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A REVIEW: WEATHER SATELLITE RECEPTION BY APT DECODING

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Abstract: **Sophisticated low earth orbit satellites (LEO) send us information on the movement of the cloud and on precipitation as well as on the temperature of the land and sea surfaces. These satellites are interesting, because they constantly transmit an image signal which can be easily deciphered. This information is useful for weather prediction and precipitation. The main objective of this work would be to build a cheap ground station to take pictures from these satellites and to provide a harsh weather forecast and precipitation. The SDR software, the V-dipole, QFH Antenna, and other open source software have been used to receive such signals. Analyzing digital satellite communication protocols is an opportunity to explore all layers of signal path, including a physical layer with the phase-modulated signal we obtain, and to correct errors (settlement code to be decoded with the Veterbi algorithm and Reed Solomon block code). A satellite receiver of NOAA (National Ozeanic Atmospheric Administration) satellites to receive the weather signals. This is done through an arrangement consisting of an SDR (Software Defined Radio), an adaptive antenna on the VHF band and web and FTP servers for analysing the obtained images remotely. The SDR maintains connection with the satellite in the specified time period.**

Keywords: ***Weather Satellite Reception, NOAA Satellites.***

I INTRODUCTION

Meteorological studies typically aim to sample an atmospheric volume in three dimensions with the progression of the system under investigation. This objective is achieved through measurements from a number of places and platforms on many scales. Distant space measurements, such as from the weather satellites, are usually used to provide information on the synoptic climate of the system. In situ, the measurement of aeroplane platforms within a defined field of interest may provide more accurate information for a limited period. In addition, ground-based devices can provide high-resolution time series at a small number of places. While the availability of images in real time opens up the possibility of a measuring platform to test an area of interest in time and space, in these field experiments also satellite photos are archived for later studies. A direct reception or the use of an earth-based reception facility and data connections between the ground and an aircraft can provide photographs directly with aircraft research personnel.

1.1 Satellite communication systems

When communication takes place between two Earth stations via a satellite, satellite communication is carried out. As carrier signals, electromagnetic waves are used. These signals provide information between ground and space, such as speech, audio, photographs or any other information. Satellites can be used to communicate from anywhere in the world. We know that communication means the sharing and exchanging of information over a network or canal, that is, the transmission, receipt and processing of data, between two or more individuals. Great, the communication from ground stations via satellite overcomes limitations as satellites are positioned at a certain height above the Earth due to Earth's curvature.

1.2 Technical Background

The satellites are the primary scanning instrument with the Advanced Very High Resolution Radiometer (AVHRR). The device is designed so that five energy channels can be detected from the surface of the Earth. These five channels extend from the visible spectrum, the infrarouge and the infrarouge. Data is transmitted directly from these channels. The transmission takes place in a high speed digital format and is called the high-resolution photo transfer (HRPT). The original data is derived from an analogue Automatic Picture Transmission (APT). This signal is then multiplied to allow only two of the original channels to appear in the APT format. This is accomplished on the satellite by using every third scan line of the digital High-Resolution Picture Transmission (HRPT).A carrier frequency of 137 MHz is used by the broadcast signal in order to perform frequency modulation. A 2.4KHz amplitude modulated sub carrier is used for the transmission of the Automatic Picture Transmission signal on the 137 MHz carrier. The design of the analog APT system is such that it can produce real-time video images that can be received and reproduced by satellite ground station that are of low cost.

1.3 QUADRIFILAR HELIX

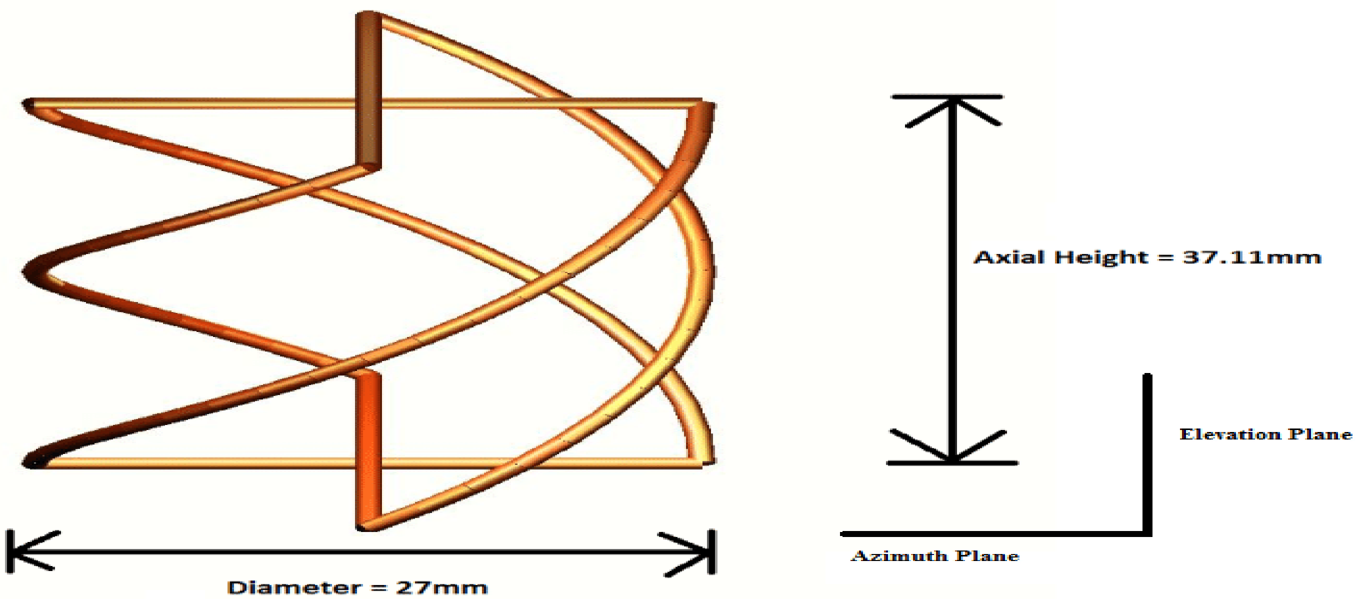

Figure: 1 Quardrifilar Helix Antenna

Several antennas can be designed to achieve adequate APT reception. These antennas are designed to take into account the frequencies, signal intensity and transmission polarity factors. A Quadrifilar Helix Antenna is the antenna used here. It's an all-way antenna. An antenna that radiates an equivalent power radiation in any sense, perpendicular to an axle, with power varying from axis to axe, decaying to zero on an axis. An antenna is an antenna class of the same power. Quadrifilar Helix Antenna (QFH) is the same antenna used for transmitting APT signals on board of NOAA satellites, making it the strong antenna for the reception of NOaA signals. The benefit with the Quadrifilar Helix antenna is that the radiation pattern is much higher than with other APT antennas. The loss of signal intensity in another antennas, such as simple turnstile antennas, also does not affect it. The Quadrifilar Helix is typically made of four helices with a half-turn. They are often split along an ordinary cylinders' circuit. The radiation pattern in the plane perpendicular to its main axis is omnidirectional. Signal radiation is almost circularly polarised in the hemisphere. This makes it ideal to receive signals from weather satellites that orbit polar. Quadrifilar Helix Antennas also have inherent gains between 3dB and 5 dB if they have been engineered well. If the antenna crosses 5-10 degrees above the horizon, the Quadrifilar antenna provides a nearly noise free reception. The rotary antenna has a slightly lower level of efficiency. A self-phasing antenna is the QHA installed. It has a smaller circuit and a greater curvature. Resonant frequency is determined by the measurements of the antenna. The antenna's input impedance is based on the conductor diameter used to form loops. The mast and antenna arms are constructed using PVC pipes. The pipes are used to shape and rigidize the antenna skeleton and to hold the antenna filars in the helical form that they wish to be. The two vertical loops consist of an infinite balun coaxial cable RG 6. To use a single coaxial cable, simply shorten the centre conductor and twist. In the use of the antenna not only proper construction play a major role but also environmental factors.

II LITRATURE REVIEW

Cesar Velasco et al. (2017) The report presents a low cost prototype for acquiring and processing automated image signals (APT) through Polar Orbit satellites to show meteorological imagery in a national Ocean and Atmosphere (NOAA). The toolkit uses GNU Radio to process signals on the basis of SDR technology. The entire framework includes open source tools and software. [1]

M. Mokhtarzade et al. (2008) In this article, a new method of extracting high-resolution satellite images from Quick Bird and IKONOS is presented. Two separate stages for road and road vectorization are part of the proposed methodology. High-resolution IKONOS and Quick-Bird images are used for road detection by neural networks. This article attempts to optimise the functionality of the neural networks with a range of texture parameters. The parameters of these textures have varying window sizes and grey levels, both from source and from preclassified images. The idea of the road map clustering from the earlier road detection stage is based on road vectorization. In this step, a new flexible clustering method for road key points identification is proposed, notwithstanding genetically guided clustering. [2]

Wei Shao et al. (2008) This paper presents an approach that can be adapted to the Viterbi decoder to recondition codes. In the Viterbi decoder any calculations are not able to identify and create the decoded data from the zero hamming distance. The decoder can stop in real time until no error is found in the received code words, or the decoder is set back to fix errors. The power output of the Viterbi decoder therefore amounts to 97 percent, with EB/No as low as 13 dB, which saves considerable capacity. [3]

François Petitjean et al. (2011) In the next few years, satellite image time series will be increasingly available with the introduction of spacious tasks intended to provide Earth with high spatial resolution every few days. Optical images can be used to generate land use and maps containing descriptive names. This time, however, will be unusual for time and time series as compared to various lengths due to meteorological phenomena such as cloud. The article provides an approach to time series analysis in the image, which is able to handle abnormal samples and also allows the time series to be contrasted for each aspect of a pair with a different sample. In theory, we show dynamic time-warping in two real-time applications and demonstrate its functions. [4]

Wassila Leïla et al. (2012) This paper gives a brief overview of LEO weather satellites available (APT). This paper also demonstrates how an advanced terrestrial VHF station for LEO weather satellite APT images is designed and assembled. The basement has the power to automatically monitor selected NOAA satellites through the controlled VHF X-Quad Yagi multi-use antenna. The NOAA satellite receivers receive a 137-MHz FM signal from a wideband Icom receiver and process it using an external USB Sound Card, a dedicated APT/WEFAX programme. The solution proposed would allow economic access to the APT APT data fleet through the NOAA POES solution. [5]

III SOFTWARE DEFINED RADIO

Software Defined Radio(SDR) is a radio communication system, with a software programme used on a personal computer or embedded system to implement components which have traditionally been deployed in the hardware. Cross functionality is limited by traditional hardware-based radio devices. They can be changed only by a physical procedure. As a result, production costs are higher and multiple standards are less flexible. A major point of concern in any receiver is the quality of the signal. The processing of the signal happens entirely in the digital domain. As a result of this the quality of the signal is creditable. The software defined radio is used for observing a wide range of frequencies .It is made more attractive to amateur radio operators by implementing it on a chip making it portable. The SDR used for the implementation of the receiver system is Nooelec mini SDR-2.

IV SYSTEM ARCHITECTURE OF SATELLITE COMMUNICATION

The architecture of satellite communication has three main segments, space, control and Earth segments:

• Space segment consists of one or more satellites that communicating with each other using inter-satellite links and communicate with the Earth using ground stations.

• Control segments receives and monitors satellite signals through telemetry data, and sends control commands to the satellite to make sure that functions.

• The Earth/Ground station segment, either directly or indirectly, links satellites to users and administers the traffic. Either large structures consisting of large antenna systems or small handsets with very small antennas can also be ground stations. The following figure illustrates the architecture of satellite communication and its interface with earth or soil.

4.1 Satellite communication services and frequency allocation

Satellite services vary from the broadcasting of weather data and information to military and intelligence services, depending on the functionality of the space and ground segment configurations. Services are provided on different frequency bands, or allocation, all with different designations so that they can be referred easily. Higher frequency bands mostly give access to greater bandwidth. However, higher frequency bands are also more vulnerable to signal degradation due the absorption of radio signals by atmospheric weather conditions, e.g. rain, ice and snow.

Congestation became a serious problem, in particular with the increased use of satellites for several purposes in lower frequency bands. New technologies for the use of higher bands are instead being investigated due to the congestion. From 0.1 MHz to 1000 GHz is the frequency spectrum. For the satellite communication, the frequency range is higher than 100 MHz. As explained in the following table, frequencies are grouped into different bands:

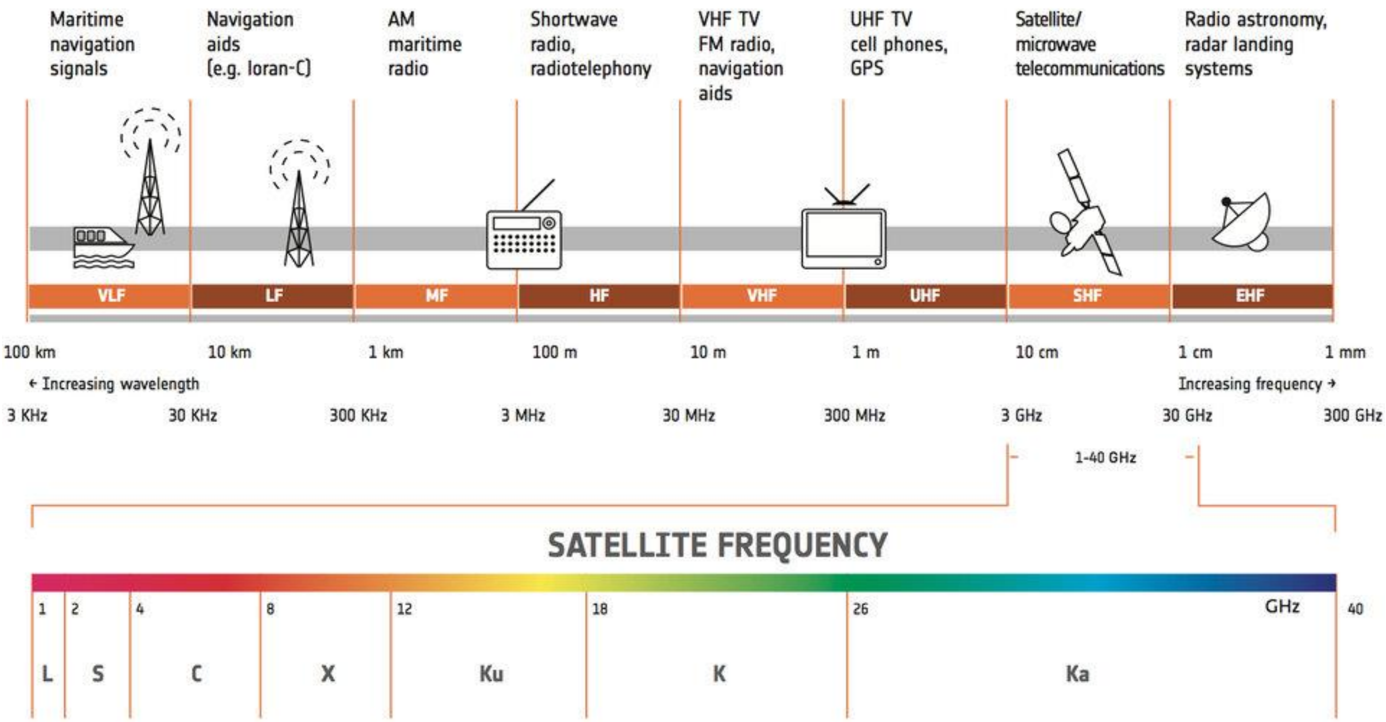

Figure: 2 Satellite communication services and frequency allocation

One of the many benefits that can be reused when using a radio frequency. The capacity of the spectrum can be increased if the assigned frequency band is complete. The gain or the size of the antenna is increased. The capacity can also be increased by reducing the width of the beam, where different beams of the same frequency are geographically directed. Polarization can be used as a reuse method of frequency by transmitting various information to various terrestrial stations, while using the same frequency, by orienting polarisation 90° out of phase.

V NOAA WEATHER SATELLITES

The NOAA was established on December 3, 1970, to combine the functions of various agencies focused on conditions of weather and temperature. the NOAA was established as the scientific authority for various agencies. The NOAA's principal activities are:

Monitoring and observing Earth systems with instruments and data collection networks.

- Understanding and describing Earth systems through research and analysis of data. - Assessing and predicting the changes of these systems over time.

- Engaging, advising, and informing the public and partner organizations with important information.

- Managing resources for the betterment of society, economy and environment.

VI SATELLITE'S SENSORS AND IMAGE FORMAT

In order to understand how the equipment of ground stations receives images from polar orbiting satellites, it is important to understand about the sensors onboard these satellites, and how images are created, formatted, modulated and transmitted from the satellites to ground stations.

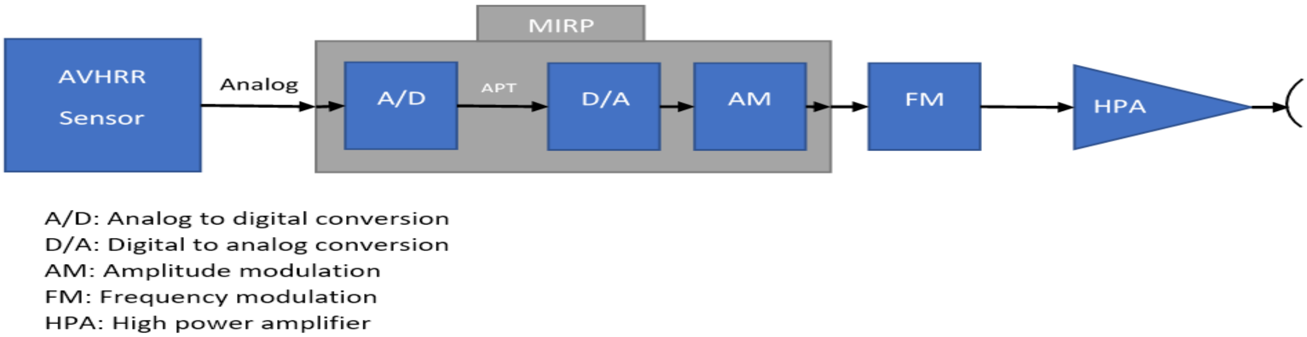

Figure: 3 Satellite transmission chain

A high-resolution radiometer (AVHRR) instrument is the main sensor on board NOAA satellites. AVHRR is the latest in a long line of onboard polar satellite imaging instruments. Morning pictures are used most frequently for land studies, while afternoon pictures are used to study the atmosphere or the sea, because of the different Earth's lighting. Together, they provide global coverage twice a day, ensuring data are not more than six hours old in any region of the Earth. The area on the surface of the Earth that is visible by the satellite is about 2500 km in width. These satellites orbit on an average height of approximately 520 miles (837 km) 34 above the Earth's surface. The highest ground resolution that can be obtained from the current AVHRR instruments is 1.1 km, which means that the satellite records information for areas on the ground that are 1.1 × 1.1 km (size of one pixel) for HRPT and 4×4 km for RPT. The main purpose of these instruments is to monitor clouds and to measure the thermal emission of the Earth. These sensors have proven useful for a number of other applications, including the surveillance of land-surfaces and the state of the oceans.

VII AVHRR/3 CHANNEL CHARACTERISTICS

Channel #	Resolution at Nadir/Pixel	MμSpectral Range-(Wavelength)	Typical uses
1	1.08 km	"0.58-0.68 (visible)"	"Daytime cloud and surface mapping, snow and ice melting"
2	1.08 km	"0.725-1.00 (near-infrared)"	"Land-water boundaries, sea surface temperature, vegetative indexing"
3A	1.08	"1.58-1.64 (near-infrared)"	Snow and ice detection
3B	1.08	"3.55-3.93 (Thermal)"	"Night cloud mapping and sea surface temperature, forest fire monitoring"
4	1.08	"10.30-11.30 (thermal)"	"Sea surface temperature, night cloud mapping, soil moisture."
5	1.08	"11.50-12.50 (Thermal)"	"Sea surface temperature and night cloud mapping."

Table: 1 Table 6 AVHRR/3 channel characteristics

VIII CONCLUSION

In a number of meteorological trials with promising results, an APT satellite imaging system was successfully installed in an aircraft. The antenna is the most critical part of an APT system. Here is the evolution of a "electrically small" low-profile patch antenna, which provides a good compromise between antenna performance and airborne size. The Image to ASK audio & ASK audio to image algorithm implemented uses uncompressed transmission thus is having very low over head & thus is low on processing or memory constraints, & thus can be decoded on low power devices such as mobiles/tablets & portable displays such as GPS Receivers/Photo Frames.

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