

Introduction to Microwave Remote Sensing

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Abstract—This paper reviews a brief overview of the Microwave Remote Sensing and the History of Microwave Remote Sensing along with its instruments such as Radiometers (Passive Sensors) and Imaging Radar (Active Sensors). This paper is inspired by various other studies based on the history and launches of various satellites for remote sensing using radiometers and imaging radar with their pros and cons.

Index Terms— CORONA, IKONOS, Imaging Radar, IRS-1A, Microwaves, Radiometer, Remote Sensing, SEASAT

I. INTRODUCTION

THE word Remote Sensing is defined as the process of measuring the physical properties of any distant objects typically from aircraft and satellites using reflected or emitted energy.

Remote sensing collects data about Earth by detecting the energy that is reflected from the surface. These sensors are mounted on either UAV/drones which are close range or Aerial or Satellite sensors which are far range. Microwaves are a kind of electromagnetic wave whose wavelengths starting from about 1 cm to 1 m; with frequencies between 3 GHz to 30 GHz. The microwave ranges are often referred to as the different frequencies bands: S, C, X, Ku, K, Ka (IEEE radar band). Photography had set the beginning of the history of remote sensing. The origin of other types of remote sensing can be traced back to World War II, with the development of radar, sonar, and thermal infrared detection systems.

TABLE I
VARIOUS IEEE MICROWAVE RADAR BANDS AND THEIR FREQUENCY AND WAVELENGTH RANGES.

Microwave Band	Frequency	Wavelength
S band	2 to 4 GHz	7.5 cm to 15 cm
C band	4 to 8 GHz	3.75 cm to 7.5 cm
X band	8 to 12 GHz	25 mm to 37.5 cm
K _a band	12 to 18 GHz	16.7 mm to 25 mm
K band	18 to 26.5 GHz	11.3 mm to 16.7 mm
K _u band	26.5 to 40 GHz	5.0 mm to 11.3 mm

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Microwaves were chosen for remote sensing applications due to their numerous advantages. This part of the spectrum has unique capabilities for remote sensing objects in the day as well as night. These waves can penetrate through clouds and penetrate, acquiring images in any weather. Not only they can transmit through water but can penetrate vegetation canopy which is useful for studying surface water or flood extent.

II. HISTORY OF REMOTE SENSING

Remote sensing is generally referred to as the use of aircraft or satellite-based technologies to collect information to detect and classify objects on Earth.

The history of remote sensing started with the famous balloonist G. Tournachon, who made photographs of Paris from his own balloon in 1858. Earlier ways of communication were pigeon messenger and other instruments like kites, rockets. The need for systematic aerial photography was required during World War I for military surveillance. Various modified aircraft like P-51, OV-1, and many others were used to collect information for aerial photography. During the war, the cameras were specially designed for aircraft use and were mounted on the aircraft. The data obtained from the aircraft sensor pods were used by the government and the military which later was also accessible for the public in the late 20th century.

Earlier the term "aerial photography" was used instead of "remote sensing" which was initially introduced in 1960 due to the advancements in aerial photography beyond the traditional black and white photos. In the period of 1960-1970, there was a drastic shift to carry out remote sensing from satellites rather than airplanes, as satellites tend to cover a greater area than planes and ensure regular monitoring. A major change from analog to digital storing of imagery was occurring, which made it possible to analyze and display images on computers. Computer technology in the same era was advancing from large mainframe computers to compact microcomputers which enabled graphic form rather than numerical outputs. Later in the second half after the Cold War, there was a visible development of artificial satellites which allowed remote sensing to become globally accessible. These sensors due to advancements were now able to record several different portions of the electromagnetic spectrum, which is beyond what the human eye could view. Several things occurring on the Earth's surface were now visible which were previously inaccessible with normal aerial photography.

Until 1995 **CORONA**, America's first satellite series

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