig. 1)

4.1. Distributed Systems / Leaderless Systems
 - 4.1.1 Human Inspired
 - 4.1.2 Non-human/ Animal Inspired

4.2 Centralize / Leader /Neighbour follower

In the distributed system every low powered entity works in a group and try to achieve big goal which individual entity cannot achieve. In the nature there are many animals behavior which works in distributed fashion. These systems can be used to solve many real time complex problems. Some of animal behaviors are discussed below.

4.1 Distributed Systems/ Leaderless Systems

In the distributed system every low powered entity works in a group and try to achieve big goal which individual entity cannot achieve. In the nature there are many animals behavior which works in distributed fashion. These systems can be used to solve many real time complex problems. Some of animal behaviors are discussed below.

4.1.1 Human Inspired

Many human inspired techniques are used to solve the different complex problem of area surveillance. These techniques are developed by using human behavior and human intellectual system. Sanjeev Wagh and Ramjee Prasad focused comparative study of human organ components for optimizing energy and routing path in wireless sensor network [20]. Some of the importance human inspired techniques are studied in this section.

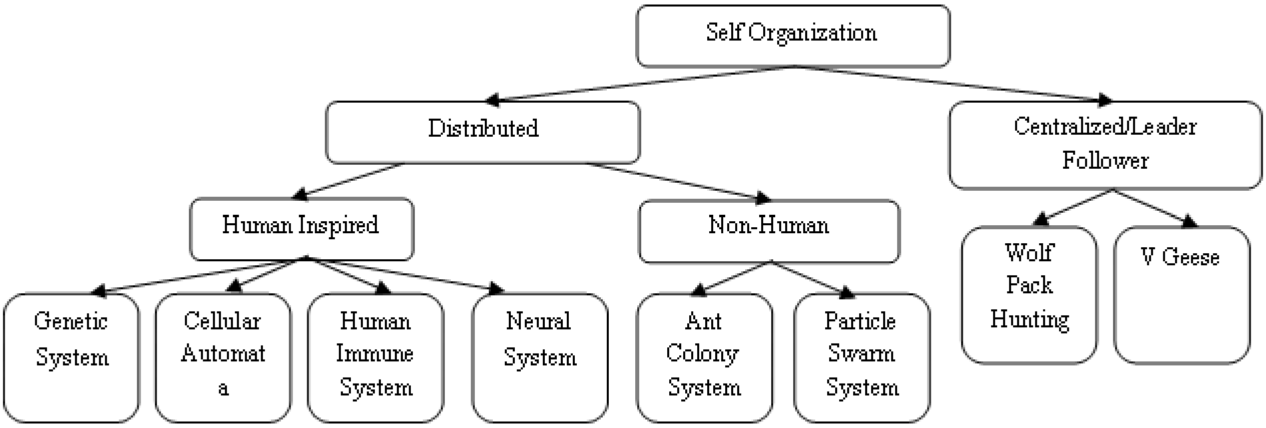

Fig 1: Self Organization Classification

i. Genetic System

By processes in biological evolution such as natural selection, inheritance, recombination, and mutation. GA is generally realized in a computer model, in which a population of runner solutions to an optimization problem progress to better solutions. The evolution starts from a population of completely random Individuals and occurs in generations. In each generation, the fitness of the entire population is evaluated, and multiple individuals are selected from the present population based on their fitness. These are modified, mutated, or recombined to make a new population, which becomes present in the next iteration of the algorithm. Usually, the solutions are represented in strings of 0s and 1s, though different encodings are also possible

Genetic algorithms are based on natural selection discovered by Charles Darwin [21]. They employ natural selection of fittest individuals as optimization problem solver. Optimization is performed through natural exchange of genetic material between parents. Offspring's are formed from parent genes. Fitness of offsprings is evaluated. The fittest individuals are allowed to breed only.

In computer world, genetic material is replaced by strings of bits and natural selection replaced by fitness function. Matting of parents is represented by cross-over and mutation operations.

A simple GA consists of five steps [22]:

1. Start with a randomly generated population of N chromosomes, where N is the size of population, l – length of chromosome x.
2. Calculate the fitness value of function φ(x) of each chromosome x in the population.
3. Repeat until N offsprings are created:
   3.1. Probabilistically select a pair of chromosomes from current population using value of fitness function.
   3.2. Produce an offspring y_i using crossover and mutation operators, where i = 1, 2, ..., N.
4. Replace current population with newly created one.
5. Go to step 2.

ii. Neural System

An artificial neural network (ANN), is a group of interconnected artificial neurons & processes to compute task.

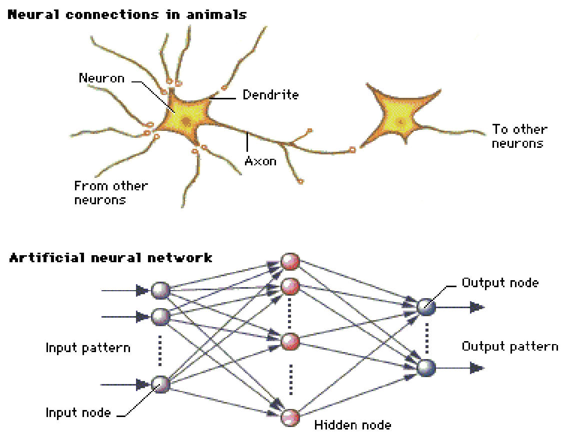

Fig 2: Basic Neural Network Structure

A neural network has to be configured such that the application of a set of inputs produces (either 'direct' or via a relaxation process) the desired set of outputs. Different methods to set the strengths of the connections presents. Prior knowledge is a one way is to set the weights explicitly. Another way is to 'train' the neural network by feeding it teaching patterns and letting it change its weights according to some learning rule. Basic nural structure is shown in Fig. 2.

In more practical terms neural networks are non-linear statistical data modeling tools. They can be used to model complex relationships between inputs and outputs or to find patterns in data.

Neural networks essentially comprise three pieces: the architecture or model; the learning algorithm; and the activation functions. Neural networks are programmed or "trained" to "store, recognize, and associatively retrieve patterns or database entries; to solve combinatorial optimization problems; to filter noise from measurement data; to control ill-defined problems; in summary, to estimate sampled functions when we do not know the form of the different functions." It is precisely these two abilities (pattern recognition and function estimation) which make artificial neural networks (ANN) so prevalent a utility.

iii. Immune System

The overall human immune system is implemented through the interactions between a large number of different types of innate and acquired cells rather than the function of one particular human organism. From a large number of different cells, lymphocytes (white blood cells), play a central role. Their main mechanism is distinguishing self cells, which are the cells of human body, from non-self cells, which are dangerous foreign cells. Each lymphocyte is specialized in reacting to a limited number of structurally related harmful foreign cells, known as antigens. Lymphocytes have the specific binding areas, called receptors, which have complementary shapes to the determinants of antigens, called epitomes. A specific antigen is recognized by its epitomes binding to lymphocyte antibody receptors [23] [24].

iv. Cellular Automata System

Cellular automata (CAs) are a promising method to solve complex problems like traffic surveillance system and ASS. It works in distributed manner which consists of large number of simple homogeneous components which are connected lacally. These systems perform complex computations with good efficiency and robustness. So CA is having wide scope of application in natural science, mathematics and computer science. It is used in parallel computing devices for high speed simulation of scientific research. It is also used for studying cooperative and collective performance in complex systems.

The original concept of cellular automata is most strongly associated with the great scientist and mathematician John von Neumann. According to the history recounted by Burks, von Neumann was deeply interested in connections between biology and the (then) new science of computational devices, “automata theory.” Paramount in his mind was the biological phenomenon of self-reproduction, and he had posed a fundamental question: “What kind of logical organization is sufficient for an automaton to be able to reproduce itself?” The idea of using cellular automata as a framework for answering this question was suggested to von Neumann by Stanislaw Ulam [25]. Thus, the original concept of cellular automata can be credited to Ulam, while early development of the concept can be credited to von Neumann.

Comparison of all human inspired techniques is shown in Table 2.

4.1.2 Non-human/Animal Inspired

Many non human inspires techniques are used to solve the different complex problem of area surveillance. These techniques are developed by using animal and behavior and their intellectual system. Some of the importance non-human inspired techniques are study in this section.

Table 2: Comparison between GA, NS, IS and CA

Characteristics	GA	NS	IS	CAS
Introduced in and By	(Fraser, 1957; Bremermann, 1958; Holland, 1975 [5],[22]	1943, 1945 Warren McCulloch and Walter Pitts [23]	1796-1870 Jenner Koch 1870-1890[23],[24]	1970 1974 Jerne, N.K. Toward 1996 Hunt and Cooke [25]
Mechanism Based on	Chromosomes, Population Based Stochastic Search Method, Survival of the fittest.	Brain, neurons	Leukocytes, Cell Receptor	Cells, Cells Grid
Strengths	Optimize path	Training and Testing is required, can find Novel attach or Path	Identify easily other cells so it secures body	Used only for homogeneous system
Weaknesses	Require more time to execute	Require more time to execute	Require more time to execute	Require more time to execute
Application in ASS	Grouping and Routing, Optimizing Routing path	Routing in Heterogeneous System,	Security and Routing with multiple data input	Dynamic Routing in Network with multiple data input.

i. Ant Colony System

In the nature, ants lay pheromone and so they produce pheromone trails between the nest and a food source. On a computer, the pheromone has been replaced by artificial stigmergy, the probabilities in the routing tables. To compute and update the probabilities, intelligent agents are introduced to replace the ants. There exist two kinds of agents, the forward agents and the backward agents. All forward and backward agents have the same structure. The agents move inside the network by hopping at every time step from a node to the next node along the existing links. The agents communicate with each other in an indirect way by concurrently reading and writing the routing tables on their way [26] [27].

In general, ants are always be able to find a shortest path for food source and habitat in the process of the feeding. When an ant passing, ants release a specific secretion, namely pheromone, this pheromone helps them to sense the path and they guided by it. The more ants pass, stronger pheromone achieves. Further this will also causes higher probability of choose the same path by other ants. This behavior of ant colony shows the positive feedback phenomenon of information. Ant structure is shown in Fig. 3.

ii. Particle Swarm Optimization

There are extremely good coordination while moving or food foraging in heard, swarms of insects, flocking of birds and fish schools. These groups behave in distributed manner by communicating with surrounding group members only. Every group member follows next to its group member. Most of the groups are extremely large and there is no leader. This suggests that local communication mechanism which maximizes information transfer among individuals could be evolutionary beneficial.

Particle Swarm Optimization (PSO) developed by Eberhart and Kennedy in 1995 [28], this method is for optimizing numerical functions and real-world problems.

This method was originally developed as a tool for simulating social behavior, it has becomes a powerful optimization technique closely relating to evolutionary algorithm.

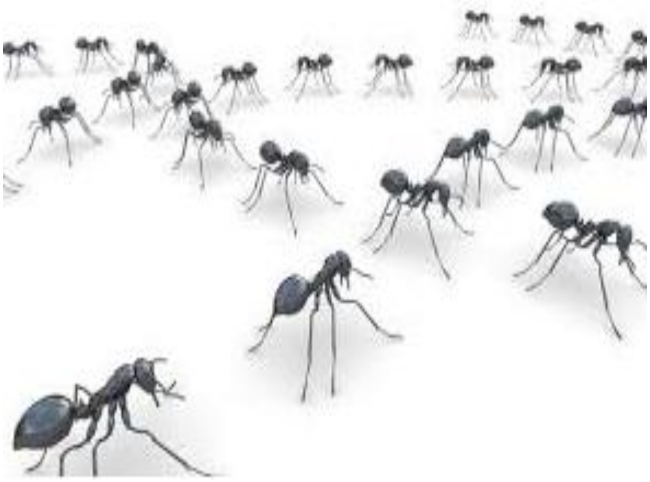

Fig 3: Ant Structure

Within the past fifteen years, a movement has begun to move beyond the theoretical understanding of biological swarms. Instead, engineering and artificial intelligence researchers are seeking to replicate the efficacy of biological swarms to solve real-world problems. While the applications of swarm intelligence have propagated beyond the fields of engineering and computer science into business, telecommunications, finance, social psychology, etc., robotics-based applications are the focus of this research. A number of researchers have undertaken the task of demonstrating complex, intelligent system behavior in groups of cooperative, mobile robots. This has been accomplished with some success, albeit limited to highly constrain experimental situations. The tendency of most researchers is to discuss the potential benefits of swarm-based robotics without developing an operational robotic swarm.

Swarm intelligence claims historical underpinnings from both biology and engineering. Reviewing the genesis and subsequent development of swarm intelligence research therefore requires approaching the subject from both entomology and robotics. Swarm technique of school fish and flocking birds is explained below.

a. *School of Fish*

A group of fishes move together and in coordination with each other forms a pattern. Generally fish in a group move uniformly and maintain a certain distance with each other. Fish schools are attached to each other by an internal force and stay in group. [29]

Fishes are not intelligent to create some regular patterns but with local interaction they move near to each other, so ultimately whole group forms a pattern. This technique can be used in traffic & networking problem, self organized robots and ASS. Fish school is shown is in Fig. 4.

a. *Bird Flocks*

One of the most obvious observations that can be made about the natural world is that it is based on dynamics. Indeed the latter is as present in nature (fluids, animal groups, etc.) as it is in man-made systems (vehicle traffic, autonomous robots, etc.).

In most cases we talk about cooperation or coexistence of groups of entities, which can be homogeneous or not. Furthermore it can be said that in most cases the basic means of cooperation or coexistence is coordinated movement. In man-made systems this capability had to be introduced, but in the natural world it has been present since the days of its creation. This is why most authors when modeling, simulating or introducing coordinated movement capabilities into men-made systems draw their inspiration from the natural world primarily from coordinated groups of moving animals. Examples of coordinated animal groups abound, but the most commonly known are flocks of birds, schools of fish and swarms of insects.

Fig 4: Fish School

Of all coordinated groups of moving vertebrates, birds are at the same time the easiest to observe and perhaps the most difficult to study [30]. This is primarily because most of the animal congregation research is highly dependent on collecting [31] large sets of four-dimensional data (i.e. three in space and one in time). In fact, as a contrast to birds, most mammals move in a two-dimensional plane, which simplifies obtaining real-world data, and fish can be brought into a laboratory and enclosed in an aquarium for study. Probably because of the easier and more fruitful tracking of confined objects [32], fish schools have been a frequent research theme [30] [33].

On the other hand, scientists involved in bird congregation's research are challenged by the highly difficult and almost luck-dependent data collection [30]. Just the fact that a single bird in an organized flock can move through six degrees of freedom at velocities up to 150 km/h makes collecting real-world data very difficult. Flocks °y in a three-dimensional space that cannot be easily contained and their flight paths cannot be predicted. Even by knowing the locations where there is a reasonable probability of flock appearance one cannot predict its flight path. Furthermore the three-dimensional acquisition and analysis techniques generally demand either fixed camera or detector positions. The free flying flocks must thus be either induced to fly in the field of the cameras or the cameras must be placed in locations where there is reasonable probability that adventitious flocks will move through their field. According to Heppner [34], this may be one of the reasons why there is a current of imaginative speculation, and lively controversy in literature on bird congregation structure and internal dynamics, but little data. However, regardless of the difficulty of data acquisition, some basic understanding of bird flocks is already available. In Fig. 5 flocking birds pattern is shown.

The scientific motivation for studying motion coordination is the analysis of emergent and self-organized swarming behaviors in biological groups with distributed agent-to-agent interactions. Interesting dynamical systems arise in biological networks at multiple levels of resolution, all the way from interactions among molecules and cells [35] to the behavioral ecology of animal groups [36]. Flocks of birds and schools of fish can travel information and act as one unit (see Figures 3), allowing these animals to defend themselves against predators and protect their territories. Wildebeest and other animals exhibit complex collective behaviors when migrating, such as obstacle avoiding, leader election, and formation keeping. Certain foraging behaviors include individual animals partitioning their environment into non overlapping zones.

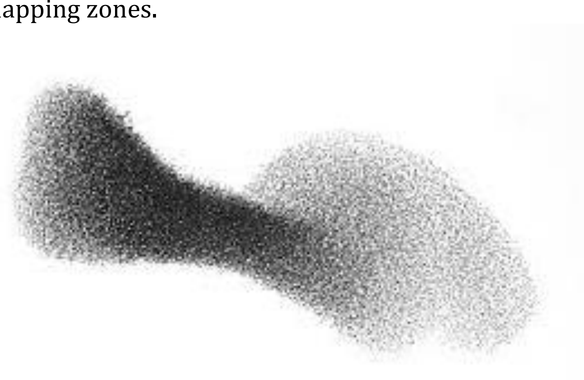

Fig 5: Bird Flocks

Comparison between Ant colony and Particle swarm is shown in Table 3.

Table 3: Comparison between Non-Human / Animal Inspired Algorithm

Criteria	Ant Colony	Particle Swarm
Introduced in and By	1988 Moyson Manderick 1989 Goss, Aron, 1991 Marco Dorigo [26],[27]	Eberhart and Kennedy in 1995 [29],[30]
Mechanism Based on	Ants, pheromone, distributed	Fish school or birds flocks Velocity clamping, Inertia weight, Construction coefficient, distributed
Strengths	It finds optimize path	It finds optimize path
Weaknesses	It gives probable solution not exact solution	It gives probable solution not exact solution
Application in ASS	Scheduling task, MSN routing problem, Localization in ASS	Scheduling task, MSN routing problem, Localization in ASS

4.2 Centralize/Leader/Neighbor Follower

There are some real time applications where we need to have a centralize control. Under its supervision other entity performs. In the nature there are some animal species who works centralizing manner. Some of Centralized controlled animal behavior discussed below.

i. Wolf Pack Hunting Model

The Surveillance of object in the network by the wireless sensor network can be implemented by the wolf pack hunting model. The model considers a team of wolf predators, i.e. a wolf pack as the one shown in Figure 6, comprising an alpha wolf and several beta wolves. Studies have shown that wolves hunt in packs of about 5 to 20 members and keep a certain hierarchy while eating a captured prey with the stronger alpha wolf eating first. This organization permits the wolves to hunt animals that are even larger than their own size [37].

Fig6 : Pack of wolves finding food

Fig 7: Pack of attacking

The wolf pack hunting model uses the following important assumptions [73]:

- Wolf teams are conformed by a group leader (alpha wolf) and at least one follower (beta wolf).
- Beta wolves group around the alpha wolf keeping a certain distance from the leader and among them.
- Wolves in the model receive only visual information from the environment, using this input to calculate their positions and distances. Any other type of communication between wolves is not allowed.
- Visual fields are limited to a single camera recognizing objects by their colors. If alpha wolf is outside beta wolf visual field, then beta wolves loses track of leader.
- Head direction is kept constant relative to body motions.
- Walking speeds are kept constant for all wolves at all times.

Formations consist of one or more beta wolves following an alpha wolf. Beta wolves keep a radial distance *r* around the alpha wolf effectively forming a circumference centered at the alpha wolf as shown in Fig 7. Movement direction *d* is shown for all wolves. Lines in blue represent beta wolf visual field with angular size 2α. Beta wolves follow alpha wolf movement directions. If θ represents the angle between beta wolf moving direction and visual sight of alpha wolf; then when $\alpha < \theta$, beta wolf loses track of alpha wolf. Wolves keep around a circumference centered at the alpha wolf and follow it by visually tracking their leader. Fig 6 shows how pack of wolf moves to find food, and Fig 7 shows their attacking strategies.

ii. V Geese

Geese forms V pattern while flying. Due to V shape flying it reduces 20 to 30 percentage energy. Each goose responds to its environment, probably reduces wing resistance & keeps certain distance from its neighbour. Red Knots and dunlins [38] found their study that to fly 5Km/hour faster in flows than they were flying alone. The V pattern formation makes local interaction easier & allows goose to maintain visual contact with each other.

The leader (front most Goose) has to race most wind resistance while there is less wind resistance for those who are behind. And last Goose has to face less resistance. When leader is tired then another Goose take its position and become a leader [38]. V-gees V pattern is shown in Fig. 8.

This technique can be used to same power in robots and MSN.

Fig8: Pattern of Geese

Features of Wolf Pack and V-Geeses are shown in Table. 4.

Table 4: Comparison between Wolf Pack and V-Geeses

Criteria	Wolf Pack Hunting	V Geese
Introduced in and By	1991 Balch and Arkin 2004 Vallesa and Weitzenfeld [73]	1897 Kaname Akamatsu 1997 Steven Radelet and Jeffrey Sachs [38]
Mechanism Based on	Wolfs, Centralized	Geese, centralized
Strengths	Central Coordination for security	Central coordination for travelling, reduce energy
Weaknesses	Routing is not efficient	Routing is not efficient
Application in ASS	To capture the target.	To reduce the energy while routing

5. SUMMARY

As we are aware that ASS is a complex system and to find targets in unknown location there is no simple solution. So nature based self organization is a perfect solution to solve it. All techniques have their own advantages and disadvantages and can be useful to specific application. Many researchers had already proved that for autonomous robots, nature based self organized technique is very effective.

Advantages

- Agents are simple, low powered, less memory and less capability
- Single agent is not capable to do the task but group can complete complex task
- Communication is done locally with local information
- Individual failure of agent does not affect the performance of whole team
- Agent reacts to dynamic changing environment

Disadvantages

- Single agent can not perform task
- It is stochastic process
- There is no linear or analytical method to solve problem
- Parameter can have a dramatic effect on the emergence of collective behavior
- It depends on positive or negative feedback of agents
- This technique cannot work for non coordinated system

In section II some important points to consider in designing Ass is described. Still there are some points which can be studied like hardware design of MSN, localization problem of MSN and SSN, use of GPS in navigation, environmental problems and various sensor equipments. In Section III author discussed nature based navigation techniques of animals. These techniques can be used in real time system for navigations. Section IV and V explains in details self organization and how it is adapted by nature based systems. Author had discussed problems in Ass which can be solved by Self organization. And Section VI focuses nature based systems to solve complex problems of area surveillance. Author explained Genetic System, Nural System, Immune system, Cellular Automata, Ant colony, fish school, flocking birds, Wolf pack hunting and V-Geese techniques in detail and its application in ASS. The objective of this paper is to introduce all powerful nature based technique which can be used to implement ASS. And as per my opinion all techniques are explained in detail

6. CONCLUSION AND FUTURE SCOPE

Learning natural science is not only analogy but it is a scientific foundation of interdisciplinary approach which is mostly recognizing for the invention of next generation. The paper has introduced ASS problem which aims to find multiple targets in unknown location by navigating MSN using self organization technique. For self organization different nature based techniques are studied to minimize routing, energy and faults. Comparative study shows their application for specific problems, advantages and disadvantages and parameter used of all techniques. The nature based self organized techniques are applicable to all disciplines like agriculture, medical, Engineering, science etc. The paper will give guidelines to researchers and students who are eager to use nature based system in their study.

Most of the nature based self organization techniques which are described in paper are applicable for homogeneous system. But in real life we have to face challenges of heterogeneous systems, its way of communication, routing etc. It is necessary to find nature based self organization techniques which work on heterogeneous system.

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