

Microwave Remote Sensing System Development in MACRES

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Abstract: Since its establishment Malaysian Center for Remote Sensing (MACRES) has focused on the measurements from airborne and space borne remote sensors. In the year 1999 MACRES in collaboration with Multimedia University Malaysia (MMU) began developing its own remote sensing sensors to meet Malaysian Remote Sensing needs. MACRES adopted a very systematic approach to the development of these microwave sensors. Starting from non-imaging ground base microwave remote sensing sensors MACRES is now well into developing its first Airborne Synthetic Aperture Radar. With the capability of developing its own sensors MACRES will profit more on the microwave remote sensing application research. This paper will demonstrate MACRES capability in developing Microwave Remote Sensing Sensors to meet Malaysian remote sensing society needs.

Keywords: Microwave Remote Sensing

1. Introduction

Since 1999 Malaysian Center for Remote Sensing (MACRES) is doing research and development in microwave remote sensing together with Multimedia University (MMU). The main purpose of this research and development project is to develop microwave remote sensing system that caters for Malaysia's remote sensing users. Microwave remote sensing is necessary as a large part of Malaysia is almost always covered with clouds.

The physics of microwave remote sensing is more complex compared to the optical remote sensing. The process involve in getting the required information from microwave remote sensing data is much more difficult. Due to this fact, MACRES develop a systematic approach in developing its own microwave remote sensing capability. This entails basic or fundamental research, application research, system development research and human resources development.

For system development research the programmes is further divided into three segments, ground based systems, airborne systems and space borne systems.

2. Objective

The main objectives of this project are to develop a scatterometer system for environmental monitoring, imaging radar and the development of multipurpose anechoic chamber.

From the development of microwave remote sensing systems Malaysia are to be able to be self-reliant in the technology of remote sensing sensor technology, to be able to use and fully utilized a custom-

ized microwave remote sensing sensor that caters specifically to Malaysia's users and to develop the know-how and know-why of microwave remote sensing sensor technology.

On whole Malaysia will benefit from the specialized engineers and scientists generated by this project.

3. Systems Development

This project is headed by MACRES in collaboration with the expertise from MMU. Engineers and scientists from MACRES and MMU work together to develop the systems. There are three main systems to be developed under this project. The first being scatterometer system for environmental monitoring. This scatterometer is to be a ground based systems and design for monitoring crops such as paddy, oil palm and rubber trees.

The second system to be developed is a multipurpose anechoic chamber. This anechoic chamber will serve as a testing and verification laboratory for the research done in microwave remote sensing systems.

An airborne synthetic aperture radar (SAR) is being developed by MACRES and MMU and this project is expected to be completed by the year 2005.

The experience gained from developing the mobile scatterometer and airborne SAR will be used in developing the space borne SAR.

1) Mobile Scatterometer System

The objective of the development of this mobile scatterometer system is to assist MACRES scientist in determining the backscatter of vegetation. A C-Band Scatterometer is successfully developed in the year 1999 and the system was integrated onto a truck with a hydraulic boom in 2001. This will enable the system to make *in-situ* measurements.

The mobile platform includes a truck, a telescopic boom, a 1.5-meter parabolic antenna, a PC-based scatterometer system, a power generator, and a control room (cabin). The main objective of the design is to position the parabolic antenna and RF system at approximately 26 meters height (vertically). The received backscattered signal will be captured and sent down to the digital computer (placed inside the cabin) via low loss cable [1].

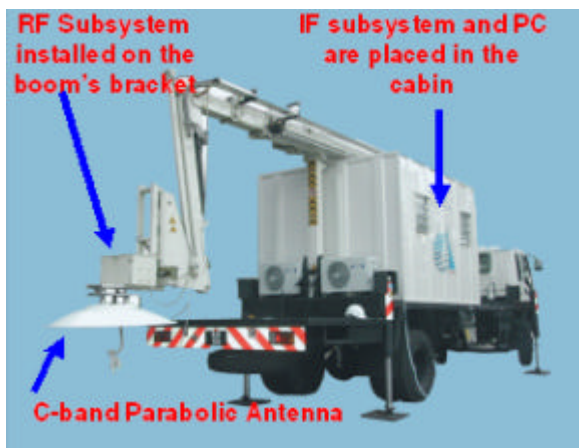


Figure 1 Mobile Scatterometer

Table 1. C-band Mobile Scatterometer system specification

System parameter	Selected Value
Operating Frequency	6 GHz
System Configuration	FM-CW
Polarization	VV, HH, VH, HV
Measurement Range	20 – 100 m
Dynamic Range (σ^0)	+ 20 dB to – 40dB
Platform	ISUZU FVR 33 equipped with a GSR 279TJ Hydraulic boom
Operating Height	20 - 26 meters
Platform Dimensions	9m x 3m x 4.5m

The mobile C-Band Scatterometer System has undergone its first field measurement campaign in April 2003. The measurements were done in a paddy field. The purpose of the measurement is to get the microwave backscatter from paddy and compare it with a theoretical model. Several other field measurement are planned in order to see different backscatter measurement from different stages of paddy growth.

The future plan for this project is to develop an L-Band scatterometer system. MACRES and MMU is working together in developing the system.

2) Multipurpose Anechoic Chamber

The anechoic chamber is developed to serve as an indoor measurement range. This measurement range will help in determining the radar cross section of a given target. In microwave remote sensing the scientist is often would want to know the backscatter characteristics of a given target. They would create mathematical models to predict the behavior of a target and verify it with measurements made in controlled and uncontrolled environments. The anechoic chamber gives the opportunity to the scientist to do measurements in a controlled environment.

A multipurpose anechoic chamber that operates from

30 MHz through 18 GHz has been designed and constructed at Multimedia University. The unique asymmetrical shape of the chamber structure allows for the use of 610 mm thick foam absorbers to achieve the extremely wideband performance. It can be used for various types for RF and microwave measurements. The facility will provide measurement services to the industries as well as supporting R&D activities in the area of Applied Electromagnetic [2].

The developed anechoic chamber can be used for measurements of dielectric constants of vegetation components and soil samples, radar cross section measurement, EMC test, antenna measurement, evaluation of RF transceivers and calibration of scatterometer.

The room is shielded with metal sheets to prevent interference from external as well as to prevent leakage of microwave signal to the surrounding area. Floor, ceiling and wall are also covered by absorbers to emulate a non-reflective free space.

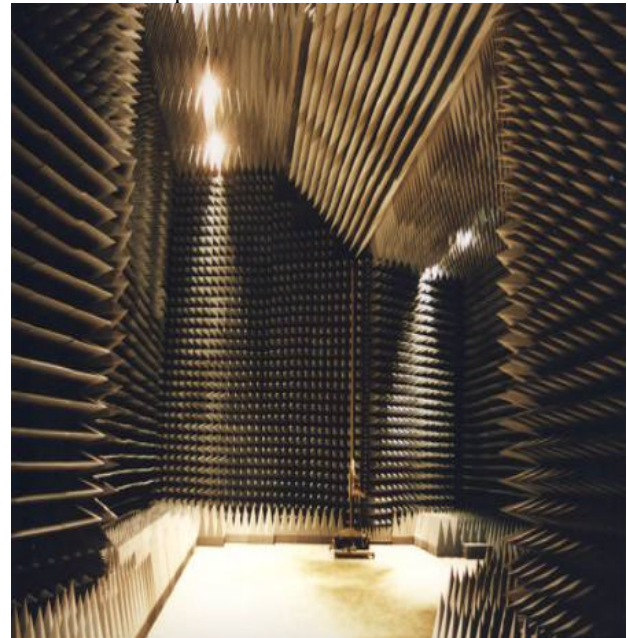


Figure 2. Anechoic Chamber at MMU

3) Synthetic Aperture Radar (SAR)

The trend for remote sensing demands for a day and night, all weather coverage of the earth surface, and in Malaysia with its persistent cloud cover there are growing need for a sensor that can penetrate the cloud covers. In view of this trend MACRES and MMU has embarked on an R&D project to develop airborne C-band synthetic aperture radar. The purpose of this project is also to serve as a test bed for SAR technologies and its application. The specification for MACRES-MMU SAR is shown in Table 2. However this project is still in development.

The specification for the airborne SAR system is made to cater for monitoring vegetation vertical canopy structure such as paddy. The airborne SAR will be used in application such as monitoring the growth stages

of paddy and vegetation crop discrimination.

The future plan for this project is to include a multi polar and multi band capabilities.

Table 2. C-band Mobile Scatterometer system specification

System parameter	Selected Value
Mode of Operations	Strip map SAR
Operating Frequency	6 GHz
Waveform type	Linear FM
Polarization	VV
Platform	Airborne
Altitude	~7.5 km
Incident angle	50°
Target Type	Distributed σ^0 0db to – 30 db
Desired Swath	8km (width), 10km (length)
Spatial Resolution	10 m (range), 10m (azimuth)

4. Conclusion

The experiences gain through the implementation of ground-based and airborne microwave remote sensing systems development and applications will contribute to the implementation of space microwave remote sensing programme that is being implemented in the country. The initiative that are being undertaken by MACRES in close collaboration with other agencies and institutions is a major concerted effort to attain national capability to meet current and future global high technology challenges especially in space and airborne remote sensing technologies.

Acknowledgement

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