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# INVESTIGATION INTO MIMO BASED COMMUNICATION FOR ENERGY-CONSTRAINED WIRELESS SENSOR NETWORK

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**Abstract:** In cooperative MIMO architectures, individual nodes with single antennas collaborate with each other to act as a MIMO unit. User-cooperative Multi-input multi-output systems have been generating significant interest due to their capacity/performance gains over Single-input single-output systems. So individual node complexity associated with traditional MIMO implementations is alleviated. This feature is especially beneficial in sensor networks and cellular systems where individual node energy, size and cost are important constraints. Cooperative MIMO schemes provide all the benefits of traditional MIMO systems.

**Keywords:** MIMO, SISO, WSN, Cooperative MIMO, Virtual MIMO

## [1] INTRODUCTION

We encounter many applications of wireless systems our daily lives. While cell phones and wireless Local Area Networkhas already become an indispensable commodity, wireless sensor networks and embedded wireless systems have the potential to radically affect the way we interactwith the physical world.Wireless sensor network have gained world-wide consideration in recent years, particularly with the proliferation in Micro-Electro-Mechanical systems technology which has facilitated the development of intelligent sensors. These sensors are small, with limited processing and computing resources. These sensor nodes can sense, measure, and collect information from the environment and, based on some local decision process, they


can trans mit the sense data to the users. The sensors nodes consist of sensing, data processing, and communicating component, leverage the idea of sensors networks. A sensors network [1] is composition of a large number of sensor nodes that are densely deployed either inside the phenomenon or very close to it. Intelligent sensor nodes are low power devices equipped with one or more sensors, a processor, memory, a power supply, a radio and an actuator. Since the sensor nodes have limited memory and are typically deployed in difficult-to-access locations, a radio is implemented for wireless communication to transfer the data to the base station. Battery is the main power source in a sensor node. Secondary power supply that harvests power from the environment such as solar panels may be added to the node depending on the appropriateness of the environment where the sensor will be deployed. In some cases it is possible to scavenge energy from the external environment [2] like solar cells as power source.External power sources often exhibit a non-continuous behavior so that an energy buffer is needed as well. In any case, energy is a very vital resource. Therefore, energy conservation is a key issue in the design of systems based on wireless sensor networks.

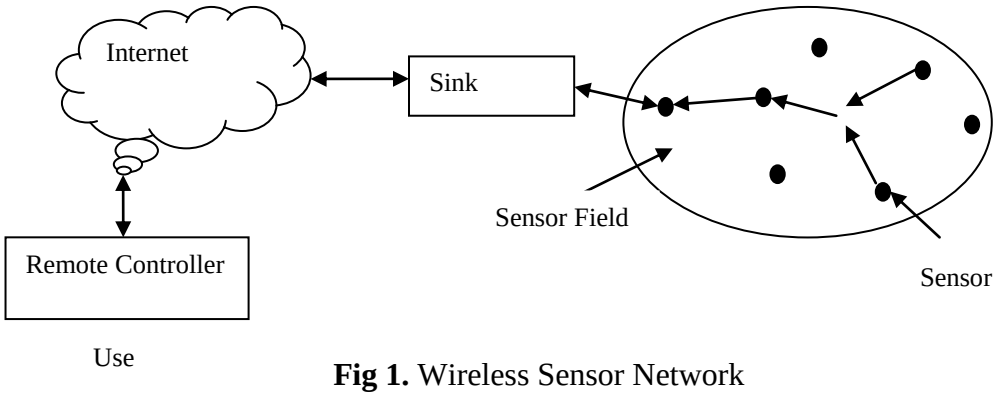


**Fig 1.** Wireless Sensor Network

## [3]MIMO

MIMO (multiple input, multiple output) is an antenna technology for wireless communications in which multiple antennas are used at both the source (transmitter) and the destination (receiver). The antennas at each end of the communications circuit are combined to minimize errors and optimize data speed. MIMO is one of several forms of smart antenna technology, the others beingMultiple input, single output and single input, multiple output.In radio, multiple-input and multiple-output, or MIMO is the use of multiple antennas at both the transmitter and receiver to improve communication performance. It is one of several forms of smart antenna technology. Here the terms input and output refer to the radio channel carrying the signal, not to the devices having antennas [5].
Motivated by information theoretic predictions on large spectral efficiency of multiple-input-multiple-output systems, recently there has been a great amount of research on various MIMO techniques for wireless communication systems. However, the fact that MIMO techniques could require complex transceiver circuitry and signal processing leading to large power consumptions at the circuit level, has precluded the application of MIMO techniques to energy limited wireless sensor network [3].

## [4]COOPERATIVE MIMO

**CO-MIMO,** also known as **Network MIMO** (**Net-MIMO**), or **ad hoc MIMO**, uses distributed antennas which belong to other users, while conventional MIMO, i.e., single-user MIMO, only employs antennas belonging to the local terminal. CO-MIMO improves the performance of a wireless network by introducing multiple antenna advantages, such as diversity, multiplexing and beamforming. If the main interest hinges on the diversity gain, it is known as cooperative diversity.

In this scenario, a source node may not have any other nodes which are close to each other. However, due to broadcast nature of the wireless system multiple nodes may be able to listen to the source and aid in forwarding the information to the destination. These intermediates nodes are called relays.

One or more intermediate nodes can act as relays. At the destination, in addition to direct link from source, the transmitted information is received from different spatially independent path throughrelays and hence provides diversity advantage.

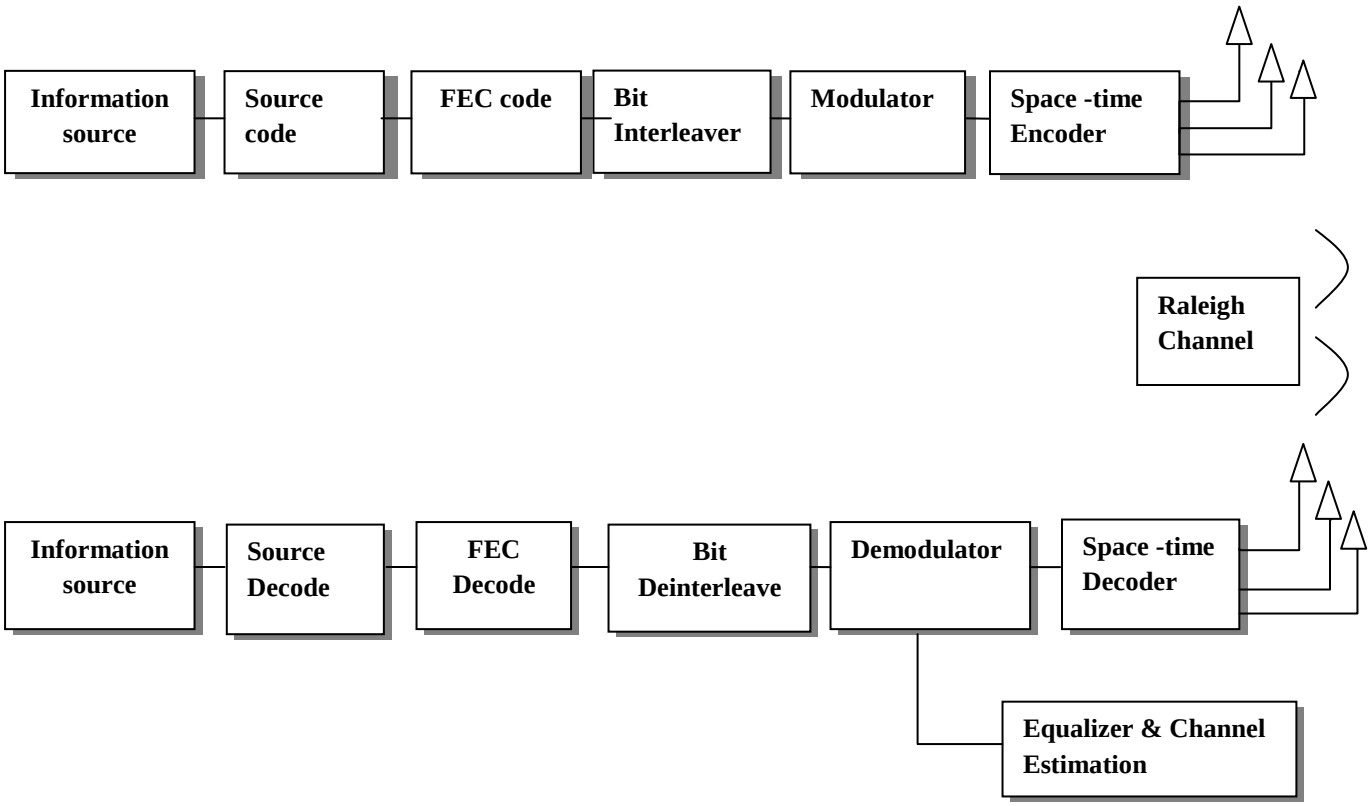


**Fig. 3** MIMO System Model

## [5]VIRTUAL MIMO

Virtual multiple input multiple output (MIMO) techniques are used for energy efficient communication in wireless sensor networks.In recent years, virtual MIMO has attracted a growing interest because of its energy efficiency in large field of networks. In virtual MIMO network, a group of sensors cooperate to transmit and receive data. Although the participation of multiple transmitters and receivers in a transmission save significant energy in long-range communications, the increase in the number of transmitters and receivers also increases the circuitry power consumption [6].As a result, the energy optimization techniques have to be adapted with the environment. Due to the circuitry complexity and difficulty of integrating separate antenna, virtual MIMO concepts are applied in wireless sensor networks (WSNs) for energy efficient communication to save energy and increase reliability.A large number of protocols and methods are proposed for energy efficient communications in WSNs [6].In virtual MIMO, multiple senders and receivers participate in long-range communication to improve data reliability in fading channels. The performance of virtual MIMO in WSNs depends on the structure of network layer and data link layer. There are several approaches for implementing virtual antenna array in WSNs [6].Although the core implementation of virtual antenna array or co-operative transmission lies on physical layer, there is deep dependency on the higher layers (network and data link) to implement this issue. In a cognitive network framework, the network components can modify the operational parameters to respond to the needs of particular environment [6].

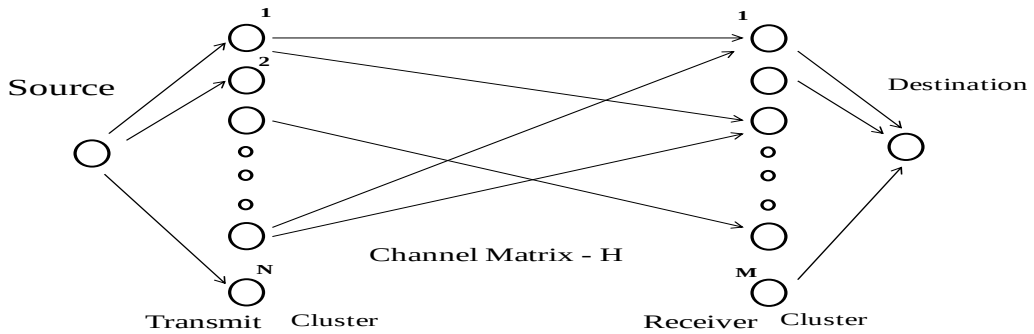


**Fig 4.** Virtual MIMO

## [6]APPLICATIONS OF WIRELESS SENSOR

- Habitat and Ecosystem Monitoring
- Seismic Monitoring
- Civil Structural Health Monitoring
- Monitoring Groundwater Contamination
- Rapid Emergency Response
- Industrial Process Monitoring
- Perimeter Security and Surveillance
- Automated Building climate control

## [7]APPLICATIONS OF MIMO

Spatial multiplexing techniques make the receivers very complex, and therefore they are typically combined with Orthogonal frequency-division multiplexing (OFDM) or with Orthogonal Frequency Division Multiple Access (OFDMA) modulation, where the problems created by a multi-path channel are handled efficiently.

The IEEE 802.16e standard incorporates MIMO-OFDMA. The IEEE 802.11n standard, released in October 2009, recommends MIMO-OFDM.

MIMO is also planned to be used in Mobile radio telephone standards such as recent 3GPP and 3GPP2. In 3GPP, High-Speed Packet Access plus (HSPA+) and Long Term Evolution (LTE) standards take MIMO into account. Moreover, to fully support cellular environments, MIMO research consortia including IST-MASCOT propose to develop advanced MIMO techniques, e.g., multi-user MIMO (MU-MIMO).

MIMO[10] technology can be used in non-wireless communications systems. One example is the home networking standard ITU-T G.9963, which defines a powerline communications system that uses MIMO techniques to transmit multiple signals over multiple AC wires (phase, neutral and ground).

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