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MIMO IN WIRELESS COMMUNICATION: A COMPREHENSIVE REVIEW

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Abstract: This paper focuses on present day scenario of communication through MIMO technology. MIMO systems are high in demand because of their versatility features. They offer high data rates, throughput, different frequency of operability as per demand and many more. Because of this it finds application in LTE, WiMax, HSPA+ and other wireless communication and latest technologies.

Keywords-MIMO, Antenna types, precoding, spatial multiplexing, diversity coding

I. Introduction

An antenna is a structure i.e., generally of metallic objects, wire, or group of wires used to convert high frequency current into EM wave and vice versa. Like an antenna is used in transmitter side then it converts high frequency current into EM wave and if it is used in receiver side then it will catch the EM wave and convert it into electrical signals.

First antenna concept was given by James Clark Maxwell, it was first published in 1873. In 1886; Professor Heinrich Rudolph Hertz established the first wireless system. In 1901 Guglielmo Marconi developed a concept to transmit a signal over large distance. In 1920's Yagi antennas was developed it was developed by H-Yagi and S.Uda, become very popular in World. In 1939's Horn antennas were developed it was just like a hollow metallic pipes. In 1940's Array antennas was developed which increases directivity in particular direction. Late 1940's and early 1950's parabolic reflector came into existence during the World War-II. Beginning in early 1960's, numerical methods were involved to analyze and designed very accurately the system. In 1970's patch antennas was developed which was different shape and sizes and dimensions. Now a days MIMO antennas was become very popular due to lots of benefits, its first concept given by A.R Kaye and D.A George(1970's), Brandenburg and Wyner(1974's) and W.van Etten (1975's, 1976's) published a paper on beamforming. In 1993 Arogyaswami Paulraj and Thomas Kailath given an idea of spatial multiplexing using a MIMO concept. In 1996 Greg Raleigh, Gerard J.Foschini and Emre Telatar given a new idea to mimo technology. In 1998 spatial multiplexing was become very helpful to increase the performance of MIMO wireless communication.

II. Antenna Types

A. Wire Antennas

Wire antennas are the earliest form of antenna and the most popular, which can be seen or find applicability in on buildings, automobiles, aircraft ships and spacecraft. It can possess different shapes and dimensions as per requirement e.g., helical wire, dipole. Loop antennas are not only found in circular in shape it may be in rectangular, ellipse, square or other configurations.

B. Aperture Antennas

Aperture antennas are one of the sophisticated forms of radiating system, which is used nowadays because of its performance characteristics. It has higher frequency range. It finds application in aircraft and spacecraft.

C. Microstrip Antennas

Modern day communication system is widely using microstrip antennas. In a microstrip patch antenna, a patch is situated/placed on a grounded substrate and excited. Patches are of many shape and dimension such as rectangular, square, circular and triangular. Among these shapes, circular patch are very easy to design, so are incorporated in antenna design. There are different methods of excitation such as slot feed, micro strip line feed, probe feed and different other techniques. It can be fabricated easily; can be designed micro technology/circuit

design on PCB. It finds application in commercial and government sectors, spacecraft, aircrafts, cars, missiles, satellite and mobile systems.

D. Array Antennas

For broadcast service, devices which transmit in all possible directions are needed but practically it is not possible. But in point-to-point communication, demand to increase directivity in particular direction is needed. Such kind of device is fulfilled by making proper arrangement of several individual element in a proper manner so that directive gain can be increased in particular directions. Array antennas are the arrangement of several antennas so spaced and phased that their individual contribution comes in particular directions and cancels out in opposite directions.

E. Reflector Antennas

For long distance communication, radiating device capable of transmitting and receiving signals that travels millions of miles is required. A most commonly used antenna that fulfilled such kind of need is parabolic reflector. It is made up of large diameter so that it can achieve high gain.

F. Lens Antennas

Lens antennas are such kind of devices that prevents the signal to spreading in undesired directions. Such type of device has given a proper shape and configuration and appropriate material is chosen so that it can divergent energy into the plane waves. Such types of antennas are used at higher frequencies if at lower frequencies its weight and dimensions are large.

III. MIMO Technology

MIMO (Multiple Input, Multiple Output) is an improved and advanced antenna technology for wireless communications. In this technology multiple antenna are used at transmitter and receiver end. Antennas which are used at each end of the communications system are combined to reduce errors rate and improve the data speed. MIMO is the form of smart antenna technology, the others being MISO (multiple inputs, single output) and SIMO (single input, multiple outputs).

MIMO systems are more complex, despite of this disadvantage, it is widely used in wireless communications, because it offers, significant increase in the data throughput and link range, without additional bandwidth or increase in transmitter power. It also improves the spectral efficiency and the link reliability.

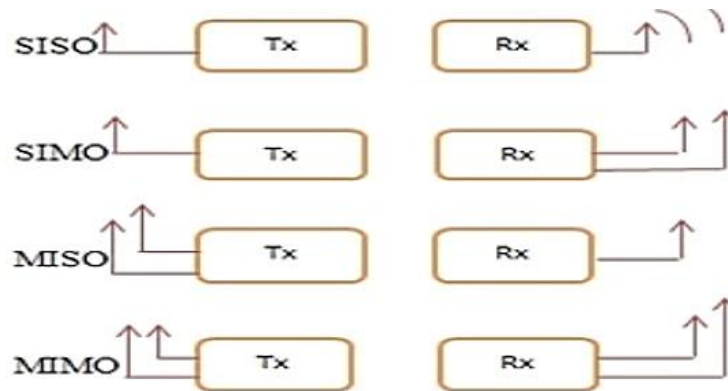


Figure 1 Forms MIMO Technology

A. SISO

Single-Input Single-Output is a form of MIMO antenna where transmitter and receiver both consist of single antennas. It is one of the simplest forms of MIMO Technology.

B. SIMO

Single-Input Multiple-Output is a form of MIMO technology where transmitter has single antenna and receiver has multiple antennas.

C. MISO

Multiple-input and single-output is a form of MIMO technology where the transmitter has multiple antennas and receiver has single antenna.

D. MIMO

Multiple-input multiple-output is a form of MIMO technology where transmitter and receiver both have multiple antennas.

IV. MIMO Working

MIMO working function is sub-divided into three main categories; precoding, spatial multiplexing or SM, and diversity coding:

A. Precoding

It is a multi-stream beamforming. In more common terms it was supposed to be all spatial processing which occurs at the transmitter end.

B. Spatial multiplexing

It needs MIMO antenna configuration. In this technique a high rate signals is splited into several lower rate signals and each signal is transmitted by a different transmit antenna in a common frequency channel.

C. Diversity Coding

This technique is used if there is no channel knowledge at the transmitter end. In diversity methods, a single stream is transmitted, but the signal is coded using techniques called SPACE-TIME CODING.

V. MIMO Applications

MIMO is an essential part of modern wireless communication system. So it finds application in such fields:

- IEEE 802.11n(Wi-Fi)
- 4G
- 3GPP Long Term Evolution
- WiMax and HSPA+

VI. Discussion

In MIMO Technology, different number of receive and transmit antennas are used for the purpose of transmission and reception of signals. This is achieved by spreading the total transmitted power over to achieve the array gain, and hence throughput of the channel increases linearly and thus increases the spectral efficiency and link reliability.

VII. Conclusion

Demand of MIMO technology is growing because of its incomparable properties such as it provides high spectral efficiency and link reliability, increased the Wi-Fi range, increases the data throughput and link range without additional bandwidth. It is complex as compared to other radiating systems, but it serves the purpose of different antennas, and therefore it is suitable and applicable in modern day wireless communication systems.

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