# PREDICTING THE TWIN CLUSTER-HEAD USING MARKOV MODEL FOR CONSERVING SENSOR ENERGY IN POLYHOUSE FARMING

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## ABSTRACT

*In recent years, the development of wireless sensors has given a new direction to farming procedures. The various parameters such as temperature, humidity, ventilation, etc. are kept under controlled supervision which gives rise to higher and better production. A major challenge in wireless sensor networks is the energy conservation of sensors. One of the leading factors of energy wastage is failed transmission attempts due to channel dynamics and interference. In this paper we propose a novel approach for utilizing poor channel period through twin cluster heads to transmit packets efficiently. This method first select two cluster heads from each cluster that have maximum energy levels (senior cluster head and junior cluster head) using Hidden Markov Model. Then a noisy channel will be predicted using pushback HMM based scheme and no data packets will be transmitted from cluster head to the base station during this period. During the noisy period senior cluster head turns its status into sleep mode whereas junior cluster head starts sensing for data packets from the other sensor nodes. When the noisy period gets over both the cluster heads start transmitting packets sequentially. Again the cluster heads will be chosen periodically to utilize sensor energy levels.*

***Keywords: Energy Level, Hidden Markov Model, Noisy Channel, Sensor, Twin Cluster Heads.***

## I. INTRODUCTION

Wireless sensor networks comprises of few hundreds to thousands of spatially distributed sensor nodes which helps in monitoring of various physical and environmental conditions. They play a major role in home automation, agriculture, disaster prediction and management, traffic control, nuclear reaction control, military operations, environmental and health monitoring. Wireless sensor networks have taken farming a step ahead. They are the enabling technology for efficient agriculture. Prior to WSNs, farmers had to rely on satellite and aircraft imagery or other map based systems to accurately target their growing areas whereas WSN provides real time feedback. Sensors monitor temperature, humidity, Barometric Pressure, Carbon Dioxide (CO) gases, soil measure, soil acidity/pH, etc. The data collection, monitoring and materials application to the crops allows for higher yields and lower cost. Each area receives only what is required for its particular space, and at the appropriate time and duration.

One of the crucial aspects of sensor node is their energy constraint. Sensors are usually small, inexpensive devices, powered by battery, not possible to be recharged after deployment. Thus, there is a need for energy preservation to ensure longer life span of sensor nodes.For preserving the energy of the whole network, a sleep-awake schedule is used in [1]. The analytical method to target at the probability of individual lifetime of a sensor node is proposed in [3]. Since the topology and the placement of the WSNs can affect the energy cost for communication [4], the two-phrase placement solution for the communication domain design is studied in [2]. Since it aims to solve the WSN placement design for the specific civilian applications and needs the accurate placement by hand, it is impractical for the situation of the large-scale or unmanned placement.

The energy level information is useful in the WSNs in many ways, such as the routing protocol to choose the energy-efficient optimal route, the improvement of the load balance, and the reliability of data aggregation. Since the quality of data aggregation is largely dependent on the data provided by the member node in a cluster, in the data-centric sensing task, the accuracy of data is imperative. Moreover, it is ineffective only to extend the lifetime of the network when part of the sensor nodes in charge of data collection run out of energy [5].

In this paper, we aim at proposing a novel approach for selection of twin cluster heads in place of a single cluster head. Firstly a hidden markov model is used to predict the energy levels of each sensor node [5]. Depending upon the energy level information two cluster heads are selected (senior cluster head and junior cluster head). The senior cluster head senses data packets and then transmit it to the base station. But there is possibility of noisy channel between the cluster head and the base station. During this noisy period the packets will not be transmitted and the retransmission is required. Since, the transmission process consumes a large amount of energy it is not a wise idea to retransmit messages again and again.

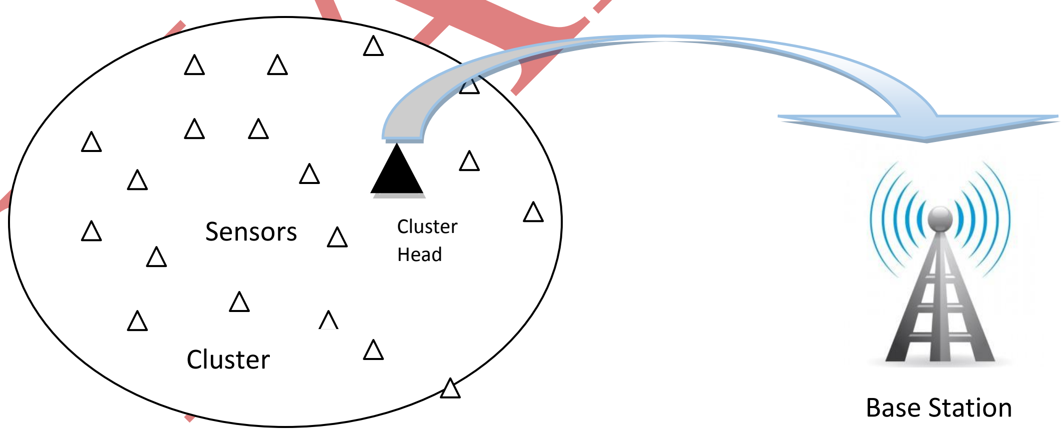



**Fig. 1 Wireless Sensor Network in Cluster Based Protocol**

Thus we use a hidden markov model to predict the time period for which the channel will be noisy [6]. No data will be sent by the cluster head to the Base Station (BS) during this period. But if the cluster head resumes its operation after noise it will have a large amount of data to be transmitted and it may lose its energy in between transmissions. Thus to prevent a hole creation we use twin CH approach.

In this approach by hmm model we select two cluster heads. The one with maximum energy is senior CH (Cluster Head) and the one with second maximum energy is junior CH. The senior cluster head will do its work of sensing and transmitting normally but when the predicted noisy period comes it switches to sleep state and the junior cluster head comes into picture. The junior cluster head will start its sensing work immediately and when the delay gets over the senior cluster head will wake up and the packets with senior cluster head will transmit first and then junior cluster head will transmit the sensed data packets.

The remainder of this paper is organized as follows. First, we summarized about polyhouse farming in section II. Section III illustrates the proposed method. Section IV gives concluding remarks, followed by future directions for research in section V.

## II. POLYHOUSE FARMING

Polyhouse farming is the cultivation of crops under protected conditions. They are used to provide a higher temperature and/or humidity than that which is available in the environment. They also protect crops from intense heat, bright sunlight, strong winds, hailstones and cold waves. This allows fruits and vegetables to be grown at times usually considered off season. Every factor influencing a crop can be controlled in a polyhouses. Polyhouses are often used in floriculture and nurseries.

**Fig. 2 A Polyhouse Farm**

The monitoring and control forms the core elements of poly house development. An automated polyhouse refers to the sensor and actuator network which detects the environmental changes as well as the needs of the crops and takes necessary actions. When the sensor network detects a value that is higher or lower than the predefined values, actuator gets activated and performs the necessary action. A polyhouse may cater to the needs of crops on individual basis. Polyhouse network could be wired or wireless. Wi-Fi, ZigBee and mobile devices are the current technologies of wireless sensors [10]. ZigBee [11] is a technology for a suite of high level communication protocols using small, low-power digital radios based on the IEEE 802.15.4-2003 standard for wireless personal area networks (WPANs), such as wireless headphones connecting with cell phones via short-range radio[12]. In such systems, multiple sensors are used to transmit the data to the data centre or a field server.

Sensors have limited battery capacity. They lose their charge rapidly and also it is not possible to recharge them after deployment. Thus battery capacity is a major challenge in WSNs. In this paper we present an energy conservation model for sensors in polyhouse farming.

## III. PROPOSED METHOD

In order to conserve energy of sensor nodes, this paper proposes a method to prevent the energy consumed in retransmission of data packets. The proposed approach uses the concept of twin cluster heads instead of a single cluster head. In single cluster head scheme, the cluster head transmits data packets again and again during noisy channel period. This retransmission consumes a lot of energy of sensor nodes. Thus there is a need to prevent this energy loss so that the cluster head could resume its transmission after noisy period gets over.

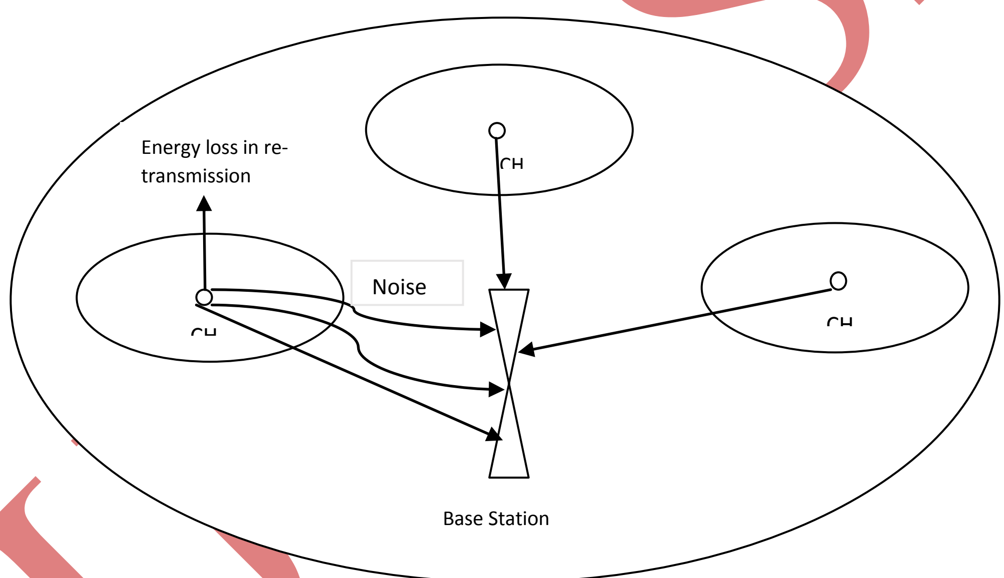
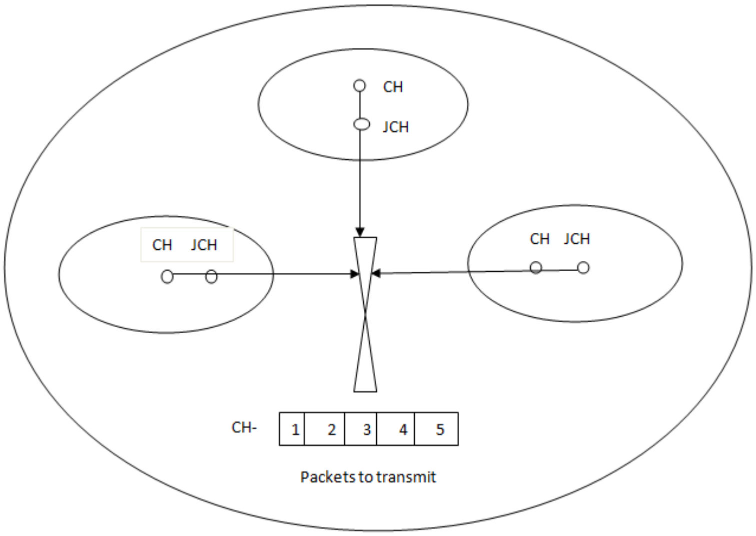



**Fig. 3 Normal Execution**

### 3.1 Selection of Twin Cluster Heads

Cluster-based protocol is widely used in WSNs. A cluster refers to a group of similar sensor nodes that are in proximity. Each cluster has a cluster head. The criteria for selecting cluster head could vary according to the application such as the sensor node having highest energy, the one in proximity to the Base Station (BS). The time




During noisy period:

CH (Senior Cluster Head): Sleep

JCH (Junior Cluster Head): Sense

**Fig. 4 Proposed Execution**

slot scheduling is required in cluster-based protocols for the transmission stage of data packets. The energy consumption in the data transmission in a packet is mainly dependent on the radio range of transmission and the bits of the sent packets. In the cluster-based protocol, since the entire member nodes are in the radio range of a cluster head, the energy consumption by radio transmission depends largely on the total bits of packets.

To determine the cluster head, paper [5] proposed a Hidden Markov Model based approach to predict the energy levels of each sensor node. The energy is divided into several energy levels that shows different energy ranges of sensor nodes. The major part of energy in sensor nodes is consumed in transmission of data packets. Thus the sensor node which has done least transmissions is assumed to have higher energy. The hmm based approach classifies the energy into three levels: low, medium and high.

To select the cluster head, energy level of each node is computed by the HMM based approach. The node with maximum energy is considered as the senior cluster head and the node with second maximum energy is considered as the junior cluster head. Normally, the senior cluster head performs the sensing and transmission of data packets. The cluster head selection repeats periodically after regular intervals (approximately 2 seconds). But the problem comes when noisy period occurs. The data packets fails to reach base station during this noisy period and thus cluster head may lose its energy in retransmitting data packets. Thus if cluster head remains with no energy the data packets it holds will never reach base station. To prevent this loss of packets, twin cluster heads are used. The junior cluster head takes over the sensing job of senior cluster head as soon as the noisy period arrives. During this senior cluster head goes to sleep mode. This prevents energy loss of senior cluster head.

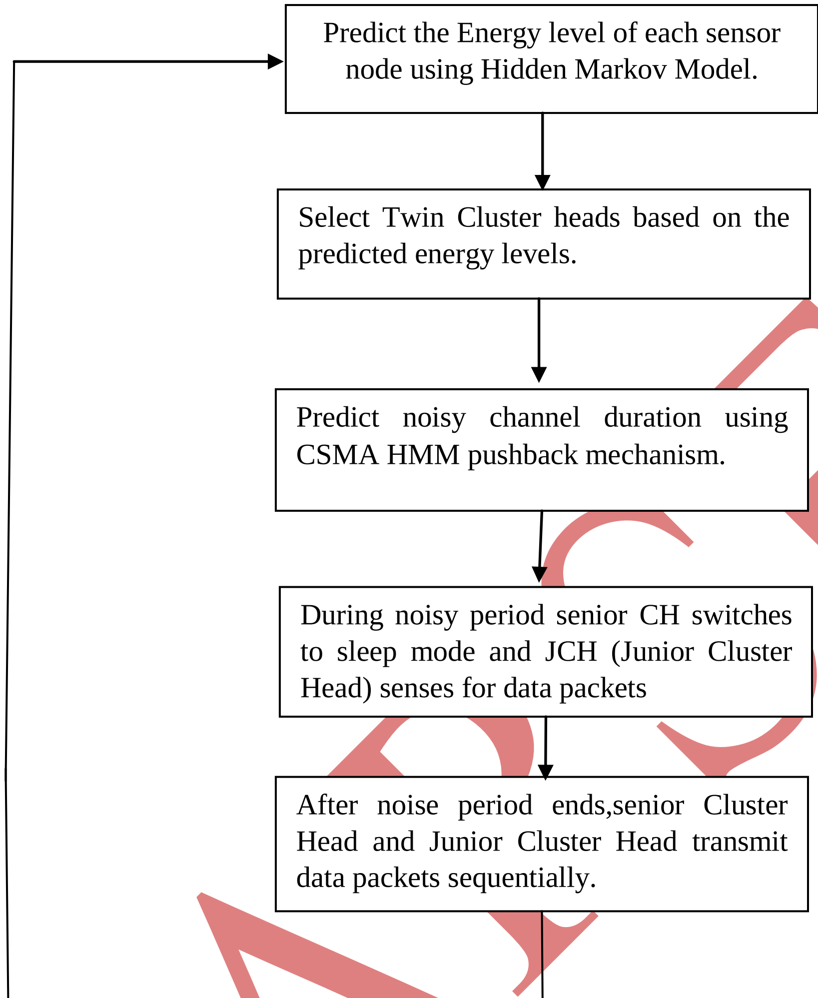



**Fig. 5 Flow Diagram of Proposed Method**

### 3.2 Prediction of Noisy Channel

Paper [6] proposed a Pushback mechanism based on CSMA with exponential backoff. It predicts the noisy period when data transmission will not occur effectively. This prediction helps in preventing the retransmission of data packets.

During the noisy period, the senior CH will go in the sleep mode but in the pushback mechanism, if the node goes in sleep mode, it may miss the opportunities to receive the packets from other nodes. Thus to overcome this problem, we use twin cluster head approach. In twin cluster head approach, when channel will become noisy the senior CH will stop its transmission of data and will switch to the sleep mode. Immediately the junior CH will be active. In this noisy duration, the junior CH will do the sensing process and receives the packets from its cluster members. After the noisy period ends, the senior CH will wake up and resume its transmission and the senior CH and the junior CH will send data packets to the BS sequentially. After complete transmission, the cluster heads are again selected according to hmm energy level prediction model.

## IV. CONCLUSION

This paper introduces a technique to conserve the energy of sensor nodes in retransmission of packets during the noisy period. It helps to reduce the high computational overhead on the sensor nodes. Using pushback algorithm packet success rate and the energy level is improved significantly without degrading the throughput of the network. In the noisy period none of the cluster heads will transmit packets to the base station whereas they switch their status on and off for utilizing energy required for the reception of data packets from the cluster nodes. This method periodically selects twin cluster heads that have maximum energy level for further conserving the energy of the sensor network. This method is highly suitable for energy constraint wireless sensor network.

## V. FUTURE WORK

In future we want to extend the proposed idea to the network and perform some simulation for the proposed scenario. Also we will conduct a study to analyze the various parameters of energy consumption and will try to propose some methodology to increase the overall network lifetime.

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