A PATH PLANNING TECHNIQUE UNDER DISASTER MANAGEMENT FOR LOCALIZATION OF MOBILE ANCHOR NODE USING WSN

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Abstract
The main challenge is to design and develop an optimum path planning mechanism to decrease the required time for determining location, increase the accuracy of the estimated position and increase the coverage. The localization of all deployed sensors with high reliability can be achieved using OFDM based CR technique. In recent years, a promising unknown-nodes positioning method has been developed that localizes unknown nodes, employing a GPS-enabled mobile anchor node moving in the network, and broadcasting its location information through wireless sensor network. In contrast to the existing system, the transmissions of data are processed through the available channel and the unknown nodes are identified by using CR network which will lead to increase in accuracy and decrease in delay.

Index terms: Wireless sensor networks, cognitive radio, OFDM, Mobile anchor node.

I. INTRODUCTION

Wireless Sensor Networks (WSNs) are a novel process of embedded integration, wireless communication and micro sensor technology that is currently on the rise[1]. The basic hardware units for building WSNs are low-cost, low-power tiny sensor nodes. As the latest technology of information collecting and processing, WSNs show significant potential for a wide range of applications including environmental monitoring, disaster relief, target tracking and industrial online fault diagnosis. Since sensor nodes are able to work in inhospitable environment, WSNs can be deployed in disaster areas for disaster relief. When disaster strikes, affected area are hostile due to collapsed buildings and damaged roads. People buried in rubble are eager to be discovered through timely search and rescue operations. However, relief efforts would be hampered by blocked roads and washed out bridges, as well as damaged utilities. With the help of WSNs, the efficiency of search and rescue can be greatly raised.

We should note that localization is the precondition of many applications of WSNs, such as forest fire detection, military reconnaissance, disaster relief, and target tracking. For instance, after an earthquake, a large number of people will be trapped under debris. Sensor nodes can detect signs of life and only when location information of these sensor nodes is obtained, can trapped people be discovered and rescued. Thus, in an area of interest, it is significant to obtain the location information of sensor nodes within the margin of error. Recently, numerous localization methods have been proposed for WSNs. These methods can be classified into two generic groups: range-based and range-free. Range-based localization determines the position of unknown nodes using the distance or angle to establish geometric constraint equations. Range-free localization uses the connectivity or pattern matching method to estimate the location of unknown nodes. Both range-based and range-free localization methods require anchor nodes, which are equipped with GPS units to provide reference positions. However, since the cost of an anchor node is hundreds of times that of an ordinary one, it is unrealistic to increase the ratio of anchor nodes, especially for large-scale WSNs and affordable disaster management. Thus, a feasible method is to enable a mobile anchor node to walk along a planned trajectory and timely spreads its location information to locate unknown nodes. Furthermore, different trajectories adopted by the mobile anchor node have different influences on position error. To date, most studies of path planning focus on path length and localization accuracy, while ignoring energy consumption in different motion states. However, in a realistic rescue scenario, a mobile vehicle consumes more energy in the phases of startup and turning than when travelling at constant speed [2122]. Thus, the number of corners needs to be minimized for efficient path planning.

II **RELATED STUDIES:**

For implementing the localization process on the disaster affected areas some of the networking process has been investigated to get the desired results. Here we have considered some of the related works as follows,

A. LMAT algorithm

Finding the optimal trajectory of a mobile anchor node for localization is a challenging problem. Essentially, path planning for localization has two goals:

(1) offering high network coverage and

(2) providing good localization accuracy.

Mobile node coverage has been well studied in WSNs where the goal is to ensure that the mobile anchor node can travel through the entire WSN. In our case, this goal becomes less strict. Instead, we simply need to ensure that all sensor nodes can receive sufficient beacon messages from the mobile anchor node. The second goal of path planning is much more challenging. If the positions of beacon are non collinear, their signal strengths can be accurately mapped to their distances to unknown nodes. However, because the positions of unknown nodes are unknown, it is not possible to determine a trajectory, in advance, that can ensure suitable beacon positions for mobile anchor node. Moreover, the movement of the anchor nodes makes the problem more complicated. Finally, in a realistic environment, multipath fading causes larger random signal variations because of reflections, scatterings, and so on. Hence, the localization accuracy does not only depend on the beacon positions of the mobile anchor node but also on the quality of beacon needed to be considered. In WSNs, the mobile anchor node periodically sends position message packets with itself coordinates, then, the distance between an unknown node and a mobile anchor node can be calculated on the basis of RSSI attenuation. When the unknown node receives three message packets, it can calculate itself coordinates using (fig.2) trilateration method.

However, the coordinates of the unknown node cannot be calculated when three beacon positions of the anchor node are in a straight line with the unknown node. Furthermore, in the process of calculation ,because of the measurement errors, the localization error between real and estimated position is very large. In order to solve these two problems, we use trilateration localization algorithm to calculate the coordinates of an unknown node. Where three received beacon packets form an equilateral triangle.

This method not only solves the collinearity problem (fig.,(2)) but also improves the localization accuracy of unknown nodes with reduced energy consumption and delay. LMAT algorithm optimizes the traveling trajectory of an anchor node by adjusting the communication radius to suit different size of the deployment area in a WSN.

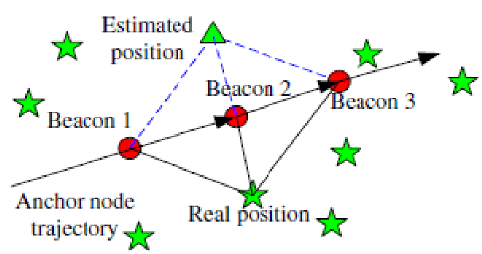

Fig. 1. Collinearity problem of beacon positions

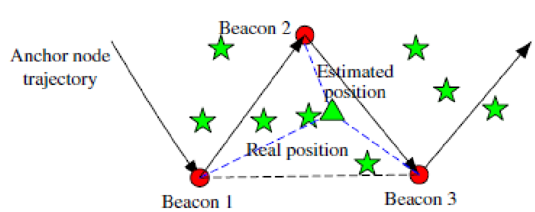

Fig. 2. Trilateration localization algorithm

B. Adopting Cognitive Method in WSN

Recently, cognitive techniques have been used in wireless networks to circumvent the limitations imposed by conventional WSNs.

Cognitive radio (CR)[7] is a candidate for the next generation of wireless communications system. The cognitive technique is the process of knowing through perception, planning, reasoning, acting, and continuously updating and upgrading with a history of learning. If cognitive radio can be integrated with wireless sensors, it can overcome the many challenges in current WSNs. CR has the ability to know the unutilized spectrum in a license and unlicensed spectrum band, and utilize the unused spectrum opportunistically. The incumbents or primary users (PU) have the right to use the spectrum anytime, whereas secondary users (SU) can utilize the spectrum only when the PU is not using it.

C. *Why OFDM is a good fit for CR*?

In the paper [4] they discuss about the OFDM's underlying sensing and spectrum shaping capabilities together with its flexibility and adaptivity make it probably the best transmission technology for CR systems. In the following, we present some of the requirements for CR and explain how OFDM can fulfill these requirements. Practical CR systems can be developed using two approaches: current wireless technologies can evolve to support more cognitive features over time, or new systems that support full cognitive features can be developed. By employing OFDM transmission in CR systems; adaptive, aware and flexible systems that can interoperate with current technologies can be realized.

III. EXISTING SYSTEM

For localizing the nodes in the environment some of the localization and path planning technique has been used which are explained as follows.

The main issue of the localization algorithm is to design the path planning scheme of the mobile anchor node. According to the path planning and relevant localization schemes, the mobile anchor node moves in the network as well as broadcasting location information to localize unknown nodes. The different types of path planning and localization schemes may affect localization results of unknown nodes. Path planning schemes can be divided into two types: static and dynamic. Here, we focus on static path planning of the mobile anchor node. The anchor node consumes different amounts of energy during phases of startup, turning, and uniform motion considering the disasters. SLMAT ensures that each unknown node is covered by a regular triangle formed by beacons. Here it relates to Static path planning technique which analyzes the static mobile anchor node through GPS. These methods can be classified into two generic groups: Range based localization and Range free localization. Range-based localization determines the position of unknown nodes using the distance or angle to establish geometric constraint equations. These trajectories can achieve a good trade-off between accuracy and time required for localization with minimizing futile beacon positions. In the existing the localization can be achieved with the presence of obstacle incorporated using range based technique. These will enables even in the presence of obstacles. SLMAT considers the actual situation after a disaster and reduces the number of corners to conserve energy.

A. *Mobile anchor node-assisted localization*

The mobile anchor node can be fixed by the following process that can be explained as follows,

SLMAT Algorithm

For the analysis of mobile anchor node there are four phases to apply the SLMAT algorithm. Here, one of the phases is discussed as follows:

a) *Deployment of beacon points*

After determination of the communication range r of the mobile anchor node, beacon points need to be deployed. Because the localization error of regular triangle is optimal. Thus, if each unknown node can be covered by a regular triangle, its localization accuracy will be improved. Assuming that the communication range is r, the side length of every regular triangle is d. Here are there situations of the deployment of beacon points.

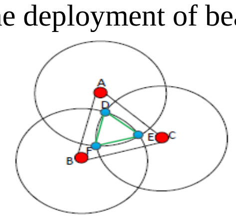

Fig. 3. Deployment of beacon points

b) Energy consumption

The energy of a mobile anchor node is not infinite when it is applied to assist disaster relief; both turning and startup result in substantial energy consumption. Thus, during the period of localization, the cost of mobility is the sum of energy consumed during the phase of startup, turning, and uniform motion. Compared to the cost of mobility, the energy used for information transfer can be ignored. Considering the flexibility of the mobile anchor node, it is suggested that the mobile anchor node can turn off only after stopping at each corner, where n and l denote the number of corners in the path and the path length of the mobile anchor node, respectively:

Etotal= Estartup+n × (Estartup + Eturning) + l × Etraveling

According to [2], Iturning > Istartup > Itraveling when the mobile anchor node travels on concrete pavement. Time consumption during startup, turning, and travel are Tstartup, Tturning and Ttraveling.The total energy consumption of the mobile anchor node is calculated using all the phases such as obstacle free and obstacle presence in the network.

c) Obstacle free path planning

To minimize the number of turns in motion, the mobile anchor node is inclined to move in a straight line. Fig. 4 illustrates the trajectory of SLMAT. Energy consumption of the mobile anchor node based on length L and H .

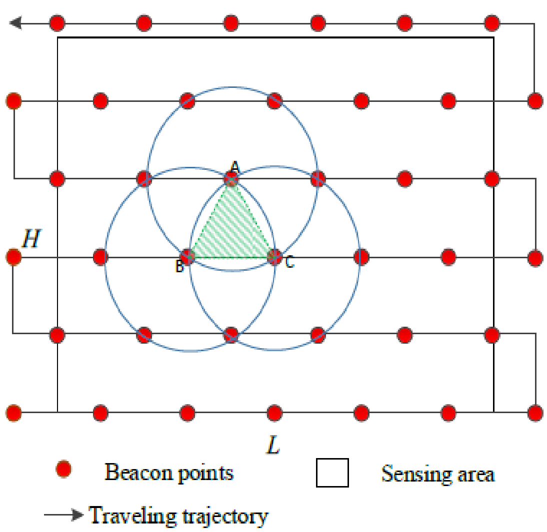

Fig. 4. Obstacle free travelling trajectory

B. Disadvantage of existing system

While using the SLMAT algorithm, the localization of nodes will consumes more energy. Also the available range of spectrum is less leads to data traffic thereby increases the delay. So we cannot get the desired information of nodes which causes the system to be ineffective with high interference during the packet delivery.

IV.PROPOSED SYSTEM

As discussed in the previous section as high energy consumption and delay which is the main problem of using SLMAT algorithm that can be overcome by using CR based OFDM technique as follows,

Here we propose a CR based OFDM technique, where information from disaster areas is obtained without any delay. Also, CR plays a major role in switching the transmission to the available channel of the entire spectrum will reduce the delay and interference. This also leads to more efficiency and high accuracy. Our proposed trajectory can successfully analyze all deployed sensors with high energy efficiency and better spectrum utilization. Here we investigate a reliable and accurate wireless channel model to provide realistic results and evaluate the performance of our proposed path planning mechanism. Moreover, the obstacles are considered in the network field and the Z-curve obstacle handling trajectory is investigated for a real environment. These can provides the high interoperability and can easily adapt to different environmental conditions through the sensor network.

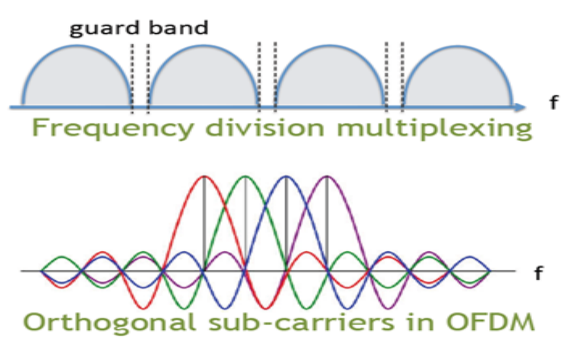

Fig. 5. FDM and OFDM

CR based OFDM also provide high spectral efficiency, robustness against narrow band with easy implementation using FFT for better analysis of the data.

A. CR based OFDM:

OFDM is a multicarrier modulation technique that can overcome many problems that arise with high bit rate communications, the biggest of which is time dispersion [4]. The data bearing symbol stream is split into several lower rate streams and these streams are transmitted on different carriers. Since this splitting increases the symbol duration by the number of orthogonally overlapping carriers (subcarriers), multi path echoes affect only a small portion of the neighboring symbols. Remaining inter-symbol interference (ISI) is removed by extending the OFDM symbol with a cyclic prefix (CP). Using this method, OFDM reduces the dispersion effect of multi path channels encountered with high data rates and reduces the need for complex equalizers. Other advantages of OFDM include high spectral efficiency, robustness against narrowband interference (NBI), scalability, and easy implementation using fast Fourier transform (FFT).

CR's ability to sense and be aware of its operational environment, and dynamically adjust its radio operating parameters accordingly. For CR to achieve this objective, the physical layer (PHY) needs to be highly flexible and adaptable. A special case of multicarrier transmission known as orthogonal frequency division multiplexing (OFDM) is one of the most widely used technologies in current wireless communications systems.

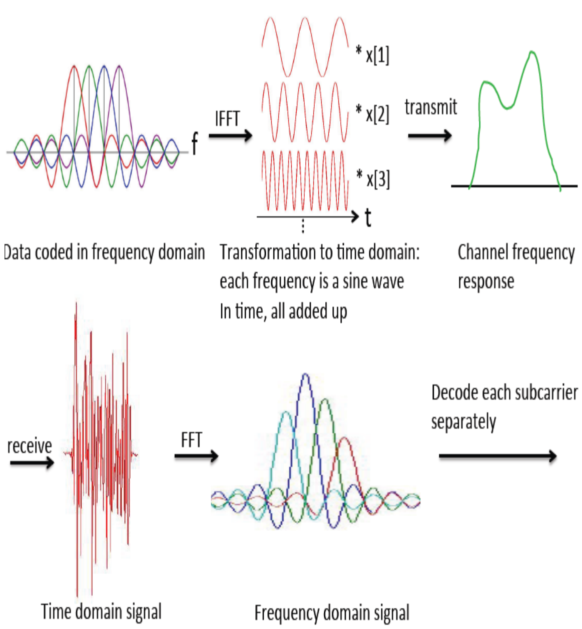

Fig. 6. Orthogonal frequency division multiplexing

OFDM has the potential of fulfilling the aforementioned requirements of CR inherently or with minor modifications. Because of its attractive features, OFDM has been successfully used in numerous wireless standards and technologies. We believe that OFDM will play an important role in realizing CR concept as well by providing a proven, scalable, and adaptive technology for air interface.

B. Cognitive radio wireless sensor networks:

CR-WSNs are basically a set of geographically scattered self aware energy-constrained sensor nodes each of which has cognitive capabilities such as spectrum sharing, self healing, spectrum heterogeneity and spectrum handoff in the network. The CR network architecture is presented briefly in this section.

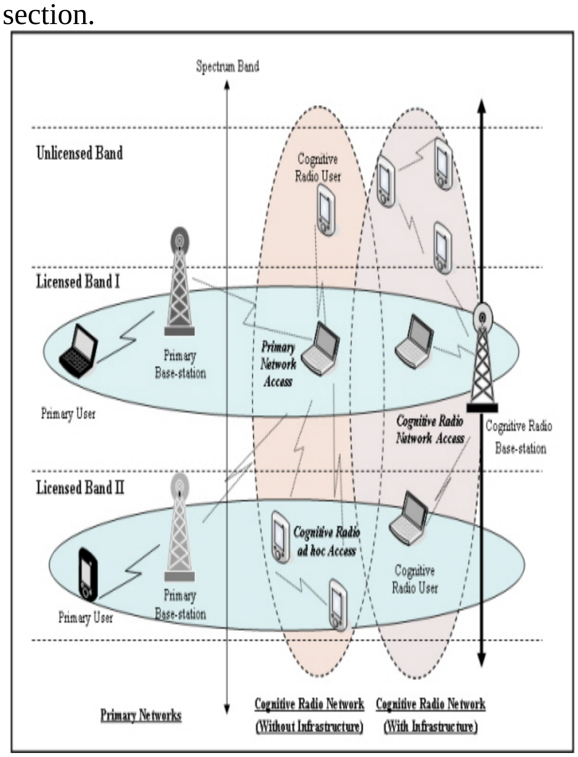

Fig. 7. Architecture of CR network

The components of the CR network architecture, as shown in Fig. 7, can be classified as two groups: the primary network and the CR network.

Primary Network: (or licensed network) is referred to as an existing network, where the primary users have a license to operate in a certain spectrum band. If primary networks have an infrastructure, primary user activities are controlled through primary base stations. Due to their priority in spectrum access, the operations of primary users should not be affected by unlicensed users.

CR Network: It is also called the dynamic spectrum access network, secondary network, or unlicensed network does not have a license to operate in a desired band. Hence, additional functionality is required for CR users to share the licensed spectrum band.

CR networks also can be equipped with CR base stations that provide single-hop connection to CR users. Finally, CR networks may include spectrum brokers that play a role in distributing the spectrum resources among different CR networks.

Spectrum Heterogeneity CR users: They are capable of accessing both the licensed portions of the spectrum used by primary users and the unlicensed portions of the spectrum through wideband access technology. Consequently, the operation types for CR networks can be classified as licensed band operation and unlicensed band operation.

Licensed band operation: The licensed band is primarily used by the primary network. Hence, CR networks are focused mainly on the detection of primary users in this case. The channel capacity depends on the interference at nearby primary users. Furthermore, if primary users appear in the spectrum band occupied by CR users, CR users should vacate that spectrum band and move to available spectrum immediately.

Unlicensed band operation: In the absence of primary users, CR users have the same right to access the spectrum. Hence, sophisticated spectrum sharing methods are required for CR users to compete for the unlicensed band.

Network Heterogeneity: As shown in Fig. 6, the CR users have the opportunity to perform three different access types *CR network access:* CR users can access their own CR base station, on both licensed and unlicensed spectrum bands. Because all interactions occur inside the CR network, their spectrum sharing policy can be independent of that of the primary network.

CR ad hoc access: CR users can communicate with other CR users through an ad hoc connection on both licensed and unlicensed spectrum bands.

Primary network access: CR users can also access the primary base station through the licensed band. Unlike for other access types, CR users require an adaptive medium access control (MAC) protocol, which enables roaming over multiple primary networks with different access technologies.

According to studies, wireless sensor networks benefit from several potentials and characteristics of the cognitive radio networks. CR networks are being developed to solve current wireless network problems resulting from the limited available spectrum and the inefficiency in spectrum usage. A main aspect of CR is to autonomously exploit locally unused spectrum to improve spectrum utilization. They mentioned 5 of the most important ones of these so-called potential as follows:

- As opposed to the conventional WSNs, CR-WSNs benefit from dynamic spectrum access. This ability of CR enables WSNs to use a wider range of licensed as well as unlicensed bands without adding any extra costs.
- When an event happens, it creates burst traffic on the wireless sensor network, but using CR enables WSNs to make a good use of the wasted white spaces in other spectrums to its own benefit in order to handle this traffic.
- One of the most important issues in sensor networks is reducing their power consumption. Power consumption increases when nodes have to retransmit the packets due to network congestion and the packet loss caused by that. Implementing CR helps WSNs to handle these congestions; hence it leads to resolving the battery consumption issue.
- Making efficient use of multiple concurrent WSN infrastructure and spectrum is another benefit of this combination. As the authors mention, "Dynamic spectrum management may significantly contribute to the efficient coexistence of spatially overlapping sensor

networks in terms of communication performance and resource utilization."

- Some regulation prohibits networks to use certain bands in certain parts of the world. This problem would not be an issue for WSNs which are using CR.

IV.DATA FLOW ARCHITECTURE

In CR based OFDM the entire bandwidth is divided into various sub-channels which are transmitted parallels to achieve high data rates, and to increase symbol duration and reduce ISI [3].The data flow architecture of OFDM is shown below,

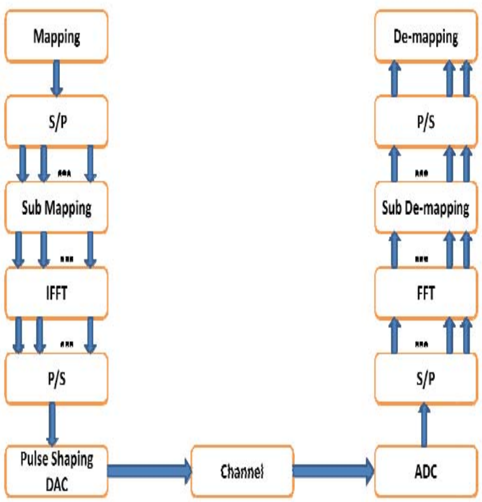

Fig. 8. OFDM Chart

The various blocks of OFDM chart has been explained briefly as follows,

(a)Mapping- This will discovers the devices on the network and their connectivity.

(b)Serial to parallel converter-This will convert the serial format to parallel format.

(c)Sub mapping-This will trace the nodes and mapped again for the better connectivity.

(d)IFFT (Inverse Fast Fourier Transform)-It will converts the signal from its original domain to frequency domain.

(e)Parallel to serial converter- This will convert the parallel format to serial format.

(f)Pulse shaping-It is the process of changing the waveform of transmitted pulse.

(g)Channel-This will allows the shaped pulse through the effective medium.

(h)ADC-This will convert the analog form into digital form.

(i)Fast Fourier Transform(FFT)-This will converts the time domain form into frequency components.

(j)Demapping-This will undergoes the reverse process of mapping.

V.SIMULATION RESULTS

This section represents the simulated result obtained by network simulator which analyse the parameters such as energy consumption, packet delivery, accuracy and delay in the presence of Before Disaster(BD) and After Disaster(AD). The output can be expressed in two ways such as

- NAM (Network Animation)
- Analysis (Trace file and X graph)

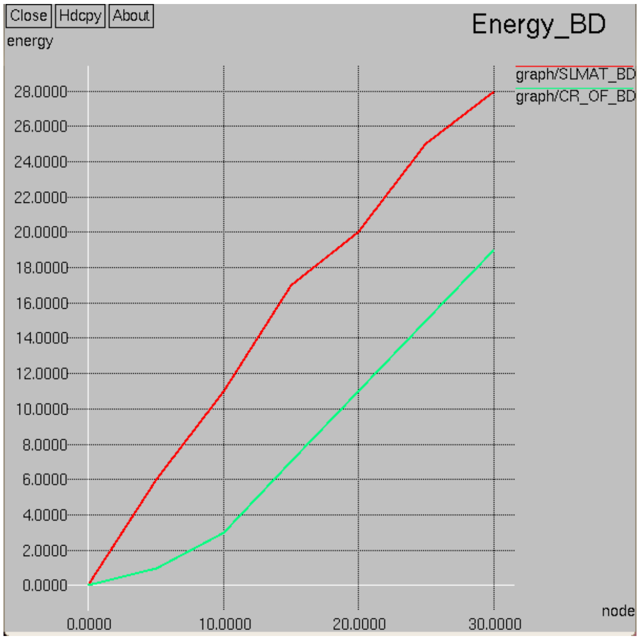

Fig. 9. Energy consumption before disaster

The Fig (9) and (10) plots the energy and number of nodes in comparison with existing and proposed system. The simulation has been performed before and after disaster where it clearly implies that the performance interms of energy consumption is more in existing system and it has been minimized in proposed system.

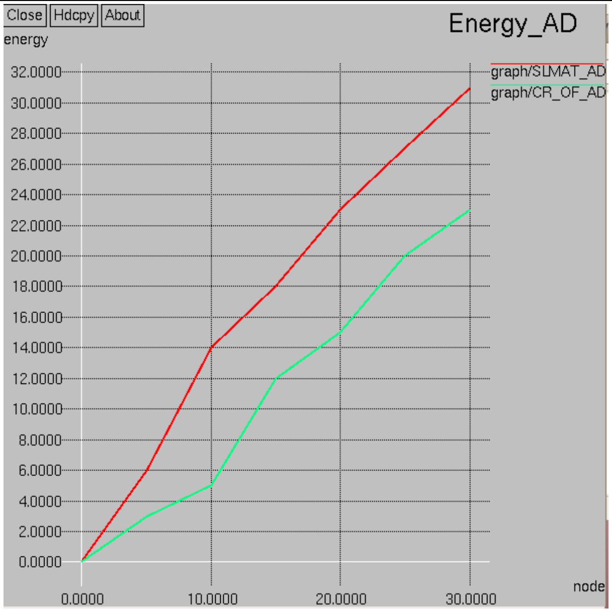

Fig. 10. Energy consumption after disaster

The following graph shows the packet delivery which is calculated with respect to nodes as follows,

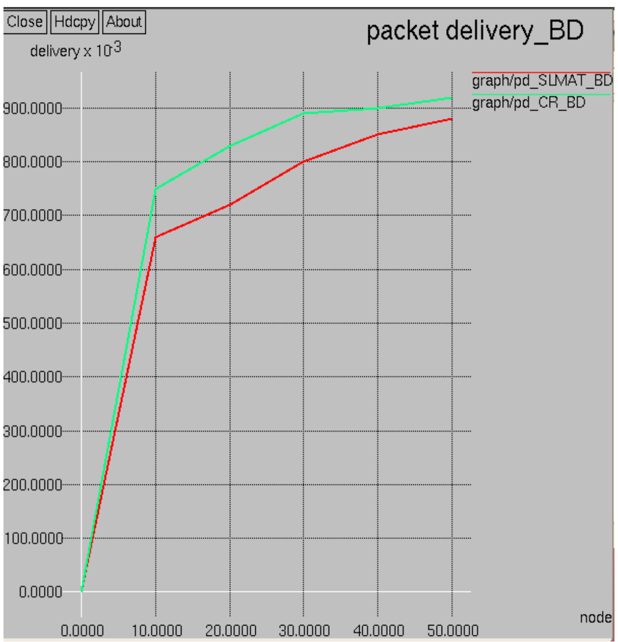

Fig.11. Packet delivery before disaster

In fig(11) the packet delivery factor has been varied with number of nodes in which the CR network delivers more number of data packets when compared to SLMAT.

Fig.12 Packet delivery after disaster

In fig(12) Comparing with SLMAT, the CR network delivers 15% more data as shown above.

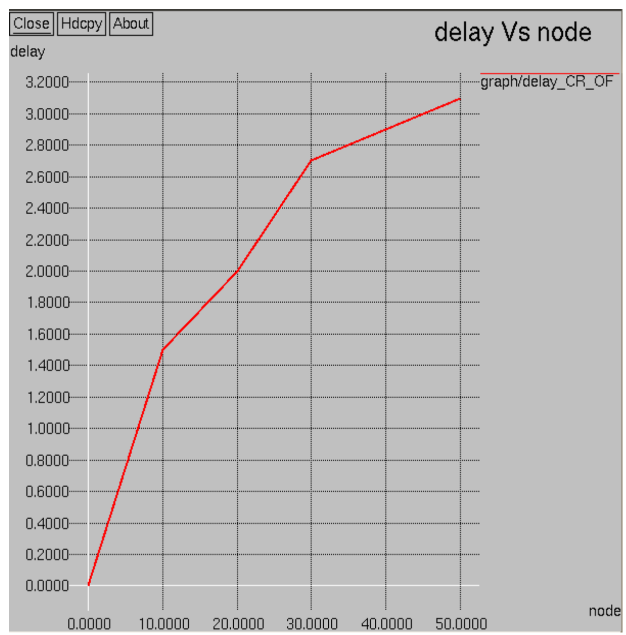

Fig. 13. Delay Vs Node

Here we have analyzed the delay with respect to number of nodes in the CR network which is shown in fig(13).

In Fig (14) the graph shows the accuracy with respect to number of nodes. When comparing with SLMAT, the CR network has reached high accuracy range.

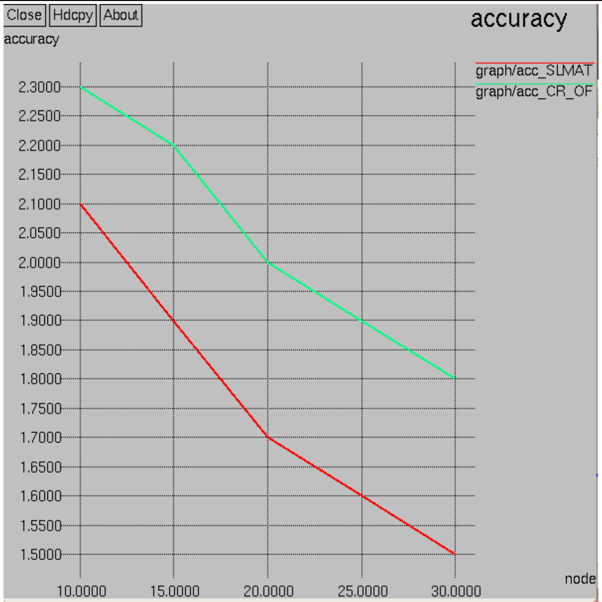

Fig. 14. Accuracy

CONCLUSION

In this paper, we proposed the path planning technique using CR based OFDM technique which provides low energy consumption with reduced delay. Moreover this improves the packet delivery with the usage of effective available spectrum along the CR network. From this the nodes can be easily detected with the high degree of accuracy thereby enhances the rescue during disaster time on the environment. Furthermore, if there exists some packet loss during data traffic it can be recovered through the available network terminal.

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