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Optimization of WSN using Biological Inspired Self-Organized Secure Autonomous Routing Protocol

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Abstract— Since last three decade, Wireless Sensor Network is one of the biggest innovative technologies; it provides facility of heavy data traffic and management telecommunication by sensing, computation and communication into a small device. Main threat for this type of data transfer is data security in terms of maintains data integrity, high consumption of energy, end-to-end delay and high cost of nodes i.e. sensor. Handling all h issue at same time is the difficult task. SRTLD and BIOSARP are two routing protocol which helps in improving performance of the WSN.

This paper is a detail description of secure architecture which is based on SRTLD and BIOSARP protocol. The main objective of this architecture is to provide high security by taking into account low energy consumption, low end-to-end delay and low node level cost. This mechanism uses concept of ACO (Ant Colony Optimization) which helps in achieving objective of the architecture.

Keywords— *Wireless Sensor Network, Ant Colony System, Optimization, SRTLD, BIOSARP*

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I. INTRODUCTION

[A] Wireless Sensor Network

In telecommunication field, wireless communication plays an important role. Wireless sensor network is key factor of wireless communication, it combines sensing, computation and communication into a small device.
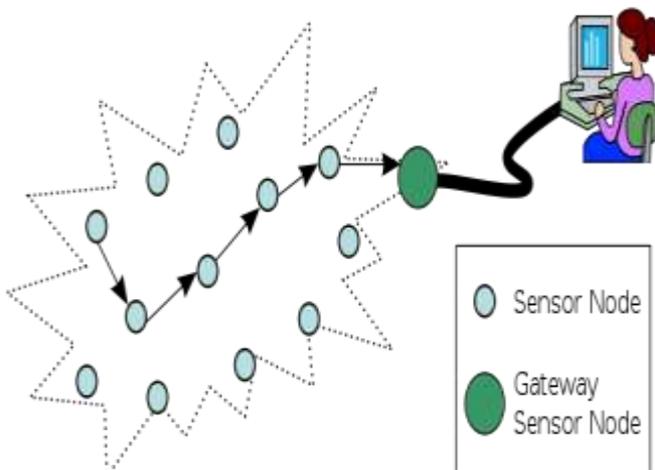

Fig.1. Wireless sensor network

Fig. 1 demonstrate the WSN, where tiny sensor nodes are distributed and they work as a monitor to monitoring physical and environmental conditions like sound, pressure, temperature, humidity etc.

Important factor in WSN is Sensor node, Sensor node is nothing but small device which is capable of detecting physical changes. It consists of 4 factors such as sensing unit, processing unit, communication unit and power unit.Fig.2 demonstrate the internal structure of sensor node –
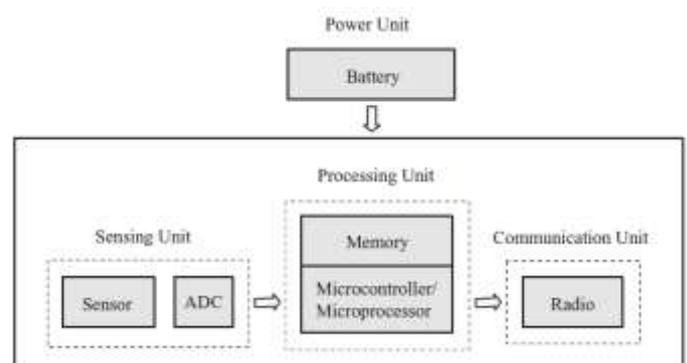

Fig.2 Sensor Node structure

WSN mainly used in applications like – Environmental monitoring, Military applications, Health care applications and Home Intelligence applications etc.

WSN architecture is classify into 2 types –

1. Flat Architecture – In this type each node plays the same role in performing sensing task and all sensor nodes are peers.
2. Hierarchical Architecture – sensor nodes are organized clusters, where the cluster members send their data to the sink.

Network Design Challenges –

- Limited Energy Capacity
- Limited Hardware Resources
- Massive and Random Deployment
- Dynamic and Unreliable Environment
- Diverse Applications

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In many WSN applications, the sensor nodes are worked on battery but they have some drawbacks like difficult to recharge or change the batteries. Prolonging network lifetime is another big critical issue. Energy efficiency is also big challenge for WSN.

In order to extend the network lifetime of WSN, extra sensor nodes needs to distribute to allow a certain fraction of the nodes to sleep from time to time. Ant Colony Optimization is one of the important concepts for improving WSN performance.

[B] Ant Colony Optimization

Ant system first introduced by Marco Dorigo in 1992.It is originally applied for Traveling Salesman Problem. Ant Colony Optimization (ACO is nothing but the artificial systems which is inspired from the behavior of real ant colonies such as pheromone communication between ants regarding a good path between the colony and a food source in an environment. This mechanism is called stigmergy. This ACO is used to solve discrete optimization problems such as WSN challenges. It consists of Swarm Intelligence, Metaheuristics and Computational Intelligence. A multi-path data transfer is also accomplished to provide reliable network operations, while considering the energy levels of the nodes.

In the ACO based approach, each ant tries to find a path in the network, providing minimum cost. Ants are launched from a source node s and move through neighbour repeater nodes ri, and reach a final destination node (sink) d. Whenever, a node has data to be transferred to the destination which is described as a base or base station, launching of the ants is performed.

Probabilistic decision rule:

$$P_k(r,s) = \begin{cases} \dfrac{[\tau(r,s)]^{\alpha} \cdot [\eta(r,s)]^{\beta}}{\sum_{r \in R_s}[\tau(r,s)]^{\alpha} \cdot [\eta(r,s)]^{\beta}} & \text{if } k \neq tabu^r \\ 0 \end{cases}$$

Where,
-- $\tau(r,s)$ is the pheromone value,)
-- $\eta(r,s$ is the value of the heuristic related to energy,
-- Rs is the receiver nodes.
-- α and β are two parameters that control the relative weight of the pheromone trail and heuristic value.

ACO algorithm is agent based [12] as it consist 4 main concepts - forward ant (FA), backward ant (BA), search ant (SA) and data ant (DA)

[C] Routing Protocol

SRTLD is popular routing protocol, in most of the experiment SRTLD evaluated on a true WSN test bed. It is based on geodirectional- basically it is localized routing protocol which generates one hop optimum node choices. The optimum call depends on the end-to-end delay, packet reception rate (PRR), and remaining battery power. SRTLD reduces the energy consumption by minimizing the transmitter power level to broadcast with a spread. It helps in handling WSN issues like broadcasting from hop causes ultra-high power consumption, extra delay, and packet loss, and therefore reduces the info turnout within the WSN. It also provides security to WSN.

BIOSARP i.e. Biological-inspired Self-Organized Secure Autonomous Routing Protocol is another protocol which also helps in WSN for tackling the issues. It utilizes ANT Colony Optimization (ACO) for finding optimum route in WSN is presented in [12-14].BIOlogical Inspired Self-organized Secure Autonomous Routing Protocol (BIOSARP) is introduced to handle self-security management module. BIOSARP is mainly based on the behavior of human immune system (HIS). As HIS provides the complete security and protection to human body BIOSARP provide security to WSN. The major function of HIS is to identify the anomalies by differentiating between self and non-self-entities. The HIS security is used in the computer technology which also known as artificial immune system (AIS). Implementation of AIS algorithms in WSN is very complex and impractical, but BIOSARP this complexity factor is handled by BIOSARP.

BIOSARP is basically based on Ant colony optimization (ACO) with ACO BIOSARP give the better performance and can be practically implemented within WSN applications for structural and environmental monitoring or for battlefield surveillance.[1]

II. Literature Review

There are different protocols and techniques are proposed for improving WSN functionality, most of them are based on ant optimization techniques. Kashif Saleem et all introduces in [1] a biological inspired self-organized secure autonomous routing protocol (BIOSARP). This protocol is based on ANT Colony System (ACS) for an optimal route decision, enhanced with artificial Immune System (HIS) inspired autonomous security mechanism. Saleem, K. et all enhanced BIOSARP protocol with SRTLD in [3], an autonomous routing mechanism. Here they used improved ant colony optimization (IACO) .By using IACO they enhanced BIOSARP functionality by reducing the broadcast and packet overhead in order to minimize the delay, packet loss, and power consumption in the WSN. Kashif Saleem et all designed a cross layer design based self-optimized (ACO) routing protocol for WSN and the results are presented in [4]. Link quality, energy level and velocity parameters are used to discover an optimal route. The signal strength, remaining power and timestamp metrics are trade in from physical layer to network layer. K.Saleem presented in [5] the design and result of ant based autonomous routing algorithm for the sensor networks their mechanism enhanced sensor network requirements, including energy consumption, success rate and time. Z. Cong et all introduced the Ant Colony optimization technique in there paper [7], they explained an innovative ant-based optimization way which allows guiding during routing decision. Mina Jafari et all implemented [9] a mechanism for Wireless sensor network routing which can be effective for the criteria of route length, end–to–end delay and network node energy for the quality of mechanism service. They proposed a method, which uses ant colony–based routing algorithm and local enquiry to find optimal routes. Bhaskaran, K et all propose [14] an ACO-based algorithm to solve the

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dynamic any cast routing and wavelength assignment (RWA) problem in wavelength-routed WDM networks. Fangyu Chen et all developed a new routing algorithm based on Ant Colony Optimization (ACO) for two order pickers (A-TOP) with congestion consideration.

III.   SYSTEM MODEL AND ITS DESIGN GOALS

A. *System Model*
Fig. 3 demonstrates the system model of WSN, which has several sub modules as –

- Network reading
- Identification of Route
- Calculation of Pheromone and Throughput
- Energy & value Estimation
- Security (Encryption & cryptography)
- Best Route Identification & knowledge Transfer

B. *Design Goals*
   Proposed system should achieve below mentioned design objectives:

- Low node cost
- Low Power Consumption
- Self-configurability
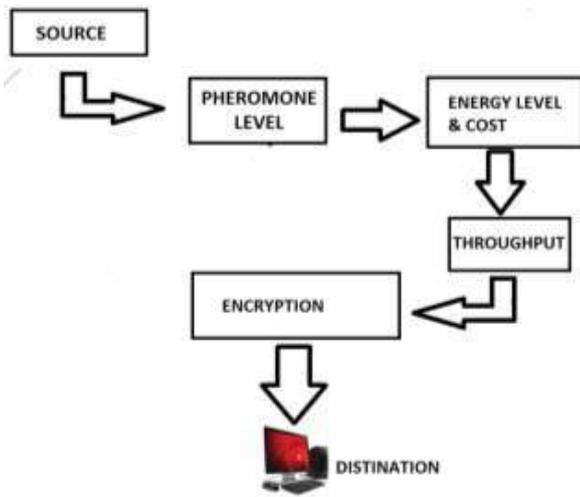- Communication Channel Utilization
- Data Security

Fig. 3 System Model

IV. PROPOSED SYSTEM

Proposed system is based implementation of advanced BIOSARP and SRTLD protocol to improve performance of WSN, which helps in achieving system objective. BIOSARP is basically based on ant colony optimization concepts. To improve performance of the BIOSARP and also tackle security issue SRTLD protocol is used.

A. *System Architecture*
Architecture of proposed WSN system is shown in Fig.5.
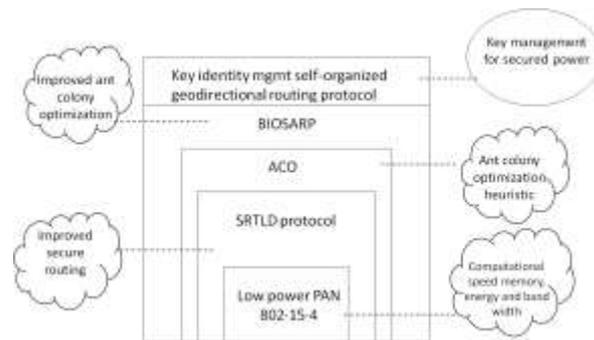

Fig.4 System Architecture

In WSN there are several nodes available, before sending any packets we need to finalized the network, in this case node sent request to server and find the required response from server. Then by using ACO (Ant Colony Optimization) technique route will get finalized. With help of routing protocol data packets are broadcasted within the decided network. With the help of cryptography security is provided to the packets, packets are in encryption format and node has its key to decrypt them after receiving. Proposed system then help to calculate the energy consumption at each node, it also calculates end-to-end delay.

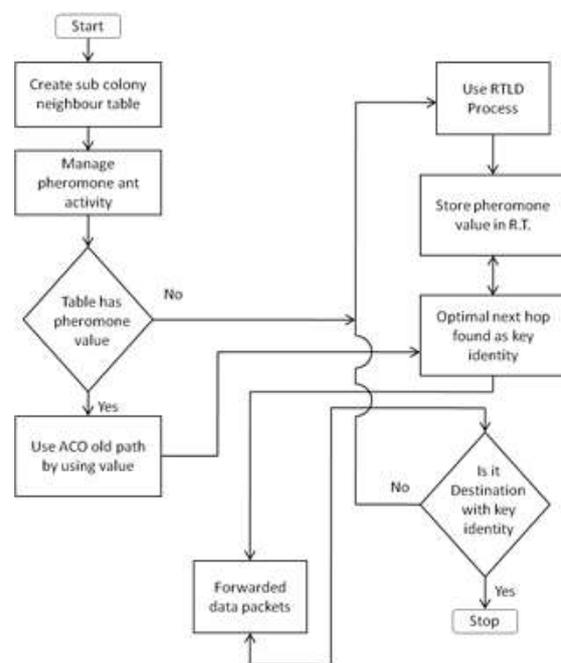   Fig. 5 shows overall process flow of the proposed system.

Fig. 5 Process Flow

Main objective of the proposed system is to provide security to data packets and also helps to increase performance of the Wireless Sensor Network by reducing power consumption at node level, by reducing end-to-end delay, providing facility of self-configuration at node level to reduce node cost. By

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implementing system which is combination of 2 protocols SRTLD and BIOSARP handle all the WSN issues.

V. CONCLUSIONS AND FUTURE SCOPE

A wireless sensor network (WSN) depends on miniaturized wireless sensor nodes that are deployed to monitor physical phenomena by communicating with each other with limited resources. The energy is very important parameter to increase the life time of WSN. In this paper presents, the biological inspired self-organized secure autonomous routing protocol (BIOSARP) which enhances SRTLD with an autonomous routing mechanism. The Ant colony optimization (ACO) techniques are used in BIOSARP which give the optimized solution for communication in WSN. The Security can add extra benefits in the system. The energy utilization can be the crucial part for Future advancement of topic.

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