COOPERATIVE MIMO MAC USING TYPE2 FUZZY LOGIC FOR WIRELESS SENSOR NETWORK

[1]B. Prabha and [2]M.Saravanan
[1]PG Scholar, Applied Electronics
[2]Associate Professor, Department of Electronics and Communication Engineering
IFET College of Engineering, Villupuram, Tamilnadu, India
[1]prabhaifetece@gmail.com,[2]saravana_vkms@yahoo.com

ABSTRACT

Energy efficiency and enhancing the lifetime is very important design requirements in Wireless Sensor Network (WSNs).To improve the network lifetime and to reduce the energy consumption using clustering scheme.Cooperative multiple input and Multiple Output can be applied and to hence significantly improve the communication performance.An inefficient Medium Access Control protocolis incorporated to diminish the performance gain of MIMO.Hence this paper proposes Space Time Block Codes using Cooperative MIMO MAC transmission. An idea of Type2 fuzzy logic is used for cluster head(CH) and Cooperative node Selection.Cluster Head is selected based on remaining power,distance to base station and concentration

KEYWORDS

Cooperative mimo,energy efficiency,MAC protocol,STBC,wireless sensor network(WSN),T2FL

1. INTRODUCTION

Wireless sensor network consist of hundreds to thousands nodes randomly in the hazardous environment for gathering a wide range of data application such as military, to measure vibration of bridges a large and other field.[1].Due to high energy efficiency and availability of limited energyit is difficulty in recharging a large number of sensor nodes and enhancing the network lifetime are the most important design goals.To design energy efficient radio channel protocol for reducing a interference and a channel fading using MIMO.

To increase the channel strength in wireless sensor network, Multi Input Multi Output (MIMO) scheme is used for wireless channel [2, 3].MIMO scheme avoid fading and reduce the energy consumption for transmitting a data, which also enhances a capacity of a channel.To achieve some bit error rate for multi hop communication it requires a lower power transmission.[4].It is unable to fix MIMO antenna directly because the size of the sensor node is small and also supports a single antenna.

In a network cooperative MIMO transmission and reception from a multiple nodes in a sensor to construct a energy efficient network for wireless sensor network [5].To estimate all channels between source and destination cooperative MIMO scheme is required.Sensor node are utilized to calculate the channel estimation for remaining transmission[4,5].To diminish the performance gain MAC protocol is used .Inefficiently designed MAC protocol which increase the cooperative control messages .

The main task of MAC protocol [6] is to scheduling the data transmission which exchange a data in same channel and also avoid collisions. Due to high energy consumption in WSNs,protocol for WSNs, need a efficient energy protocol.Mostly MAC protocol which is used for sleep –wake cycle for reducing a energy wastage for idle listening. However MAC protocol may be incorporated for application because of long packet.

The most important contention based protocol is SMAC protocol[6].To reduce a energy consumption using sleep wake cycles each node follows SMAC protocol.MAC protocol is based on Centralized architecture which is used to improve a network lifetime.[7]. Using Centralized architecture [7-11] for cooperative MIMO MAC transmission high energy consumption for cluster maintenance.

For distributed system architecture [12-13] it uses cooperative MIMO MAC transmission .Transmitting and receiving the data is done by recruiting the cooperativeneighborhood node.Multipoint MIMO MAC transmission achieves lesser energy [2].

The rest of the paper is organized as follows .Section 2 presents the proposed cooperative MIMO MAC model.In section 3 to analyze the performance of the proposed protocol.In section 4 simulation results are discussed. Using STBC techniques energy consumption is handled.

2. SYSTEM MODEL

In MIMO MAC transmission systems,transception and reception are achieved by using distributed manner [12-13]. Normally the sender recruits the remaining nodes for cooperative transmission based on high energy while comparing to other nodes based on type2 fuzzy logic for the value of energy analysis.

i)Broadcasting

Transmitting a data through multiple channels using low energy transmission to select the cooperative for sending and receiving the data using space time block code requirement using MIMO MAC protocol.

ii)STBC MIMO transmission

As shown in Fig.1b ,the size of the data bits are assigned using Space Time Block Code .using STBC code the source node will send the data to the destination node to achieve the MIMO diversity gain.

iii) Data Collection and Combining

All the data are collected by the receiving cluster and finally the data which is transmitted to the destination node.

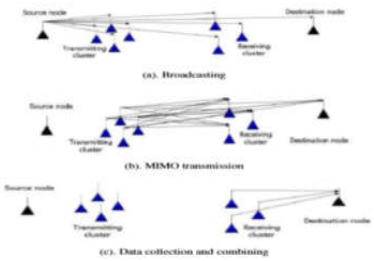

Fig.2 Proposed cooperative scheme

2.1 PROPOSED COOPERATIVE MIMO MAC PROTOCOL USING T2FL

The proposed cooperative MIMO MAC transmission from multiple nodes is discussed below. Consider the function for sender that forward a packets to receiver as shown in Fig.2

When a node has to send a data first it senses the status of the channel,whether it is free or idle.If it is idle it transfers a message with low transmission power .After it recruits the neighbor node for cooperative transmission .If it is ready the source node transmits RTS message to the destination for

reservation .The source node waits for CTS message from the destination node .If CTS will be received MIMO MAC transmission will happens using space Time Block Codes.After acknowledgement is received,it waits to sense a channel status again.

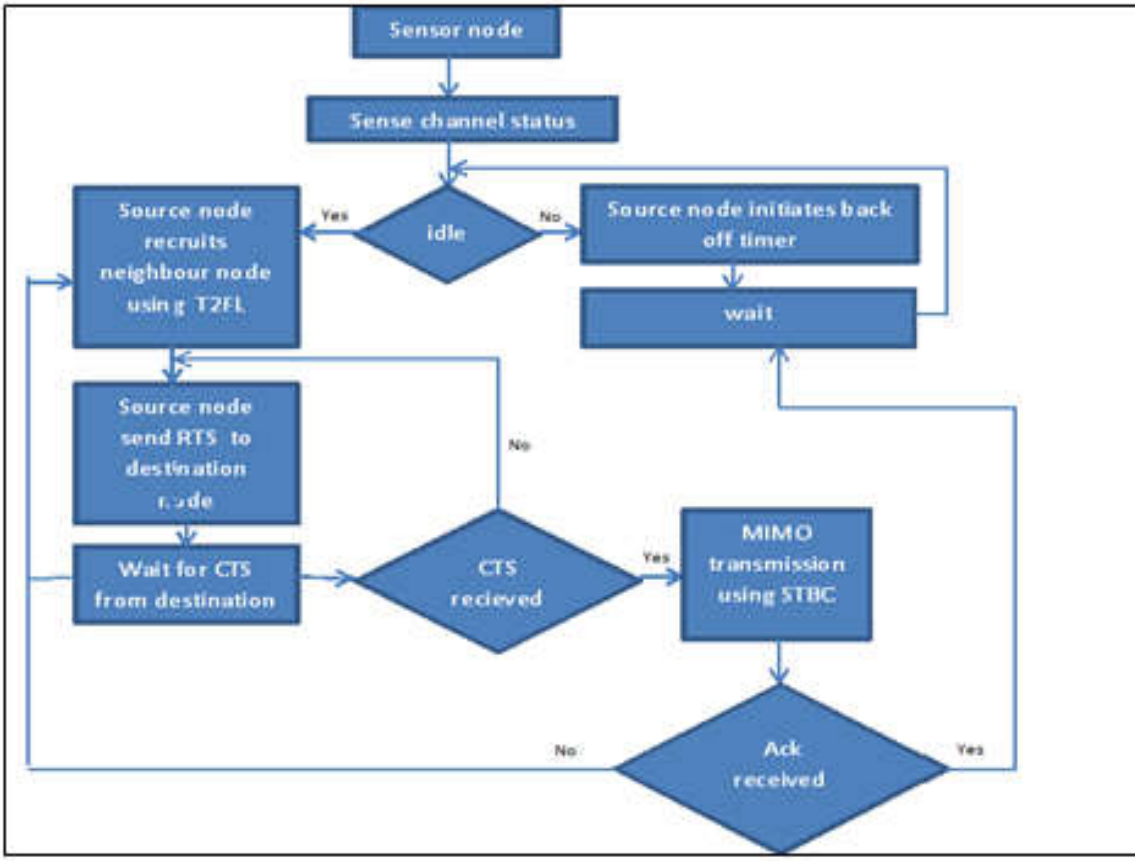

Fig.2.1 Flowchart for cooperative MIMO MAC protocol using T2FL.

If no Acknowledgement will be received again it retransmission process begins from neighbor recruitment. The destination waits for data transmission for source cluster.Next it waits for sequential transmission of data from source to destination.

3. PERFORMANCE ANALYSIS OF PROPOSED COOPERATIVE MIMO MAC MODEL

A mathematical model to evaluate Signal to noise ratio v_s. energy,signal to noise ratio v_s. packet delay,no of packets transmitted v_s. no of rounds,network lifetime v_s. no of rounds.Energy consumption is analyzed using probability of bit error rate.

3.1Bit Error Probability

A network is assumed to transmit a data in the form of bits through radio channel with type 2 fuzzy logic. The relationship between the packet error probability $p_p$is given by

$P_p=1-(1-P_b)^L$

Where

L is the frame length in bits

Packet transmission errors are generated from two factors in cooperative MIMO MAC protocol through which helps to send a data from transmitting group to receiving group .If the data will be corrupted the cooperative sending group will not send a data to the receiving group.

3.2 ENERGY CONSUMPTION ANALYSIS

Consider a scenario with M senders and N receivers in cooperative MIMO MAC transmission attempt for unsuccessful transmission and successful transmission.

The energy consumption for unsuccessful transmission is given by

$$Eu_{coop}=E_{mrts}+E_{mcts}+2E_{rrts}+(M-1)E_{scts}+(N-1)E_{scts}+E_{br}+E_{br}+E_{data}+(N-1)E_{col}$$

And the energy consumption for a successful transmission is given by

$$ES_{coop}=E_{mrts}+E_{mcts}+2E_{rrts}+(M-1)E_{scts}+(N-1)E_{scts}+E_{br}+E_{data}+(N-1)E_{col}+E_{ack}$$

Where
E_{mrts} is the energy consumption for MIMO RTS (MRTS)
E_{mcts} is the energy consumption for MIMO CTS (MCTS)
E_{ack} is the energy consumption for ACK
E_{rrts} is the energy consumed for recruiting RTS(RRTS)
E_{scts} is the energy consumption for sequential (SCTS)
E_{col} is the energy consumption for data collection
E_{br} is the energy consumption for broadcasting
$E_{data}$is the energy consumption for data transmission

Table 1. Membership functions for input variable

Remaining Battery power/ Energy (RBE)	Distance to base station(DBS)	Concentration (C)
Less (0)	Near (0)	Low(0)
Average(1)	Far(1)	Medium(1)
High(2)	Farthest(2)	High(2)

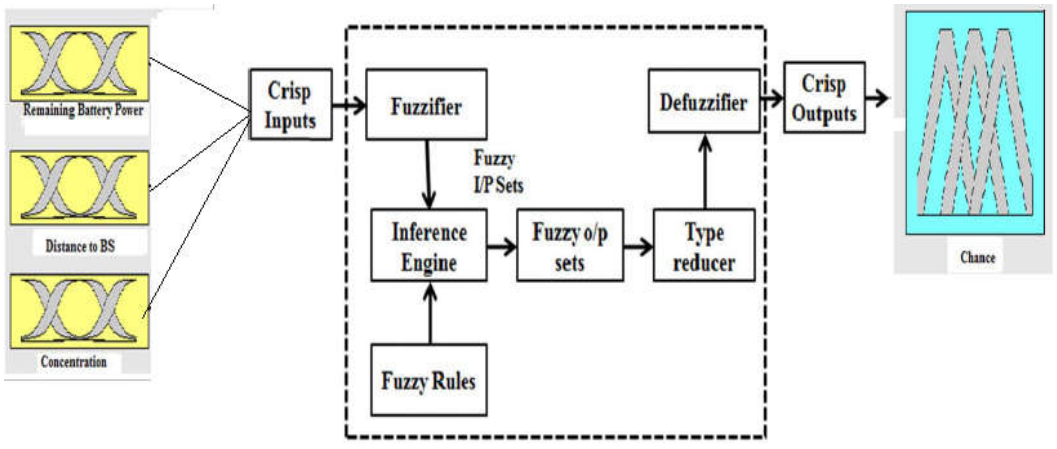

Fig.3.2. Type 2 Fuzzy logic for model for the proposed system

4. SIMULATION RESULTS

The analysis of cooperative MIMO MAC protocol is carried out using MATLAB. The proposed model is simulated for MIMO MAC using STBC techniques for threshold based uncoded schemes are evaluated interms of energy consumption and delay incurred in the transmission of data packets from source node to destination node.

Table 1.Simulation Parameters

PARAMETER	VALUE
Total frames per packet	10 frames
Total bytes per packet	410 bytes
Time for transmitting RTS	35.3 ms
Time for transmitting CTS	30.3
Time for transmitting ACK	32 ms
Time for transmitting data	0.006 s
Energy consumed for transmission of RTS,CTS and ACK	0.027J
Modulation type	QPSK
Channel	Wireless channel

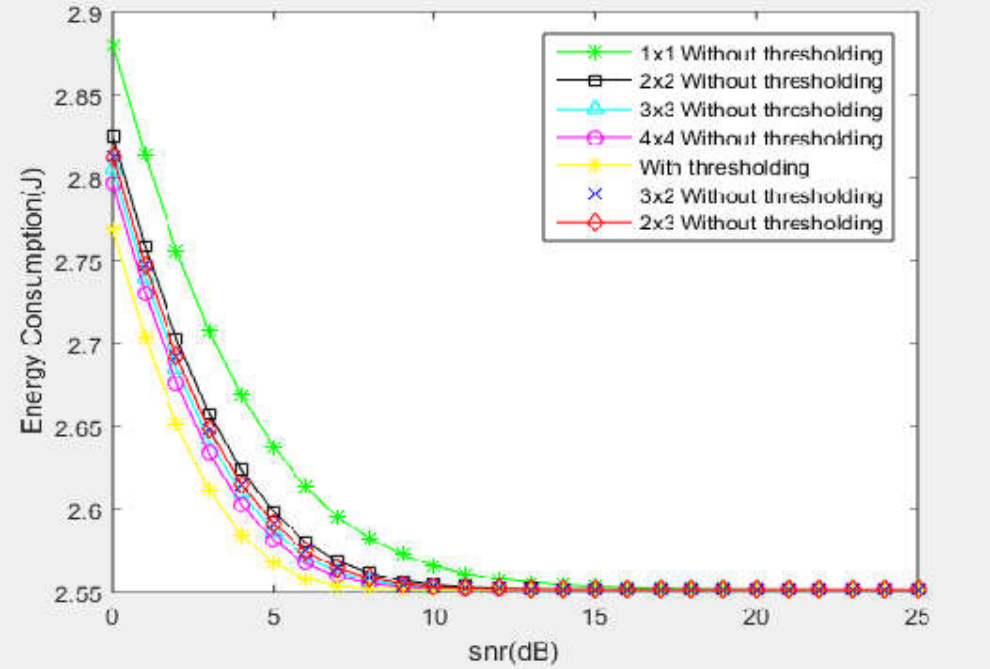

Fig.4.1 SnrVs Energy Consumption.

It is observed from the graph that the proposed scheme outperforms with fixed group size of MIMO MAC scheme by changing the cooperative thresholding scheme based on 4x4 scheme .The delay keeps reducing with respect to SNR.

It is clear that the proposed scheme which reduces the 19% lesser packet latency than without MIMO.

4.1 PERFORMANCE ANALYSIS OF STBC MIMO SCHEME

Similar graph as that of uncoded scheme are obtained shown in Fig.7 and Fig.8 for energy consumption and transmission delay.For STBC coding 4x4 group size of MIMO MAC configuration are 20% and 50% respectively.

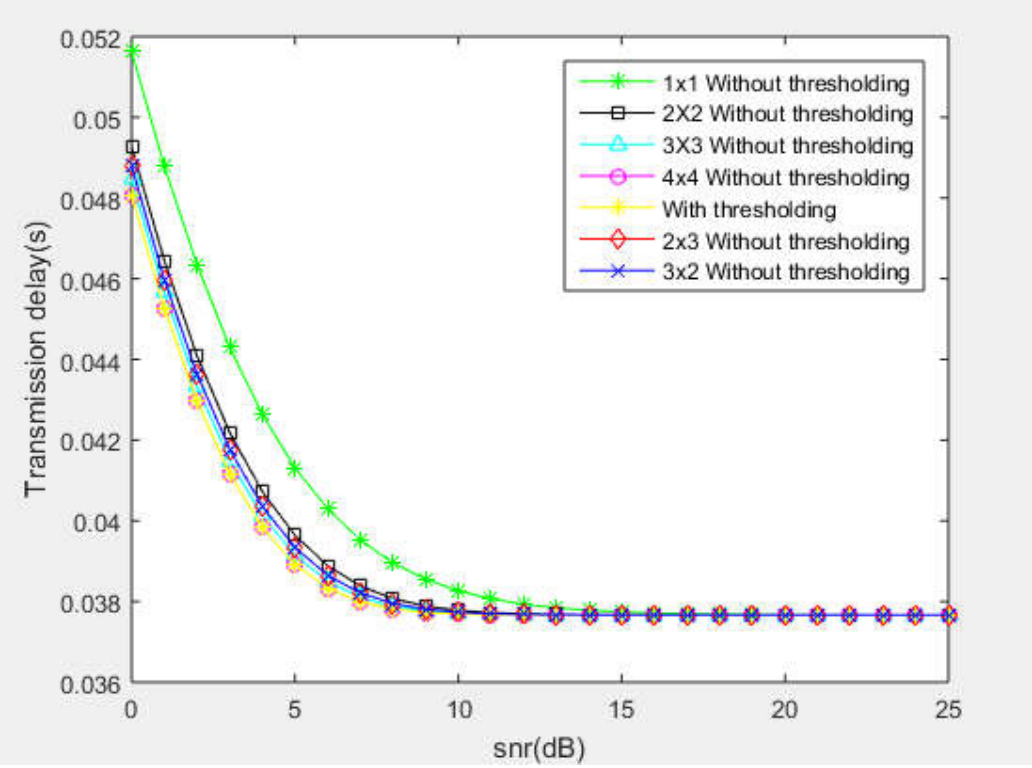

Fig.4.2 SNR vs Transmission delay

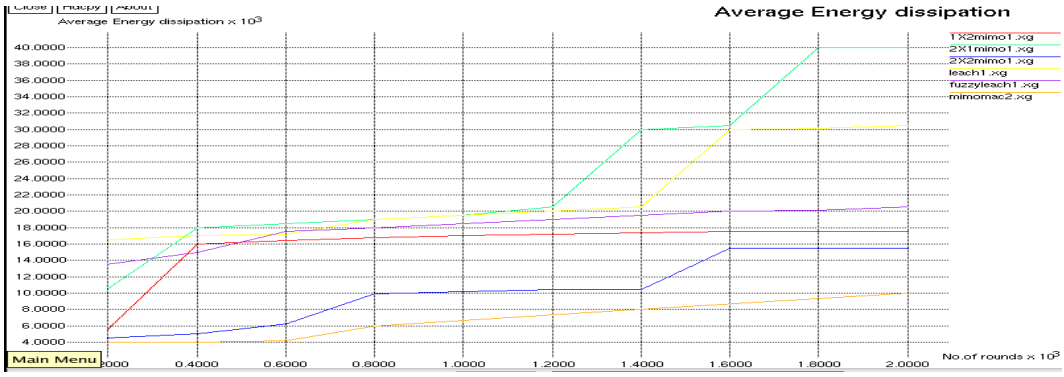

Fig. 4.3Average Energy Dissipation.

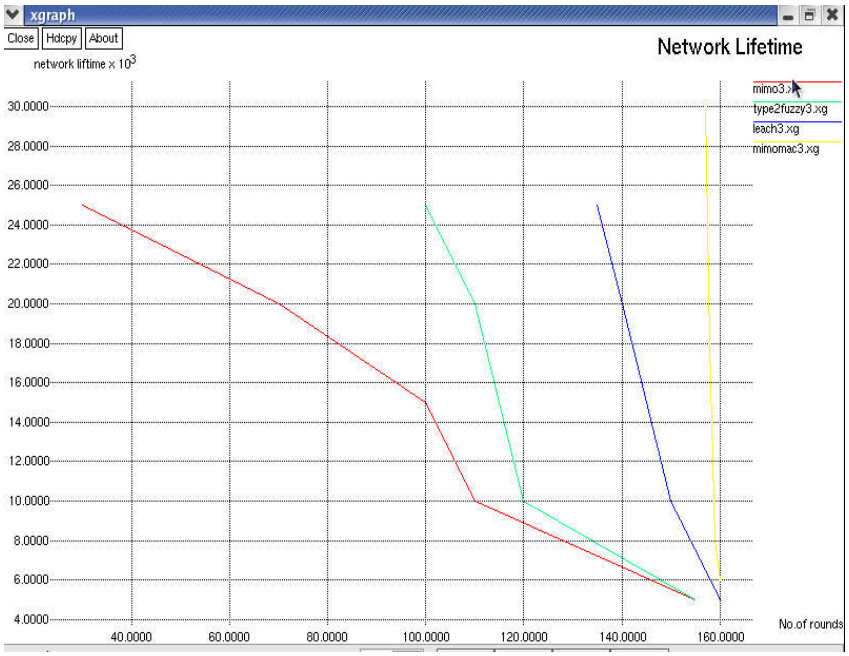

Fig.4.4 Network Lifetime

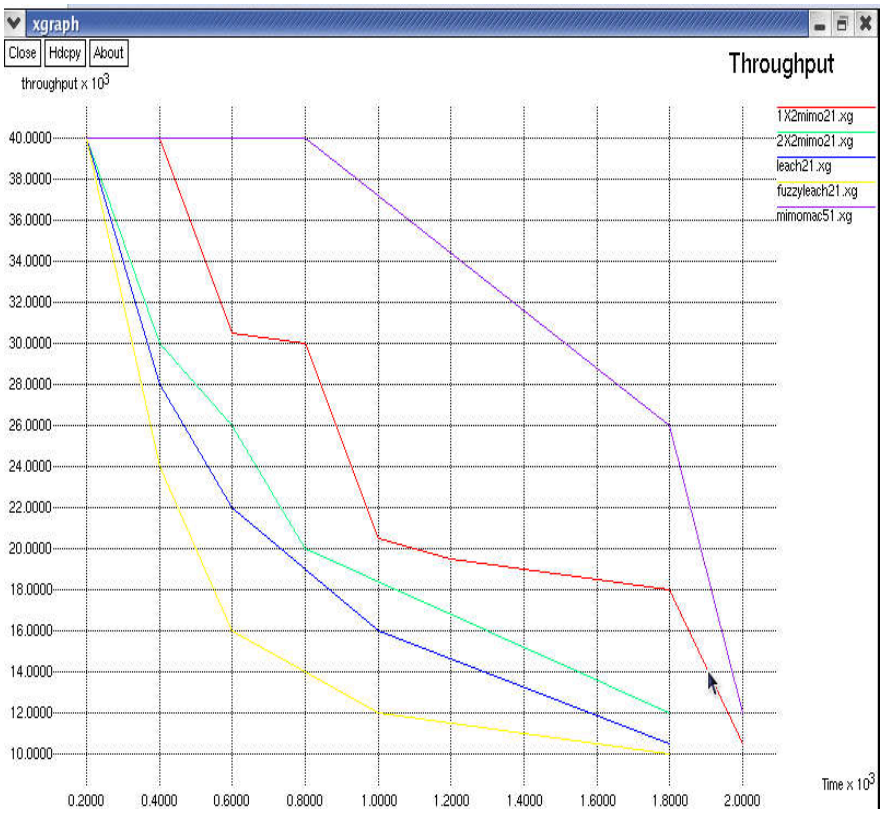

Fig.4.5 Throughput

5. CONCLUSION

A new method of cooperative MIMO MAC using type2 fuzzy logic for wireless sensor network has been used for maximize the lifetime of the network .To achieve the minimum energy consumption and delay they expected the transmission error and delay were less.The performance of the proposed MIMO MAC protocol is evaluated for fixed group size for 4x4 uncoded and coded scheme simulation results proves that the STBC performance is 60% high while using MIMO MAC protocol .The significant reduction in delay and energy results from the diversity gain and lesser probability to achieve a coded MIMO MAC system.

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