Swarm Intelligence Based MANET Routing Protocol

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Abstract

A Mobile Ad-Hoc Network (MANET) is a set of mobile nodes which communicate over radio and do not need any infrastructure. These kinds of networks are very flexible and suitable for several situations and applications, thus they allow the established temporary communication without pre installed infrastructure due to the limited transmission range of wireless interfaces communication traffic has to be relayed over several intermediate nodes to enable the communication between two nodes. Therefore this kind of networks is also called mobile multi-hop ad-hoc networks. The main problem in mobile ad-hoc networks is still finding the route between the communication end-points. This is aggravated through the node mobility. In the literature one can find many different approaches which try to handle this problem, but there is no routing algorithm which fits in all cases, this paper presents a new approach for an on-demand ad-hoc routing algorithms. This is based on swarm intelligence. Ant colony algorithms are subset of swarm intelligence and consider the ability of simple ants to solve complex problems by cooperation. The interesting point is the ants do not need any direct communication for the solution process, instead they communicate by stigmergy. The notion of stigmergy means the indirect communication of individuals through modifying their environment. Several algorithms which are based on the ant colony problems were introduced in recent years to solve different problems. This paper proposing a protocol called AntHocNet and is a hybrid ACO routing algorithm and path caching technique for better routing. This protocol is applied to multipath and dynamic networks, that is, creating multiple paths to transmit data from source to destination in the same data session. When the network topology changes, then it must be restored quickly and this is achieved through a new route discovery process.

Keywords

MANETs routing protocols, ACO (ant colony optimization), AntHocNet, Ant OR routing, Path caching, Swarm Intelligence.

I. Introduction

Basically, MANETs routing protocol are classified into three categories:

1. Proactive routing protocols often need to exchange control packets among mobile nodes and continuously update their routing tables. Each node must maintain the state of the network in real time. Reactive routing protocols only seek a route to the destination when it is needed. The advantage of these protocols is that the routing tables located in memory are not continuously updated. Hybrid routing protocols are derived from a mixture of these two protocols. And for this reason, they share some of their advantages. This paper, which shows an innovative routing algorithm, is organised as follows.

2. The main problem in mobile ad-hoc networks is still, the finding of a route between the communication end-points. In this paper developed to path caching technique for better routing. Ant will be periodically generated to identify the changes in the network. There is a need to proposing a protocol called Ant path cache routing algorithm. This protocol is applied to multipath and dynamic networks to create and transmit data from source to destination. The network topology changes, then it must be restored quickly.

In this paper can find many different approaches which try to handle the problem, but there is no routing algorithm which fits in all cases. This paper presents a new approach for an on-demand ad-hoc routing algorithm, which is based on swarm intelligence.

A. The Swarm Model

The objectives those are suitable for target applications are designed through swarm model which is having ant colony model as bottom line. Wide variety of data structures are integrated in the body of swarm aimed for heterogeneous applications. Network of Ant Colony system consists of set of nodes and every node has an initiator or source ant in turn which is born at the node. There is a peculiar relationship between every originator ant and the node to which it is associated with. The correlated communication protocol exists between the ant and respective node i.e. there is mutual authorization between one another to update any information. The node has privilege to construct, destruct, replicate or reproduce the originator ant. The minimal number of originator ant for each node is one in any system. Wide variety of information is carried out by each ant throughout the journey on the network. The communication stuff exchanged at the various nodes by the ants would be integrated with the environments. Here environment referred as a tiny portion of the memory that is dedicated to provide bi-directional interaction with incoming ants. This forms the feedback mechanism of the system based on the principles of stigmergy.

MAC address or its message digest is generally treated as identification of the ants. It is used to recognize the ant and its respective node each other. There is specific functionality to each colony of the swarm. So, the integrated swarm model is used to handle more than one function at a time. Thus increased through put and less service time with single system.

B. Principles of Swarm Intelligence [1]

1. Diversity

Providing diversity is an important feature of swarm intelligence. It improves the system’s ability to react to unexpected and unknown situations.

2. Adaptability

Swarming makes the system adaptable to any type of environmental or geographical changes. It makes the system scalable.

3. Proximity

Proximity means closeness. It keeps the system users close or aware of the system, background details, system changes and failure.

4. Stability

It makes the system constant. It provides atomicity. System works in the same fashion and gives similar responses to all environmental fluctuations making it platform independent.
5. Quality
System should provide expected and correct outputs with no or negligible errors.

6. Stigmergy
Stigmergy is a mechanism that provides self-organization and forms indirect coordination between agents and their neighbouring agents.

C. Advantages of Swarm Intelligence:

1. Scalability
Same architecture can be applied to maximum number of agents.

2. Flexibility
The agents can join or leave to and from the system without impact on the structure.

3. Economy
This is a cost-effective solution.

4. Robustness
Highly reliable and the failure of an agent can show little influence on the system.

5. Adaptability
It can easily remould to any environment without any negative impact.

D. Limitation of Swarm Intelligence
It is non-optimal and uncontrollable as it is very difficult to exercise control over a swarm. Swarm systems require guidance in the way that a shepherd drives a herd by applying force at crucial leverage points. It is unpredictable as the complexity of a swarm system leads to unforeseeable results. Emergent novelty is a primary characteristic of self-organisation by adaptive systems. It is non-immediate as linear systems tend to be very direct. Flip a switch and the light comes on. Simple collective systems tend to operate simply. But complex swarm systems with rich hierarchies take time. In Section II, we present related works, where we expose some of the bio-inspired protocols based specifically on the ant behaviour, Ant Colony Optimization (ACO), for ad hoc networks. In Section III, we expose a base protocol which supports our approach. In Section IV, the most relevant results are shown. Finally, the paper concludes in Section V, with overall conclusions, observations, and potential advancements for further investigations.

II. Related works
This paper presents some of the bio-inspired protocols, all these protocols have valid solutions, but they usually have a specific topology and characteristics of certain scenarios as a design basis. They are not always particularly similar if there are drastic changes in the dynamic topology of the network. There is a group of algorithms or routing protocols that work directly, Ant Colony Optimisation (ACO), for ad hoc networks. The interesting point is, that the ants do not need any direct communication for the solution process, instead they communicate by stigmergy. The notion of stigmergy means the indirect communication of individuals through modifying their environment. Several algorithms which are based on ant colony problems were introduced in recent years.

The concept of swarm intelligence is specifically referred to in the literature. It is based on the application of social behaviour of insects and other animals to solve the problems. The ACO algorithm is the starting point of these algorithms. The ACO algorithms are based on the collective behaviour of ants in search of food to bring back to the nest. Various tasks are performed by proposals of ACO routing, in which proactive, reactive and hybrid protocols are found. Since proactive ACO routing protocols are included, probabilistic emergent routing algorithm has a low delivered data packet ratio in scenarios with high mobility; it has a high overhead caused by control messages being sent several times in broadcast mode. Another protocol is ant routing algorithm for MANETs which, according to the authors, reduces the overhead of discovery and maintenance of the routes; but, they do not discuss how they control the generation of control messages in a dynamic environment. However, it has the common characteristic of achieving a low latency in the route discovery process, with the information of the routing table receiving correct updates. We also mention reactive protocols called ant-colony-based routing algorithm (ARA) [7]. This approach made use of the process of flooding to update pheromone tables in all nodes. This process has greater scope in the transmission of packets than a simple broadcast, but leads to high overhead. ARA is not scalable and does not detect loops. Ant colony-based multipath quality of service (QoS)-aware routing protocol is robust and can withstand better QoS, but is similar to reactive protocol, which has a high latency in the discovery of routes. As hybrid ACO routing protocols are included, ant ad hoc on-demand distance vector, in which the latency of route discovery is reduced, because the process of route discovery is reduced. Hybrid ACO routing algorithm for MANETs is a highly scalable protocol, with the disadvantage that, when the number of nodes is low, the continuous movement of the peripheral nodes incites to discover new routes causing more delay than other hybrid protocols, and AntHocNet protocol is based on the approach made in this article. This protocol does not take into account disjoint-link/node routes and has a high overhead in the process of exploring new routes. The disadvantage of the previously reviewed protocols is not using disjoint routes, whether link or node.

III. Proposed System
The existing system was designed for stateless packet relay through a non-stationary network. The swarm network binds each client to a server through a unique route that exists only for a particular connection. Each message will pass through a unique route that exists only for a particular connection. Each message will pass through a unique route that is not guaranteed for the next transmission. The message passing service can be viewed as a one-time-use-only trip. Due to the network dynamics it is not possible to maintain the state for long time. So, in most of the cases the existing systems implement stateless communication. But major drawback of this type is un-reliable packet delivery and high transmission error rate. To increase the reliability and to reduce the transmission error rate the current work introducing a novel technique called Adaptive Virtual Colony for Fast flux networks. The objective of Time Sliding Window based Virtual Colony mechanism is to construct temporary colonies based on the snapshot of the network. Every node has some timestamp based on the join time. The properties of every node will be compared with each other and some node will be selected as head to which influence is more. This head will be maintained...
for some time. Later it will be re-elected. Due network dynamics 
new nodes may join in the colony or existing nodes may leave 
from the colony. Energy loss is also one of the constraints for 
new head election. But first priority is given to energy, influence 
and stability. After the assigned time period also if the head has 
influence, the head designation will be extend to that node. 
This proposed approach is divided into two models named as Intra 
Colony and Inter Colony Communication.

In the Intra Colony communication, the head node for each colony 
will take the responsibility to provide secure communication 
between members of one colony. If the size of the colony is 
large then some nodes will be elected as protective nodes. The 
integration of these nodes will be acted as watchdog mechanism. 
Before transmission, every node of the network has to build virtual 
path to the head node and generate a session key. The source node 
will initialize the session request with in the colony in which it 
resides. Then the nodes which are encountered in the virtual path 
have to accept that session request and send acknowledgement 
to the source node. This process is only allowable within that 
colony. In most of the cases the virtual path has to satisfy one of 
the quality or distance or energy efficiency along with security. 
The generated session key is valid up single transmission only. 
Due to the virtual nature there is no need to maintain the routing 
information for long time. So network overhead will be reduced 
and due to session management, this protocol can maintain the 
short lived state between source and destination nodes. Control or 
Data messages will be encrypted/decrypted with the session key. 
The protecting nodes monitor the data transmission. 
The Inter Colony communication is same as Intra Colony up to 
individual colony level. Later on the head nodes of every colony 
will build virtual bridges among colonies. If source node is in 
one colony and destination node in another colony then there are 
three paths present between source node and respective head node, 
among head nodes of intermediate colonies of virtual path and 
destination node and its respective head node. As in intra colony 
session keys will be generated within each colony individually. 
One more session key will be created among the head nodes of 
the colonies participating in the transmission. Source node uses 
session key among the members of same colony and part of 
the virtual path. The head will decrypt the message using intra 
session key later encrypts it with the session key of head nodes. 
The receiving end head node will decrypt the message with same 
head nodes’ common session key and later on it will be encrypted 
with receiving end colony’s session key.

The current work also utilizing the Intelligent Water Drop Algorithm 
described in [2]. The swarm makes use of the IWD methodology 
to determine the fastest and most efficient route to relay message 
between the client and servers. The speed and latency of the nodes 
are used as features for the IWD algorithm. The amount of delay 
incurred by going through any particular node can be used as a 
measure of the amount of soil between two nodes.

The main problem in mobile ad-hoc networks is still, the finding 
of a route between the communication end-points. In this paper 
developed to path caching[14] technique for better routing. The 
path cache is built from the routing table. The routing table is 
built when the routing protocol injects routes. Before a packet is 
forwarded, a process performs a lookup in the routing table and 
decides how the packet should be forwarded. Each entry in the 
routing table for the network is considered. Ant will be periodically 
generated to identify the changes in the network. There is a need 
to proposing a protocol called Ant path cache routing algorithm. 
This protocol is applied to multipath and dynamic networks to 
create and transmit data from source to destination. The network 
topology changes, then it must be restored quickly.

![Fig. 1:](image1)

![Fig. 2:](image2)

![Fig. 3:](image3)
IV. Evaluation of Performance Metrics

A. Delivered Packet Ratio

Shows that delivered packet ratio are similar to through put seen previously, but with the use another scale. This is because the delivered packets influence in both the metrics, and we can also see obtaining a good ratio with 50 nodes.

1. Delivered Data Packet Ratio

Fig. 1: Delivered Data Packet Ratio

V. Conclusion

This paper is three fold. First, the state full fast flux networks using session management. Second Virtual Colony building based on the time sliding window approach to reduce the network overhead. Finally secured data transmission with crypto mechanisms. Thus the swarm network can be deployed on multiple platforms. They can also be woven into existing Internet applications to further the common good. This is made possible by the robust nature of the swarm network. The fast-flux capabilities do not require any particular host to be serviceable at all times. This reduces the dependency on dedicated hardware for its continued operation. Further research scope includes finding the solution for IDS (Intrusion Detection System) at head node using Data mining and Swarm Intelligence Methods.

References

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M.S.lavanyakrishnaveni was born in Kakinada in 1989, and received the B-Tech degree in Computer Science Engineering from Pragati Engineering College, Rajahmundry, Andhra Pradesh in 2010. She is working toward her M.Tech Post-graduate in Computer Science at JNTU Kakinada in 2012. Areas of interest in research are computer networking in MANETs.

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