NOAA Weather Satellite Station at KUTKM

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ABSTRACT

A ground station has been installed at Kolej Universiti Teknikal Kebangsaan Malaysia (KUTKM) to receive the VHF signal form the United State National Oceanographic and Atmospheric Administration (NOAA) Low Earth Orbiting Satellite (LEO) weather satellite series. The satellite signal was received and decoded as image which was displayed on computer screen in the form of visible light, infra-red or the combination of both. The image file is then processed and stored into a local computer for meteorology study in KUTKM.

1. INTRODUCTION

NOAA is a United State government organization which missions are to describe and predict changes in the earth's environment, and conserve and manage wisely the nation's coastal and marine resources to ensure sustainable economic opportunity [1]. There are two types of NOAA's operational weather satellite: geostationary operational environmental satellites (GOES) for short-range warning and " now-casting " and polar-orbiting satellites (POES) for longer-term forecasting [2].

The NOAA's LEO satellite carries a number of instruments including cameras for both visible and Infra-red light. The cameras scan back and forth at right angles to the ground path, taking picture strips that cover an area 3000 km wide and makes a continuous picture. The image, however, is not recorded on the satellite. Each image strip is immediately broadcast to the ground on frequencies in the range of 136 MHz to 138 MHz.

The objective is to setup a weather satellite station at KUTKM to receive the VHF signal from the NOAA LEO weather satellite series that can provides a unique real time view of the local sky for weather monitoring. A digital library is created, which contains information about the current and past satellite images from NOAA's Polar-orbiting Operational Environmental satellite. It allows users to search the satellite data databases, view the real-time or historical satellites images and download the weather image for further processing analysis. The satellite data, which is in the form of image, consists important information for weather analysis, forecasting, climate research and predication.

2. KUTKM NOAA GROUND STATION

KUTKM ground station is located at Faculty of Electronic & Computer Engineering at 2.183° N, 102.38° E. It can be categorized into hardware and management software. The ground station is able to record real-time satellite data, which is in the form of image and stored into a local computer for further analysis.

2.1 Ground Station Hardware

Fig. 1 shows the block diagram of the ground station. The main of the ground station is the Timestep PROscan APT weather satellite receiver. Basically, it consists of an antenna, FM receiver, and a decoder which is connected to the computer via RS-232 to display the image. The receiver operating range is from 137.30MHz to 137.85MHz. The antenna was mounted such that a clear line of sight path to the North and south horizon was achieved and it was positioned away from sources of interference. It is non-directional antenna, which is consist of two element crossed dipole and crossed reflector with a gain of 8dBi. The dipole-reflector spacing has been optimized for maximum signal combined with nearly horizon to horizon response. It is designed to intercept the small amounts of RF energy.

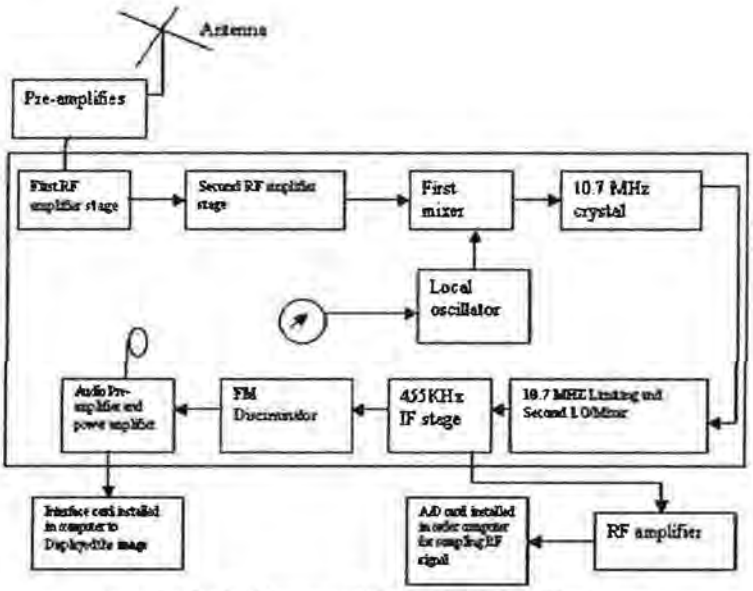

Fig. 1 Block Diagram of Ground Station Hardware

A Pentium-4 2.8GHz computer equipped with receiver and running on Windows XP platform is used. In order to run Timestep software under Window XP platform to do multitasking, the display adapter of the computer must support the direct-draw overlay. In this case, Intel® 82845G Graphic Controllers is used. After switching on the Timestep receiver, it starts scanning. The receiver will stop scanning when it detects the satellite signal. The speaker will indicates this by the sound 'tic-tic'.

2.2 Management Software

Basically, the KUTKM ground station is using PROsat for Windows *i* software provided by Timestep. The software included a satellite-tracking program, which locate the position of the satellite in orbit. The software need to be configured using ground station and satellite information. The ground station information needed is longitude, latitude and altitude of the station. The satellite information needed is Keplerian data, which contain

the information such as satellite name, satellite ID, inclination, mean motion, eccentricity and etc. Keplerian data are available form a number of sources including ASR, AMSAT News Bulletins on PBBS, AMSAT Nets and others. Besides, tow line compact notation elements provided by NASA can also be used for the program. Within this latest information, the program will automatically synchronize to all visible satellite, receive all transmitter information and store all satellite images into local computer.

2.3 NOAA Image Format

The Advanced Very High Resolution Radiometer (AVHRR) provides data for real time transmission to the NOAA local read-out services, termed High Resolution Picture Transmission (HRPT). The primary objective is to provide visible, near infrared and thermal infrared spectral radiation bands [3].

The multi-spectral radiometer of the operational NOAA satellite rotates at two revolutions per second or 120 revolutions per minute. One line of composite image data is transmitted with each revolution of the radiometer, so the basic line rate for these satellites is two lines per second. Each second represents 1000 millisecond (ms) and the basic line of NOAA data is 500-ms long. Each 500-ms line of image data is made up of two different types of image data. There are Infra-red information for the first 250-ms and visible-light data for the second 250-ms. There are a number of other distinctive elements to each line. The signal portion that represents the actual image is assumed to be an 8-step grey scale, running from black at the left to white on the right. Fig. 2 shows the video format for NOAA satellite. Each IR line begins with seven cycles during which the sub-carrier level swings from white to black and vice-verse. These seven transitions occur at the rate of 832 Hz. The pulses appears as a fine series of vertical black and white bars in the sync pulse and can be shown on the display. IR line-sync pulse produces very distinctive 'tic-tic ' sound signal when it has reached full quieting in the station receiver. The visible-light segment immediately follows the IR line sequence. It begins with a seven -pulse sync sequence. These pulses occur at a 1040Hz rate and create a sequence of vertical black-and-white stripes down the leaf edge of the image. These stripes appear slightly narrower than their IR equivalent.

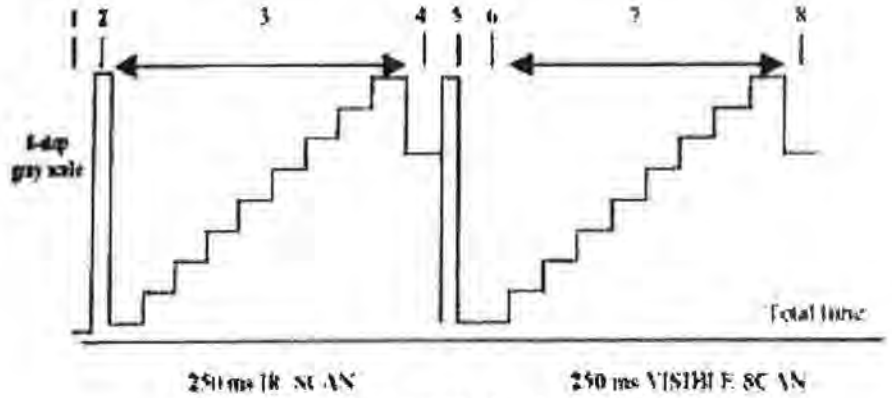

Fig. 2 Video Format for NOAA Satellite

2.4 Weather Satellite Image Server

The main weather server is a computer which is containing a several open sources program such as apache web server, MySQL database server and PHP program. The main weather server will receive weather satellite images from the installed weather satellite station. Weather satellite images will be stored into database server

for further analysis. A PHP program with GD library was used for displaying contents, to any web capable devices such as PC and 3G/GPRS mobile phone.

A method called CGI (Common Gateway Interface) was implemented to support web based weather monitoring system. CGI is a method of running an executable program from a web site to generate dynamic content. Normally, a CGI script is a small program that manipulates data from a web server. It might take the content of a form or insert data into a database. A CGI program can be written in any language that allows it to be executed on the system in real-time. All the CGI scripts in this study were written in PHP. Utilization of CGI allowed weather images information displayed dynamically as requested by users. Fig. 3 shows the block diagram of the weather satellite image server. However, Fig. 4 shows the example of the output.

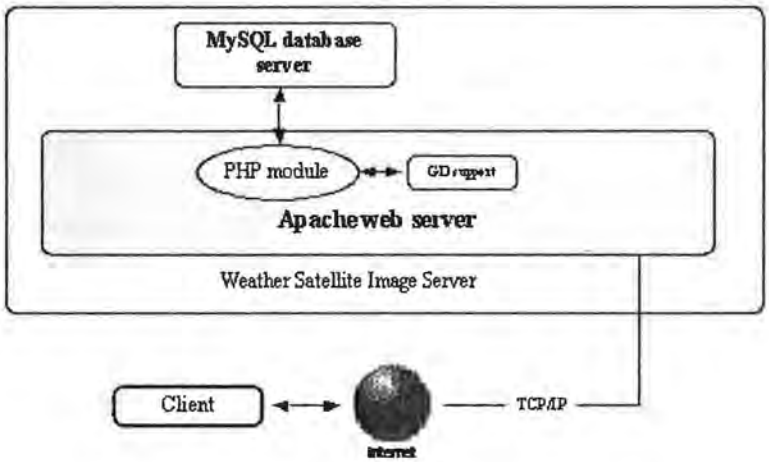

Fig. 3 Block Diagram of the Weather Satellite Image Server

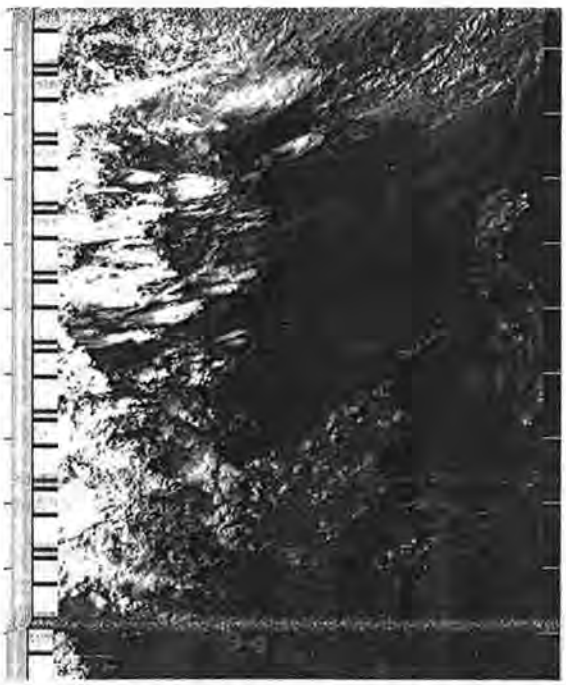

Fig. 4 Output of the Infra-red Mode Satellite Image Which Captured on 27 August 2005

3. CONCLUSION

The weather satellite images received from the satellite have been successfully display on-line. Besides receiving the satellite signals, the server also processes the satellite data automatically with all the CGI scripts which enable all the internet or intranet users to view the image through the homepage. All the satellite data is also stored in a satellite database for further research and analysis. Hopefully, this achievement will be the beginning of the meteorology study in KUTKM.

REFERENCES

[1] NOAA Headquarter Homepage (http://www.noaa.gov).

[2] NOAA satellite information service (NOAASIS). (http://140.90.207.25)

[3] NOAA Satellite Instrument (http://saars.saa.noaa.gov: 8400/instrument documents /avhrr-sensor.html).

ACKNOWLEDGMENT

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