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Review on Ant Colony Optimization Aware Routing for Wireless Sensor Networks

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***Abstract*:** Wireless Sensor Network is basically a network which consist of number of nodes called sensor nodes. Sensor nodes have capability to sense their surroundings , communicate with their neighbor nodes and also perform computation of the sense data. The sensor nodes have limitation such as limited power, small bandwidth , memory. To resolve these issues a bio-inspired technique called Ant Colony Optimization is introduce. ACO is a decentralized and metaheuristic technique. It provides efficient data transmission , find optimal routing path. The paper provides the overview of the ACO technique.

Keywords: WSN, ACO, energy efficient, pheromone.

I.INTRODUCTION

A WSN network is a combination of small embedded devices called sensor nodes, which communicate with each other to form a network[5]. The network is design to handle low data throughput, higher message latency, self-organization and low cost[5]. The main function of the network is to sense the data from a specific area, compute it and then transmit it to the sink where application lies[9].

The sensor nodes consists of battery, sensor, communication module ,the control unit and

memory [2]. Basically sensor gathers the information from the environment. The battery supplies energy to all the parts of the system and transceiver is use to communicate with environment. The memory simply store the temporary data or data which is created during processing [2].

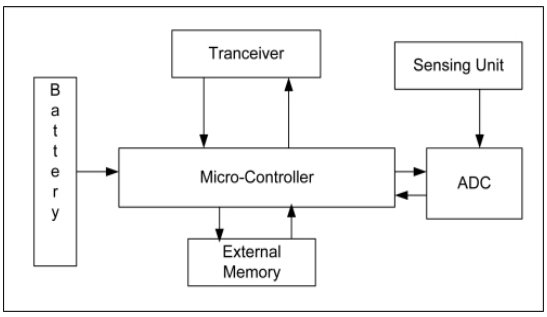

Fig 1. Block diagram of sensor node[12]

Wireless sensor network has applications related to national security, surveillance, habitat monitoring , health application , home and office application environment forecasting and military etc. In military WSN is used for target tracking and surveillance, a WSN can also assist in intrusion detection and identification. With natural disasters, sensor nodes can also sense and detect the environment changes to forecast disasters before they occur. In biomedical applications of wireless sensor network, surgical implants of sensors can help to monitor a patient's health. For seismic sensing, ad hoc deployment of sensors nodes along the volcanic area can detect the development of earthquakes and eruptions [4].

Although WSN has all above applications but it also suffer from several limitations such as limited power, small memory, hardware and software problems, hazardous environmental conditions. A bio-inspired technique named as Ant Colony Optimization(ACO) technique can overcome these problems in WSN. ACO is a decentralised and dynamic technique so as WSN.

The rest of the paper is organised as follow: Section II presents literature survey. Section III gives the overview of ACO. Section IV presents the parameters for ACO and section V gives the traditional protocols of WSN. Section VI gives the application of ACO. Section VII concludes the paper.

II. LITERATURE SURVEY:

Vishal et.al., proposed a modified ant colony optimisation technique to solve the energy problem in WSN. Modified ACO (mACO) use a number of process for mimic ant , also looking for shortest path and energy efficient route. The work was based on finding a cluster head. The selection of the cluster head depend on its energy level. Due to the rapid draining of the energy ,a new cluster head must be selected for continuous operation. The process is repeated by modified ACO.

Saburi Uday Parvatkar et.al., proposed an algorithm that introduce a new algorithm that use a state called low power state to sensor node. Basically sensor nodes had two states i.e. active and sleep state. The sensor radio turned into sleep state when it was not in use. When data packets to be sent were small in number, the energy consumed to shift the state of sensor radio from sleep state to active state or vice versa was very high. Low power state keep the sensor radio in idle state and it consume less power while switching.

K.Syed Ali Fathima et.al., presented ACO algorithm in WSN. It use ACO algorithm to provide effective multipath

data transmission to obtain reliable communication in case of node failure. In case of node failure a route error message to previous node and the current path deactivate by setting pheromone value to zero. The previous then find a substitute path to the destination. The transmission must be completed through that route. The proposed algorithm can control overhead generated by ants. It improved fast end-to-end delay and packet delivery ratio.

III. OVERVIEW OF ACO

Ant Colony Optimisation technique is a probabilistic and meta-heuristic technique. It is use to find the optimal and shortest path among the available paths in WSN. At first, Antnet routing algorithm was proposed by Marco Dorigo. The design of this algorithm was inspired by real ants.

Real ants are able to find shortest path by using stochastic decision policy based on information [10]. While searching for food, ants discern their surrounding in a random manner. When an ant finds food it carries some of the food back to the nest and while doing so, it deposit a chemical trial i.e. pheromone trail. The amount of pheromone deposit guides the other ants to the food source and also helps to find the shortest path between the nest and the food [8].

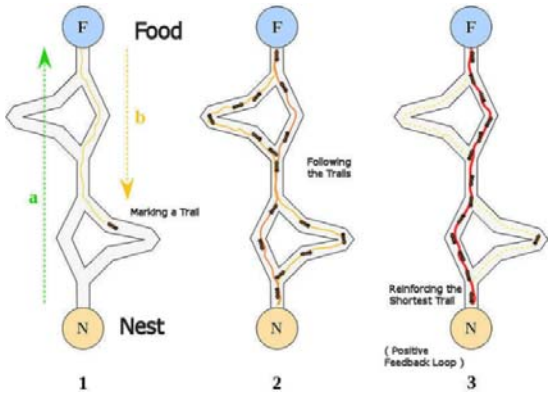

Fig2. Ants finding shortest path[13]

Ant Colony Optimisation technique is a type of swan intelligence technique. Swan intelligence techniques are based on social insect like ants, bees etc. These are use to solve different types of problems. Swan intelligence is collection of group of individual agents. These agents can work individually and can co-operate and move intelligently from one place to other in a network [9].

In basic working of ACO, the ants are divided into types i.e. forward ants (FANTS) and backward ants (BANTS). Forward ants gather the information from the network. Backward ants utilise the gathered information to adapt the routing tables of the routers on their path [10]. ACO routing has three phases. These phases are route discovery, route maintenance and route failure handling [9]. Route discovery uses control packets to discover route from source to destination. These packets move through the networks to find the route between the nodes. The route once discovered has to maintain as the network is dynamic in nature. The maintenance of the route is done by the route maintenance phase. If the current route fails, then an alternate route has to find. This is done with the help of route failure handing phase [9].

IV. PARAMETERS FOR ACO

1. Packet delivery ratio :- It is the ratio of total number of packets received at the destination to the total number send by the source.

$$PDR = \frac{\text{total no. of packet received}}{\text{total no. of packet send}}$$

2. Throughput :- Network throughput is the average of successful messages delivery over a communication channel. It is measured as bps.

3. End to end delay :- End to end delay is the difference between the time at which the sender generated the packet and the time at which the receiver received the packet.

4. Energy Consumption (C.E) :- It is the difference between initial and final energy of a node or a system.

$$C.E = \text{Initial energy} - \text{final energy}$$

5. Number of nodes :- The number of nodes are the total number of nodes or hopes which form a network.

V. TRADITIONAL PROTOCOLS OF WSN

Protocols are the set of rules which are used to transfer the data in a network. The routing protocols that are used in WSN are as follow :-

1. Ad-hoc on Demand Distance Vector Protocol (AODV):- It is a type of reactive protocol. It provide route depending upon the demand. The source broadcasts a route request (RREQ) message to find the route to the destination [7]. When RREQ is received by the intermediate node, a route to the destination is created. If the receiving node has the route to the destination then it unicast the route request (RREP) message to the source.
2. Dynamic Source Routing (DSR) :- It is also a reactive protocol. In DSR, a node always maintain a route cache which contain already available route. DSR has two important phases i.e. route discovery and route maintenance. Route discovery phase searches the route from the cache. If the route exists, it follows the same route otherwise it broadcast the request message. Route reply message is generate by the destination. Route maintenance phase deals with the transmission problems [7].
3. Destination Sequenced Distance Vector (DSDV) :- DSDV is a type of proactive protocol. These protocols are frequently known as table driven protocol. Every station maintains a routing table. These tables are adaptive to the change occur in the network. The table contains the number of nodes to the destination, lists of available destinations and sequence number given by destination node. This

sequence number uses to discriminate the routes[7].

VI. APPLICATIONS OF ACO

ACO is a reliable and energy efficient protocol. It has many applications in different eras. In communication network ACO is used to solve problems in continuous optimisation, biometrics optimisation. It is also use to solve the problem like cell placement problem in circuit design, scheduling problem and graph coloring problem and non-static problems etc [9].

VII. CONCLUSION:

In this paper, we have discussed Ant Colony Optimisation technique in wireless sensor network. The Ant colony optimisation technique solves the major problem i.e. energy consumption in WSN. ACO provides a reliable path for data transmission in WSN.

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