Importance of Digital Image Processing in Modern Satellite Communication Technology

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Abstract*: In this paper we will discuss satellite communication using Digital Image Processing (DIp). We will also discuss satellite configuration and other things. A high resolution camera is used in the satellite to click the earth surface or urban areas. It can help in many sectors like traffic, disaster management, weather, communication etc. This kind of technique is known as satellite image processing. Nowadays Machine learning and artificial intelligence are trying to get more accurate output. In Satellite communication electromagnetic waves are used as carrier signals and these carrier signals can carry audio, video or voice between space or ground. These satellites also help in defense sectors.*

Keywords: Remote sensing, Electromagnetic waves, pixel, carrier, Machine Learning, Satellite Imagery.

I. INTRODUCTION

In this paper we will be talking about analysis of Satellite's configuration and many things. The images which are used are in digital form. In this paper we are also discussing the uses of Satellite's imagery and Digital Image Processing (DIP) for the detection. The satellite scene was resolved by ground control for field observation. The satellite images are used to find landscape areas and rural areas also. There are many more other applications of Satellite's imagery. In Satellite Communication Machine learning (ML) is one of the most heavily used technologies, from this we give us many more exact outputs which helps in many fields. ML based technology shows better numerical performance. Satellite communication plays the main role in the world communication system. In the satellite communication electromagnetic waves are used as carrier signals. These carrier signals can carry audio, video , voice or any kind of data between space and ground or vice-versa. Telephone, radio, television, internet, military applications can be used satellite communication system. Around 2000 artificial Satellites are roaming around in space.
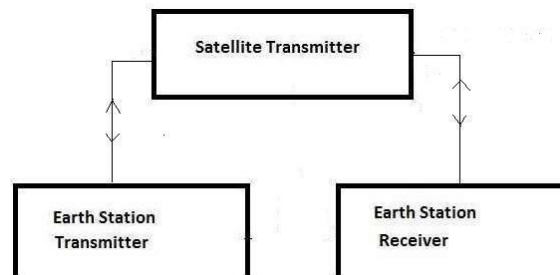

Fig-1: Block diagram of Satellite Communication

In 1945, Arthur C Clarke gave an article which was known as "Extraterrestrial Relays" published in the British magazine wireless world. This article showed the deployment of artificial Satellites in the geostationary orbits. The first artificial Satellite was Sputnik1 which was put in orbit by the USSR on 4 October 1957. It was made by Mikhail Tikhonravov and Sergey Korolev. Sputnik1 made an on-board radio-transmitter which was worked on two frequencies of 20.005 and 40.002MHz or 7-15m wavelength. This satellite was not settled on the earth orbit which can send data from one end to another end, the transmitter was there to study the properties of radio wave distribution throughout the ionosphere. The launch of Sputnik1 was a big step to experiment with the space and rocket development.

Now Digital Image Processing (DIP) is used in the satellite communication system. By using DIP technique it gives us accurate output which helps to improve our satellite structure or something like that. Main Digital Image Processing is a technique which is the use of digital computers to understand the digital image by an algorithm. It has a subcategory

which is Digital signal processing may help over analog image processing. Satellite Image processing takes a major role in the field of research and development and consists of the images of earth. Firstly photographs are clicked in the digital form and later it is processed by computers to understand the extract information. The images which are clicked, statistical methods are used to the digital images and after processing the various discrete surfaces which are identified by the pixel values. This technique is known as satellite image processing which is a part of Digital Image Processing (DIP). This satellite imagery is used to plan the infrastructures or to look into the environment conditions or understand the upcoming disaster. In one term we can also say that satellite image processing is a kind of remote sensing works on pixel resolution which collects coherent information about Earth surface.
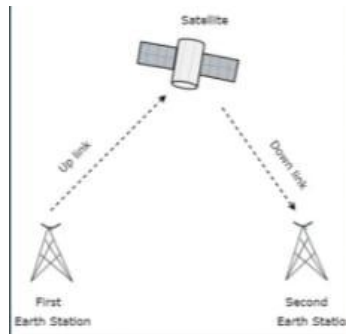

Fig-2: Overview of Satellite Communication

II. LITERATURE SURVEY

In paper1; The use of satellite imagery and digital image processing in landscape archaeology. A case study from the island of Mallorca, Spain.

In 06 December 1998 this paper was published by Antonio M. Montufo. He said in his paper to assess the potential use of satellite imagery and digital image processing for the detection and surveying of ancient land-use patterns. The rural land-use patterns in the southeastern region of Mallorca (Spain) were investigated in order to locate traces of the Roman field-division system. A satellite scene was analyzed using ground control for field observations to determine the rural patterns observed in the contemporary landscape and to identify the possible remains of centuriated systems. He also said a satellite scene was analyzed using ground control for field observations to determine the rural patterns observed in the contemporary landscape and to identify the possible remains of centuriated systems. Satellite data proved to be of use in surveying medium-scale rural patterns.

In paper2; Digital Image Processing of Remotely Sensed Satellite Images for Information Extraction.

In April 2013, this paper was published by MINAKSHI KUMAR, R. K. Singh. They said in their paper to remote Sensing (RS) refers to the science of identification of earth surface features by measuring portion of reflected or emitted electromagnetic radiation from earth's surface by sensors onboard manmade satellites orbiting around the earth. The output of a remote sensing system is usually an image representing the scene being observed. Many further steps of digital image processing and modeling are required in order to extract useful information from the image.

In paper3; Digital Image Processing of Earth Observation Sensor Data.

In January 1976, this paper was published by R. Bernstein. He said in his paper digital image processing techniques that were developed to precisely correct Landsat multispectral Earth observation data and gives illustrations of the results achieved, e.g., geometric corrections with an error of less than one picture element, a relative error of one-fourth picture element, and no radiometric error effect. Techniques for enhancing the sensor data, digitally mosaicking multiple scenes, and extracting information are also illustrated.

In paper4; Machine Learning for Satellite Communications Operations

In February 2021, this paper was published by Miguel Ángel Vázquez; Pol Henarejos; Irene Pappalardo; Elena Grechi; Joan Fort; Juan Carlos Gil. They said in their paper that ML in image processing has led to unprecedented advantages

in new services and products, the application of ML in wireless systems is still in its infancy. In particular, this article focuses on the introduction of ML-based mechanisms in satellite network operation centers such as interference detection, flexible payload configuration, and congestion prediction. Three different use cases are described, and the proposed ML models are introduced. All the models have been constructed using real data and considering current operations.

III. CONCLUSION

Satellite imagery takes a critical role in remote sensing applications, which monitor weather patterns, climate change, natural disaster and land use. Future improvement with DIP technology can improve the accuracy, resolution and interpretability of Satellite communication. Satellites equipped with DIP capabilities can take high resolution images of earth surface, urban areas etc. Which helps to find out the problems with the advancement or improvement of this technology satellite can take more accurate pictures which also help to find out minor problems also. Satellite communication with Digital Image Processing allows real-time analysis of image captured by cameras which is on Satellite. This capability has huge application in traffic monitoring, surveillance and security where image analysis is crucial. With this improvement, it helps in the traffic system. During the transmission of satellite images, there will be high chances of data loss due to signal interference. DIP technique can be used to restore or reconstructed the loss or corrupted parts of image. By improving this technique this problem will be solved soon.

REFERENCES

[1]. The use of satellite imagery and digital image processing in landscape archaeology. A case study from the island of Mallorca, Spain. Author: Antonio M. Montufo, First published: 06 December 1998.

[2]. Digital Image Processing of Remotely Sensed Satellite Images for Information Extraction. Author: MINAKSHI KUMAR, R. K. Singh, Available Online April 2013.

[3]. Digital Image Processing of Earth Observation Sensor Data Author: R. Bernstein author, January 1976, IBM Journal of Research and Development (Volume: 20, Issue: 1, January 1976)

[4]. Machine Learning for Satellite Communications Operations Author: Miguel Ángel Vázquez; Pol Henarejos; Irene Pappalardo; Elena Grechi; Joan Fort; Juan Carlos Gil, February 2021, IEEE Communications Magazine Volume: 59, Issue: 2.