An Improved Fault tolerant Clustering Mechanism for Multimedia transmission (IFCMM) of WSNs

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Abstract- Multimedia applications have taken an essential role in our daily lives, and their usage is growing day by day. The area of wireless sensor network is not an exception where the multimedia sensors are attracting the attention of the researchers increasingly. The multimedia sensors have the ability to capture video, image, audio, and scalar sensor data and deliver the multimedia content through sensors network. However, due the reason of their location and size of data they transmit for multimedia may cause the system failure in many cases. A WSN that's not ready to take care of such things may suffer a discount in overall lifespan, or lead to hazardous consequences in important application contexts. This paper presents Improved Fault tolerant distributed clustering mechanism which uses a distributed run time recovery of the sensor nodes due to sudden failure of the cluster heads (CH). It takes care of the sensor nodes which have no CH within their communication range. Experimental results show an improvement in the performance of the algorithm with respect to various metrics.

Keywords: **Multimedia sensor networks Multimedia Transmissions, routing, Improved Clustering, Dead cluster head**

I. INTRODUCTION

Wireless sensor networks (WSNs) have gained enormous attention for their wide range of applications such as environmental monitoring, military surveillance, health care, and disaster management [1]. One of the major constraints of WSNs is the limited and generally irreplaceable power sources of the sensor nodes. Indeed, in numerous applications, it is unrealistic to supplant the sensor hubs as they work under cruel condition. Thusly, lessening vitality utilization of the sensor hubs is considered as the most basic test for long run operation of WSNs. Broad examines have been completed in planning vitality sparing conventions which incorporate low-control radio correspondence equipment, vitality mindful MAC conventions, and so forth.

However, energy efficient clustering and routing algorithms [2, 3] are the most two promising areas that have been studied extensively for WSNs. In a cluster based WSN (refer Fig. 1), the sensor nodes are organized into distinct groups, called clusters. Each group has a leader, called cluster head (CH) and each sensor node belongs to one and only one cluster. Clustering WSN has following advantages. (1) It enables data aggregation at cluster head to discard the redundant and uncorrelated data, thereby reducing energy consumption of the sensor nodes. (2) Routing can be more easily managed because only CHs need to maintain the local route setup of other CHs and thus requiring small routing information. This in turn improves the scalability of the network significantly. (3) It also conserves communication bandwidth as the sensor nodes communicate with their CHs only and thus avoid the exchange of redundant messages among themselves. However, in clustering approach, a CH bears some extra work load, i.e., receiving sensed data sent by member sensor nodes, data aggregation and data dissemination to the BS.

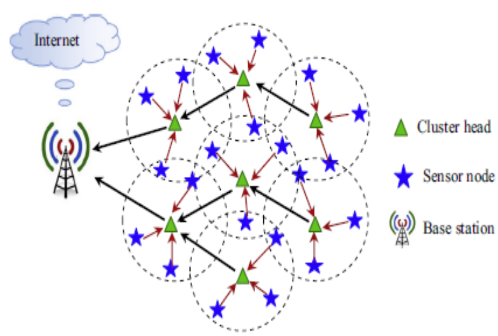

Fig. 1 Model of wireless sensor network

Moreover, in many WSNs, the CHs are usually selected amongst the normal sensor nodes, which can die quickly as they consume more energy due to such extra work load. In this context, many researchers [4–10] have proposed the use of some special node called gateways or relay nodes that are provisioned with extra energy. These gateways are treated as the cluster heads (CHs) which are responsible for the same functionality of the CHs. Unfortunately the gateways are also battery operated and hence power constrained.

In other clustering algorithms, the clustering is formed by choosing selected number of cluster heads and changing the CHs on every iteration. But, the algorithm does not consider if the selected CH fails during its iteration. This may lead to failure of packets due to network break in the system. Hence, the proposed system takes failure case into consideration.

Cognitive Radio is a promising communication technology for Wireless Sensor Networks (WSNs) [1]. Its opportunistic communication paradigm suits wireless sensor networks that carry busty traffic due to their event driven nature. Cognitive Radio can help overcome the problems of collision and excessive contention in WSNs that arise due to the deployment of several sensors connected through radio links. In comparison, conventional WSNs use fixed spectrum allocation policy and their performance is limited due to low processing and communication power of sensor nodes which are typically resource-constrained. However, WSNs operate over unlicensed bands which are becoming saturated due to a significant growth in the number of wireless applications using the same bands. Thus, the challenge is to efficiently utilize the spectrum and this challenge can be addressed by using cognitive radio technology for WSNs.

Utilizing CR innovation for WSNs prompts another worldview called intellectual radio sensor systems (CRSN). A CRSN comprises of remote psychological radio sensor hubs, which sense an occasion and cooperatively convey the data utilizing radio range in a crafty way. Utilizing CR innovation in asset compelled WSNs enhances the range usage, empowers multi-channel ability and conquers the issues identified with thick organization of WSNs or higher correspondence execution required in some WSN applications. One potential utilization of CRSN is Multimedia Wireless Sensor Networks (MWSN). MWSN comprises of sensor hubs having ease cameras and receivers. Mixed media sensor hubs are utilized to store, handle and transmit video, sound and picture information for the applications, for example, following and observing.

We consider video observation in urban condition as the applicant situation for mixed media spilling with intellectual radio sensor systems. In this situation, interactive media sensor hubs furnished with cameras is associated with remote connections in specially appointed way. At least one of these hubs is dynamic in the meantime. They ceaselessly screen the earth and transmit the caught recordings to the sink hub. These hubs work on batteries and thus vitality proficiency is an essential issue for this framework. Also, for remote transmission of video the range ought to be used effectively as these days range in urban areas is a rare asset. The authorized range groups (3G, 4G, and so forth.) are exceedingly used and the unlicensed range groups, for example, ISM groups are ending up noticeably very immersed. That is the reason we propose a vitality productive approach in light of subjective radio for an effective usage of the range.

The key issues and difficulties of MWSN are high transmission capacity request, high vitality utilization, nature of administration (QoS) provisioning, information handling, and compacting systems, and cross-layer plan:

- MWSN requires high transmission capacity with a specific end goal to convey media substance, for example, a video stream, sound stream or pictures.
- Multimedia transmission requires certain QoS ensures. In any case, QoS provisioning is extremely testing in WSNs as radio connections can have variable limit and deferral.
- Energy proficiency is essential for MWSN as sensor hubs regularly have low vitality assets.

CR technology can answer the above requirements of MWSNs. CR can provide extra bandwidth and improve the quality of service. However, such cognitive radio approaches, specific to MWSNs, need to be designed which focus on energy efficient communication to exploit transmission power and spectrum characteristics vs. performance and reliability trade-off. In addition, low cost algorithms need to be designed for spectrum sensing and dynamic spectrum usage. Most of the works in the literature focusing on CRSNs are related to only spectrum sensing [20]-[22]. A few works focus on multimedia transmission over cognitive radio networks [23]-[26], but they do not consider the WSN environment and the related constraints.

In this paper, we apply CR technology for MWSNs and the key contributions of this paper are:

- New spectrum aware clustering mechanism for CRWSN: The clustering mechanism is spectrum aware and takes into consideration the actual as well as the future expected channel states.
- New energy aware cluster head election mechanism for CRWSN: The proposed mechanism takes into consideration the residual energy of the candidate cluster head as well as the consumed energy of the elected node.
- Routing and channel selection mechanism for efficient multimedia delivery over CRWSN: The proposed routing is a classical approach which uses TDMA based intra cluster communication and CSMA based inter cluster

II. RELATED WORK

Some current works identified with CR [1] [2], concentrate on range detecting, dynamic range get to, MAC conventions [3], steering conventions and QoS [4]. Above is only an inspecting of the writing and numerous different works exists for CR for impromptu systems and cell systems since it is very much concentrated in writing. Be that as it may, the examination on applying CR to WSNs is still in its initial stage. The examination arrangements proposed for universally useful CR systems can't be specifically connected to CRSNs on account of the exceptional elements of WSNs, for example, the restricted assets and vitality limitations. Along these lines, more up to date CR arrangements are required that ought to be modified for WSNs to represent asset and vitality imperatives. In the event that we particularly concentrate on MWSNs at that point there are numerous vitality productive methodologies, as grouped in an overview on MWSN [5] [6], however psychological radio is not considered is those methodologies. Specifically, utilizing CR with MWSN includes an exchange off between range accessibility, QoS, vitality utilization and asset proficiency.

A few works identified with mixed media spilling in CRSNs are depicted in the accompanying content. The accompanying works deliver issues identified with various layers, for example, transport, system, MAC and PHY layers. Bicen et al. [7] talk about the main plan challenges for sight and sound and deferral touchy information transport in CRSN. They investigate distinctive transport layer conventions from the perspective of sight and sound transport in CRSNs. Be that as it may, different issues like bunching and steering are not handled. Keeping in mind the end goal to address the issue of high data transfer capacity requests and QoS necessities, Rehmani et al. [8] proposed channel holding for CRSNs. The thought is to bond the bordering channels when contrasted with channel total which can total non-adjacent channels, yet is more mind boggling for WSNs. They proposed the channel holding thought and called attention to many issues and difficulties. Be that as it may, the calculations and conventions to perform ideal channel holding were not considered and were left for future work.

Liang et al. [9] contemplated the QoS execution in CRSNs. They propose a need based system in MAC layer. The constant movement is planned in ensured schedule openings and the best exertion activity is served in conflict get to period. They contemplate the execution utilizing investigative models and demonstrate that attractive execution can be accomplished for constant movement. An augmentation of this investigation is introduced in [10]. Be that as it may, they don't consider the vitality utilization and just the case identified with one group of sensor hubs are examined. Multi-groups, bunching instruments and entomb bunch correspondences are not considered.

Grouping is considered by Fard et al. [11], who propose a QoS MAC convention for remote sight and sound sensor systems utilizing multi-channel approach. The remote movement is ordered into various classes and diverse channels are adaptively appointed to various activity. This approach enhances the throughput and postpones 4 exhibitions while being vitality proficient. In any case, PU movement is not thought about and each bunch head is accepted to have numerous radio interfaces, which is not practical. Wen et al. [12] propose a QoS directing convention for specially appointed CRNs by considering parameters, for example, accessible time, recurrence groups, transmission run, mistake rate, essential client (PU) interference rate and transmission run. Be that as it may, they just concentrate on end-to-end delay.

Zhou et al. [13] propose a dispersed booking calculation for video gushing over multi-channel multi-radio and multi-jump remote systems. This approach creates appropriated booking plans with the target of limiting the video mutilation, considering decency. The booking is defined as a curved improvement issue, and an answer is proposed by together considering channel task, rate distribution, and steering. The work considers the exchange off between limiting video bending of each stream versus enhancing worldwide execution by limiting system blockage. Be that as it may, they don't think about subjective radio. They accept all channels are accessible and dynamic range get to considering PU movement is not considered. In addition, take note of that vitality administration is not considered in the above works.

Low et al. [24] have proposed a calculation which utilizes a bipartite diagram of the sensor hubs and the doors for finding a most extreme coordinating of appointing a sensor hub to a CH. The calculation has room schedule-wise multifaceted nature of O (mn2) for n sensor hubs and m CHs. This is high for a vast scale WSN. It likewise requires building a BFS tree for an individual sensor hub which takes a generous measure of memory space. In [26], we have proposed a calculation with O (nlogn) time, which is a change over [6]. In any case, both the calculations have not considered the vitality utilization issue. In [10], an Energy Efficient Load-Balanced Clustering Algorithm (EELBCA) has been proposed with O (nlogn) time. EELBCA tends to vitality effectiveness and in addition stack adjusting.

Low-vitality versatile bunching chain of importance (LEACH) [29] is a well known procedure that structures groups by utilizing a conveyed calculation. It progressively pivots the work heap of the CH among the sensor hubs, which is valuable for stack adjusting. Be that as it may, the primary burden of this approach is that a hub with low vitality might be chosen as a CH which may pass on rapidly.

In MHRM (least bounce directing model) [30], each hand-off hub finds a way to the BS such that the jump check is limited. Hence, much measure of vitality is spent to transmit information as it chooses farthest transfer hub in its correspondence go. In [26], creators have built up a disseminated blame tolerant system called CMATO (Cluster-Member-based blame Tolerant component) for WSNs. The creators use the catching methods to recognize the blame. At whatever point a CH falls flat, group individuals identify it and re-select another CH to shape another bunch.

III. PROPOSED SYSTEM

This paper presents an **I**mproved **F**ault **T**olerant **C**lustering **M**echanism for **M**ultimedia **T**ransmission of Wireless Sensor Networks **(IFCMM** WSNs).

This mechanism described in two different ways:

3.1 Clustering system

- Network is divided into three types of nodes: CH, non-CH and gateways
- Gateways are selectively chosen based on their location
- Gateways play major role while transmitting packets
- In case of CH failover, the nearby gateway will be selected as CH for that iteration
- Gateways broadcasts its change of role to all nearby nodes and nodes will update in their memory

3.2 Multimedia

- All nodes are operated in multi channels. And nodes are divided into Primary User (PU) and Secondary User(SU)
- PUs will start their transmission by default
- SUs will look for channel availability by sensing the channel
- Intra-cluster communication will be achieved by TDMA algorithm
- Inter-cluster communication will be achieved by CDMA algorithm by SUs

3.3 Distributed clustering algorithm

We now present the proposed routing algorithm. Here, gateways select the next-hop relay nodes in such a way that it requires less energy and also takes care balancing of energy consumption of the gateways (CHs). This is implemented as follows.

The gateways are know about their separation from the BS and furthermore the jump include as examined bootstrapping As the correspondence is through a remote connection, entryways are additionally mindful of some data about their neighbor portals, for example, the separation from their neighbors, neighbor remove from the BS, neighbor remaining vitality and bounce include as [12,22]. By and large an entryway may have numerous conceivable next-jump transfer hubs inside its correspondence run.

However, in our approach only those neighbor gateways are eligible to serve as a relay node which has lesser hop count. Now, a gateway gj chooses the next hop relay node gr from the eligible nodes such that HCount(gi) > HCount(gr)) based on the cost function. We denote the cost function as Cost(gj, gr) which indicates the cost of selecting the gateway gr as next hop relay node by the gateway gj. For energy balancing of the gateways during data routing, our method bases on the number of those CHs which can select a particular CH (say gr) as a next hop relay node

Algorithm: Clustering-Fault-Tolerance

Step 1: S_i broadcast a HELP message within its communication range.
1.1: $ComCH(s_i) = \{\};$
1.2: $BackupSet\ (s_i) = \{\};$
Step 2: ***while*** (s_i receiving reply)
if(reply is from gateway g_k)
2.1: s_i becomes the elements of CO_{set}
2.2 : $ComCH\ (s_i) = ComCH\ (s_i) \cup g_k$
else if (reply is from sensor node s_j)
$BackupSet\ (s_i) = BackupSet\ (s_i) \cup s_j$
endif
endif
endwhile
Step 3: ***if*** $(s_i \in UnCO_{set}\ \&\&|\ BackupSet\ (s_i)| \neq 0)$ ***then***
s_i uses s_j from $BackupSet\ (s_i)$ as a *relay* with highest residual energy to send the data to the CH.
else
s_i calculates cost of all CHs from $ComCH(s_i)$ according to equation 4.13 and joins the CH with the highest cost value.
endif
Step 4: ***Stop.***

Fig 2: Distributed Fault Tolerant Clustering Algorithm

IV. SYSTEM MODELS

4.1 Network Model

We assume a WSN model where all the sensor nodes are deployed randomly along with a few gateways and once they are deployed, they become stationary. As a wireless network, the nodes do not have the global information about the network.

However, we consider that the nodes have the local information, i.e., residual energy level and the distance of its neighbors [12, 21]. Similar to LEACH [13], the data gathering operation is divided into rounds. In each round, all sensor nodes collect the local data and send it to their corresponding CH (i.e., gateway). On receiving the data, the gateways aggregate them to discard the redundant and

uncorrelated data and send the aggregated data to the base station via other CH as a next hop relay node. Between two adjacent rounds, all nodes turn off their radios to save energy. All communication is over wireless links. A wireless link is established between two nodes only if they are within the communication range of each other.
Given the transmitting power, a node can compute the distance to another node based on the received signal strength. The same strategy has been adapted in the literature [12, 21]. Therefore, it does not require any location finding system such as GPS. The current implementation supports state-of-art MAC protocols [22] to provide MAC layer communication. Gateways use CSMA/CA MAC protocol to communicate with base station [22].

4.2 Fault model

There are different purposes behind the disappointment of WSNs. Right off the bat, sensor hubs may flop because of the exhaustion of their battery control, breaking down of equipment parts, (for example, a preparing unit and handset) or harm by an outside occasion. Also, the remote connections of the WSNs may flop because of perpetual or brief hindered by a deterrent or natural condition. The connection disappointment causes the system parcels and dynamic changes in arrange topology.
In this paper, we consider only permanent failure of the CHs and do not consider the transient and Byzantine failure of the WSNs. We assume the permanent failure of the CHs due to failure of the hardware components or complete energy depletion or permanent link failure. In this paper, we consider the reliability of the CHs following the Weibull distribution [23] which is extensively used for fault model as it can provide diverse failure patterns over time with its parameters.
The probability density function of the Weibull distribution has the following form:

$$f(t) = \frac{\beta}{\eta}\left(\frac{t}{\eta}\right)^{\beta-1} e^{-\left(\frac{t}{\eta}\right)^{\beta}}$$

Where b and g are the shape and the scale parameters respectively. This function indicates the likelihood of failure at time t.

V. PERFORMANCE ANALYSIS

In all the experiments, we randomly deploy PUs and SUs nodes in a 500m * 500m area. The sink is chosen randomly for each simulation run. The PU occupies the channel randomly, and the SU can access the channel if no PU is active on this channel. The protection range for PU is 20 m, which mean the PU's neighbors within this range cannot access this channel. The radio propagation model adopted in our simulation is two-ray ground model implemented in NS2. Regarding the transmitted video, we adopt the widely used video, composed of 300 frames at a resolution of 360 x 486. The frames are packed up in 560 packets of 1024 bytes each. In order to evaluate the PSNR metric of the received video, we use the video quality evaluation tool-set Evolved [33] on the reconstructed raw videos. We note that the obtained results are the mean of 30 independent simulation runs for each scenario, represented at a confidence interval of 95%. In Table 4, we summarize the simulation parameters.

Parameter Value:

Table 1: simulation parameters Proposed algorithm is evaluated by considering the below parameters:

Area	500m * 500m
Number of PU	2, 20]
Number of SU	150
Number of channels	[2, 18]
Sensing time per channel	5ms
Channel switching time	80 μ s

5.1 Packet Delivery Ratio

In this section, we evaluate the performance of our proposed mechanism IFCMM, using the network simulator NS-2. The graph is plotted for Packet delivery ratio: SCEEM [18] vs. number of nodes and compared with existing SCEEM mechanism.

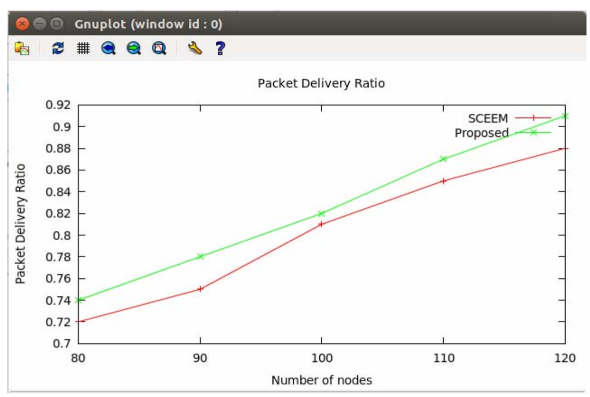

Fig 5.1: Packet Delivery Ratio vs. Number of nodes

5.2 Dead CH

The results showed in below graphs shows the comparison of dead CHs round by round. Dead CH refers to the nodes which are dead due to complete energy depletion or device failure. The results are compared with DEBR [12].

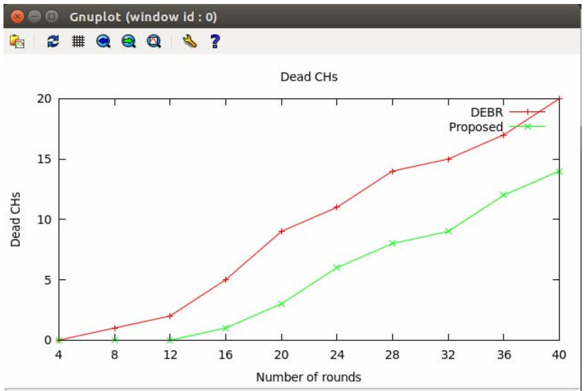

Fig 5.1: Dead Cluster Head vs. Number of nodes compared proposed with DEBR

VI. CONCLUSION

This paper presents fault tolerant mechanism for multimedia. It considers the partition of the network into clusters. Energy conservation of the cluster head node is the main aim of this design. Cluster formation is based on residual energy of the CH. Proper selection of gateway nodes which act as replacement of CH node in case of failure will help in retaining the continuity of the network. Also, video streaming technique which operates in various spectrum condition is proposed, which takes higher bandwidth and low delay. The simulation result shows that the performance of the developed scheme is better than the earlier work.

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