

A DETERMINISTIC APPROACH FOR ROUTING THROUGH POLYCHROMATIC SETS IN WIRELESS ADHOC NETWORKS

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Abstract: Graph Theory is one of the basic methodologies opted for analysing computer networks such as Adhoc networks, sensor networks. Conventional Graph theory is not an proper approach for designing the wireless networks because variety of nodes and wireless link may exist. Even the usage of random graph and weighted graph may not properly model the complex wireless networks as they merely stand on a single property. This leads to the introduction of the concept of Poly chromatic sets in modelling complex wireless networks. In this paper we put forward the concept of Poly chromatic set theory which will maintain the properties of each node that support for efficient routing, and the results have proven that it is a perfect tool to determine the nodes in wireless networks.

Keywords: Poly-chromatic sets, routing, wireless networks, random graph, weighted graph.

I. INTRODUCTION

Conventional graph theory and Set theory are the basic approaches for designing the infrastructure of network. In a graph theory a graph is represented as $G = (V, E)$, where V represents a set of vertices and G represents the set of edges. In recent years most of the applications in the area of networks are represented based on the random graph [3] and weighted graph [2]. In wireless networks unit disk graphs [1] plays a major role, as nodes transmission takes place dynamically. So, we represent the node when there is an edge of unit distance i.e., the nodes within the communication range are identified in unit disk graph, where as random graph is applied when there exists probability of edges. Random graphs are widely used in complex networks. The main drawback is designing the network based on unit disk graph, random graph and weight Graph is that it emphasizes on existence, probability and weight, but the modern complex networks needs a better tool that has key knowledge on network nodes and links such as capacity, lifetime and properties of nodes. This made V .V.Pavlov introduced a new graph theory for modelling the complex manufacturing system. Poly chromatic sets defines the properties of each elements in the whole set. So, the concept of Poly chromatic set theory [4][5][6] can be used to describe various properties of network nodes and links for designing complex wireless networks. Our proposed method makes use of this poly chromatic set theory to model the wireless network for achieving simplicity and fast convergence, which supports for efficient routing in wireless networks.

II. RELATED WORK

In conventional set theory , a set is represented as a collection of elements [9]such that $S = \{s_1, s_2, s_3, \dots, s_n\}$ where S represents set and $s_1, s_2, s_3, \dots, s_n$ are elements of the set S having similar properties for example if we consider fruits as a set S , then all the different types of fruits comes under the set S . But there is a draw back in representing by conventional graph theory i.e., for example if we consider apple, orange it comes under set S , but the properties of both fruits vary. Apple comes under non-citrus whereas Orange comes under citrus fruit. The difference is notified in the set. So, the conventional set theory doesn't describe the properties of each element in the set. This leads to the introduction of the concept of Poly chromatic sets in modelling wireless networks, where it defines each and every element of the

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set and its properties. Each property is denoted by colour. The elements having different properties are represented in different colours and each set may have any number different colours [7][8].

$$S = \{s_1, s_2, s_3, \dots, s_n\}.$$

By using the concepts of Poly chromatic set theory, we can describe the properties of each and every element in the set. For s_1 , it is denoted as $F(s_1)$ such that

$$F(s_1) = \{ F_1(s_1), F_2(s_1), F_3(s_1), F_m(s_1), \dots, F_n(s_1) \}$$

Let $F(s)$ represents colouring set of entire elements, then

$$F(s) = \sum_{i=1}^n F(s_i) \tag{1}$$

where n represents the total number of properties of elements s_1 in the set S . Likewise, the colouring of the whole set S is represented as

$$F(S) = \{F_1(s_1), F_2(s_2), \dots, F_i(s_3), \dots, F_j(s_n)\} \tag{2}$$

The number of colours (properties) of set S is given by j in the above set. Here, the elements in (1) and (2) represent different colours. In a network we can have the nodes having similar properties so, in Poly chromatic set theory it is represented as

$$S(F_1) = \{ s_{i1}, s_{i2}, s_{i3}, \dots, s_{ip} \}$$

such that there are p elements who share the same color, $p \leq n$. We can represent the elements of S and its colouring of individual element $F(s)$ as a Cartesian product of S and $F(s)$, $P_{(i,j)} = [S \times F(s)]$, where $P_{(i,j)}$ is a binary variable whose value can be defined as

$$P_{(i,j)} = \begin{cases} 1, & \text{if } F_j \in F(s_i) \\ 0, & \text{if } F_j \notin F(s_i) \end{cases}$$

Likewise, we represent the elements of set S and its unitary colouring as follows

$$P_{i(k)} = [S \times F(s)]$$

$$P_{i(l)} = [S \times S(F)].$$

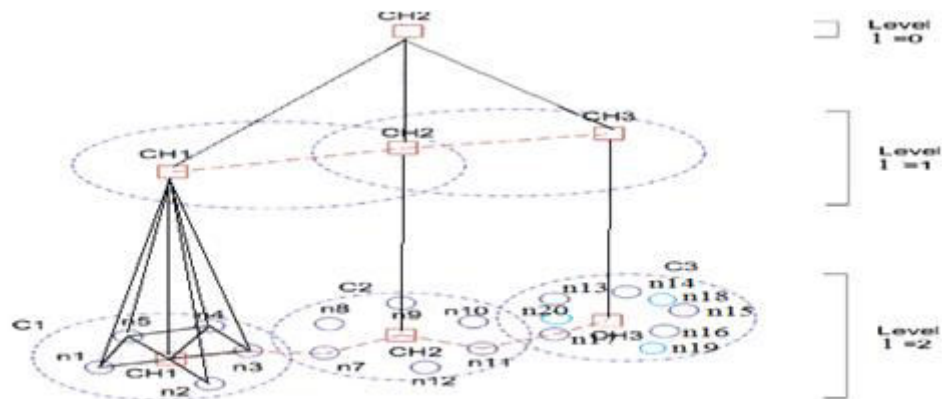
Therefore, we can represent the elements by using Poly chromatic sets based in six components.

$$PCR = \{S, F(s), F(S), [S \times F(s)], [S \times F(S)], [S \times S(F)] \}.$$

But it is not necessary to define all the elements; it depends on our consideration for describing the properties of elements

III. DESIGNING WIRELESS ADHOC NETWORKS

In wireless networks, nodes split into clusters where each cluster has a cluster head which organizes all the nodes in the cluster. Here we will adapt hierarchical model for representing the nodes where the lower layer contains clusters and in the next layer the cluster heads of the lower layers will be there, likewise the process continuous until a single cluster head node exists at particular level.



Fig(1) represents the basic hierarchical modeling through poly chromatic sets.

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By adapting Poly chromatic set theory in designing the wireless networks we define an element in the set S as s_i and its colouring set i.e., set of properties of element s_i is represented as $F(s_i)$. Then the wireless network having m nodes is described as

$$\langle s_i, F(s_i) \rangle, i=1,2,3,\dots,n.$$

Finally, a node is defined as $s(l, i, j_{l-1})$ where l represents the level of the node. i denotes that it is i^{th} node at level l and j_{l-1} denotes the j^{th} node (parent node) at a level $l-1$. and $F(s(l, i, j_{l-1}))$ represents the properties such as index, parent node, child node and so on. Thus the hierarchical model for wireless networks using poly chromatic set theory can be represented as

$$\langle s(0,0,0), F(s(0,0,0)) \rangle = \bigwedge_{i=1}^{n-1} \langle s(1, i, 0), (F(s(1, i, 0))) \rangle$$

Where, $\langle s(0,0,0), F(s(0,0,0)) \rangle$ represents the root node. And for the child nodes we will represent as

$$\langle s(l, i_d, j_{d-1}), F(s(l, i_d, j_{d-1})) \rangle = \bigwedge_{i_{k+1}=m_0}^{mn(l+1)} \langle s(l+1, i_l + 1, i_d), (F(s(l+1, i_d + 1, i_d))) \rangle$$

As we considered the wireless networks, the topology may vary so we can update whenever an addition or deletion of node takes place. So we can make use of above equation. Regarding the colour set we represent as

$$F(S) = \{s, K_i(s), K_p(s), K_c(s), K_{CH}(s)\}$$

where the set $F(s)$ consists of element of set S i.e., s and $K_i(s)$ is the node id and $K_p(s)$ is the prior node of node s and $K_c(s)$ represents the cluster id that is cluster number of the node. $K_{CH}(s)$ denotes the cluster head node [14] in the cluster. Finally,

$$F(S) = \{s, K_i(s), K_p(s), K_c(s), K_{CH}(s)\}.$$

Now, let us come to know in brief about how we adapt the Poly chromatic set theory [8], in wireless networks. In the Fig(1), we have considered 20 nodes and we split the nodes in the network area into 3 clusters. In cluster 1 there are 6 nodes. Based on the relative positions we will represent in Poly chromatic set matrix. In this matrix representation if there is a link we will represent by Boolean value 1. Otherwise, null i.e., 0. We will calculate index and make it as second unified colour of a cluster 1 by means of Adhoc-On-demand Distance Vector routing algorithm [11]. In hierarchical model for representing the nodes where the lower layer contains clusters and in the next layer the cluster heads of the lower layers will be there, likewise the process continues until a single cluster head node exists at particular level, and cluster head will manage the entire nodes within that cluster. By using Poly chromatic set theory we can easily locate the nodes by $s(l, i, j_{l-1})$. for example $s(4, 2, 3)$ represents the node is at level 4 where as its father node is at level 2 and it is at cluster 3. and further routing takes place which is mentioned in section 4. The third unified color S_p defines the prior nodes of a particular node. In this case s_1 is a source node and s_3 is a destination node of a cluster 1, here s_6 acts a prior node to s_1 since the next hop of s_6 is s_3 which is a destination node. Likewise, we will calculate S_c for the child nodes. and the S_{CH} as well, here s_6 would be the cluster head (CH) [14]. We will calculate in the similar way for all other clusters in the network area.

IV. ROUTING SCHEME THROUGH POLY CHROMATIC SET THEORY

Generally, in routing of wireless networks hierarchical routing scheme is mostly preferred since the flat routing scheme [12] has large amount of packet overhead which results in low scalability. So, in hierarchical routing there are two techniques they are dynamic routing technique which has fish-eye state routing and inter-zone routing protocol. The main advantage of implementing on hierarchical routing is less control packet overhead and scalability. We basically prefer hierarchical routing for modelling through poly chromatic sets. In the routing we will perform network partitioning and clustering. Here, the cluster head selection plays a major role. The cluster head is selected based on link quality [13], which is calculated as follows

$$LQ(i, j) = \frac{1}{pf(i, j)pb(i, j)}$$

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The link quality(LQ(i,j)) for node s_i to s_j is calculated by making use of forward delivery ratio(p_f) and backward delivery ratio(p_b) from node s_i to s_j .Based on the resultant value, link quality is assigned as an index.

A. Routing

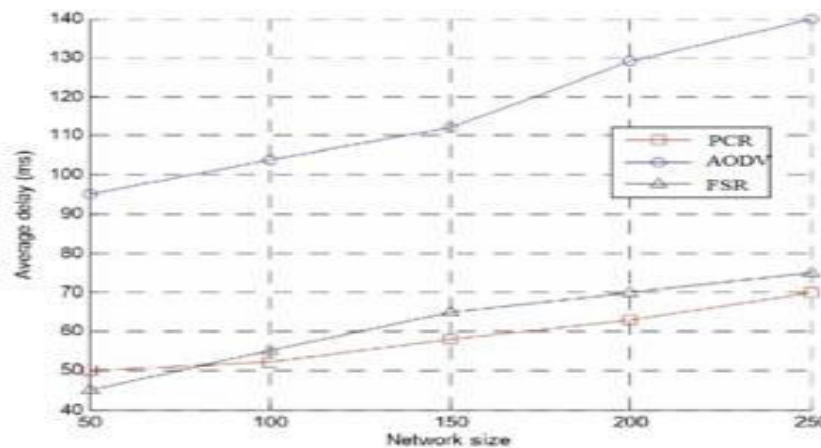
The second most import criteria is routing. In this scheme we prefer AODV[10] approach , in addition to this if we want to provide communication between source node and the destination node .then probably the source node will requests CH to check whether the destination node is within that cluster node or not. If the destination node is within that cluster node then it will transfer the data, if not, then it will check on to the next layer for destination node and process continues until it finds the destination node in any of the clusters .

V. SIMULATION RESULTS

For the performance evaluation of our proposed system we are following the below parameters in the ns2 simulator environment.

TABLE 1
SIMULATION PARAMETERS

Parameters	Range Of Values
Buffer Size	10packets
Carrier Sense Range	500m
Communication Range	100 M
Packet Size	512 Bytes
Data Rate	3mb/S
Simulation Time	300 s
Network Size	250x250m



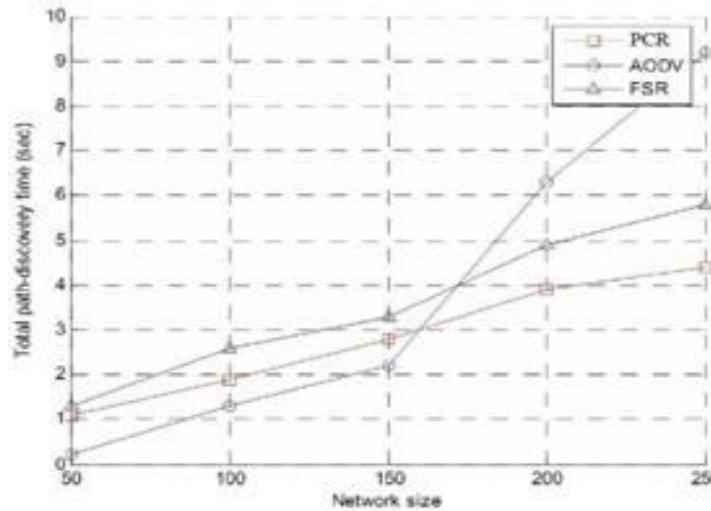
Fig(2)

In fig (2) here, we compare the results for AODV,FSR(fisheye state routing) and our proposed pcr(poly chromatic routing).which is a modified scheme of AODV . The results have shown that the delay remains constant for PCR when compared to the other two routing schemes.

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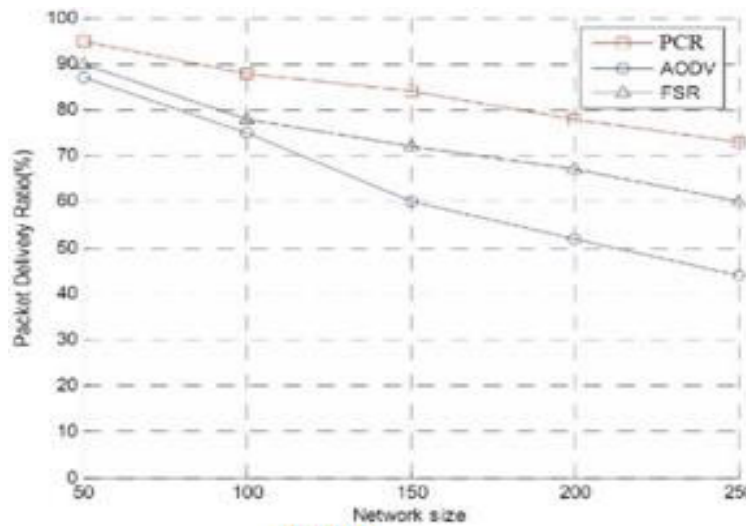
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fig(3)

similarly, in fig(3) we consider the network size as a function of total path discovery, by using our proposed scheme the nodes in the network area can be discovered efficiently in shorter period of time when compared to the other two routing schemes



fig(4)

In Fig(4) we compared network size with respect to the packet delivery ratio .we can observe the drastic change over the other two schemes.

VI. CONCLUSION

In this paper we proposed hierarchical routing scheme based on the Poly chromatic set theory which has become an optimistic tool for efficient routing in wireless networks, since discovering the nodes in wireless sensor networks is an hectic task. Simulation results validated that our proposed scheme outperforms hierarchical routing. In future we are going to implement it for a large complex networks which includes more number of levels.

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