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14. Abstract/Notes

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DISSEMINATION OF DIGITAL SATELLITE IMAGERY THROUGH TELEPHONE LINES

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ABSTRACT

The system designed and built at INPE (Instituto de Pesquisas Espaciais), Brazil, makes possible the transmission of digital stationary satellite images from an INPE Master Station at the Cachoeira Paulista plant to several users operating Remote Units. The operation is based upon the use of RAM Memories as buffers to interface the video images with telephone lines. A plan was set up to enable national industry to manufacture and to deliver the Remote Units to other interested institutions in the country.

FOREWORD

This type of equipment, called UAI (Unidade de Armazenamento e Análise de Imagens - Image Storage and Analysis Unit), has been designed originally to monitor digital satellite data received at the new born SMS/GOES (NASA Synchronous Meteorological Satellite) receiving station built in 1978 at INPE - São José dos Campos. The previous method used a scanner driven by a minicomputer that converted and buffered the digital data received to an analog signal feeding on a rotating drum. Photographic processing tended to delay examination of output by more than two hours from reception of data, and the reliability of the process was low.

The UAI stores in real time the satellite high bit rate data received, into random access memories. These memories are constantly read out in a standard TV format for presentation on a TV monitor or video cassette recording. This way, the satellite data can be seen as images building from the top of the screen down, since the instant the station starts receiving.

The old method is still used to produce photographic prints that are further sent to less demanding users.

From the beginning the development tooks two paths. One centered on the improvement of the image processing potential of the machine. The other focused on the capability of transmitting digital memory data through telephone lines to similar machines placed anywhere outside the Institute. The receiving units had to be simple and reliable.

PRINCIPLE OF OPERATION

The system for transmission of digital stationary satellite images relies on a Master Station, called UAI-M, presently at the São José dos Campos plant; and a set of Remote Units, called UAI-R's, operated by each particular user, and connected to the UAI-M through digital grade telephone lines, see Figure 1.

The Master Station can be programmed to record the whole images received (by subsampling to 512 x 512 memory pixels) or a particular area, determined by pixel coordinates over the satellite original images and sampling rate.

The recording starts automatically when the line counter and column counter, in the receiving satellite station, reach particular values for the infrared or visible data selected.

In the case of infrared images, a pre-recording enhancement can be performed over the original 8 bits, 256 gray tones data, to obtain 2 or 4 bits to be recorded.

The 2 bit data classify the whole gray level dynamic range in 4 neighbour intervals of arbitrary lenght. This is useful to precisely distinguish few characteristics of an image, like the transition from ground shades to sea shades and the Cumulus Nimbus tops, for example.

The 4 bit enhanced data are of different type, concentrating 16 gray levels (or colours, at TV time) in a narrow range of the whole 256 gray scale. The minimum range of enhancement spans 16 gray levels. This is used to track frost or sea thermal phenomena, using colours to classify.

With these two types of enhancement, economy is obtained in the use of memory and latter, at the moment of transmission, data streams are shorter.

Up to four images of 512 lines and 512 pixels per line can be stored simultaneously in the UAI-Systems, with 8 bits per pixel, totalling a capacity of 8 Mega bits of RAM storage, represented by 8 memory boards.

A TV interface circuit performs reading of the 512 x 512 video window for presentation on a TV Monitor. Reading accesses the memory video window 30 times per second, to comply with TV standards. This window can be made to jump inside the memory physical area, for purposes of independently choosing the images to be stored upon reception (UAI-R's), to be monitored through the TV (both UAI-M and UAI-R's) or to be transmitted to the remote units.

At the Master Station (UAI-M), an interface with built in microprocessor reads upon command, parallel data from the memory, and assembles it in a serial data stream of 8 or 5 bits synchronous, for transmission.

Line address, user address and memory management information are also inserted in the data stream.

Bit rates can be chosen to be 1200 or 2400 practical, with standard telephone lines. Depending upon bit rates and bits per pixel transmitted, communication time can range from 10 minutes to 30 minutes in the worst case of 8 bits/pixel and 1200 bps for a full 512 x 512 pixel image. For monitoring purposes only, with standard TV at the UAI-R's, 8 bits/pixel are hardly

needed. In those cases, 5 bits are a reasonable choice for 32 gray levels.

Each user shall previously ascertain the type and time for the image to be received, and, since the Master Units are single, an agreement shall be ascertained between users, to the best share of the image source.

Since the satellite is geostationary, transmitting each half hour, and the image types fall within certain cammonly used standards, real time access problems are not expected to occur up to a reasonable number of users. If problems of this type arise, other transmitting units would have to be built.

Once operational, distribution of the images would be made by multidrop, multipoint lines or a combination of the two systems in a more real environment.

Multidrop would be used to serve simultaneous users of the same type of images and placed approximately along the same geographical track; that would be the cheapest solution.

Multipoint would be used in the worst case of dissimilar users.

In Brazil, digital telephone lines are handled by the Transdata service from EMBRATEL. Up to now, the user is charged monthly in a amount related only to distance and bit rate used. At late 1983, a Transdata "package" service is expected to start, that would charge only effective used communication time.

In spite of the digital Transdata lines, that grant up to 9600 bps (3 minutes per image) and comes along with all multiplexing and MODEMs necessary, the use of standard telephone lines has been demonstrated up to 2400 bps, requiring the user to install a MODEM by his own. Standard telephone connections to other towns, is economic, provided total usage per day do not exceed one hour. Beyond that limit, the Transdata service is mandatory (the "package" service would be better in all cases).

Remote Units

A microprocessed interface receives the bit stream in the remote unit and translates it to paralell format for recording on a per memory line basis. A line counter is also decoded from the received data to place it in correct positions inside the memory. This will enable to request for repeated lines in a noisy environment. Another counter localizes the image in one of the four memory quadrants, when the automatic mode is selected. In the manual mode, the user places the new income image at his desire.

Stored images can be put to animation in a loop mode, in the TV screen, in any order. This creates a motion effect, useful for tracking atmospheric phenomena.

At viewing time, the user can select on of four options per colour channel (Red, Green, Blue). Each channel can be switched

off, or, a digital component of the pixel byte can be selected, or the analog image can be displayed, or, a sum of analog and selected bit is shown. This creates colours by the technique known as "bit plane slicing".

All TV images can also be recorded on video-cassette for mass storage purposes.

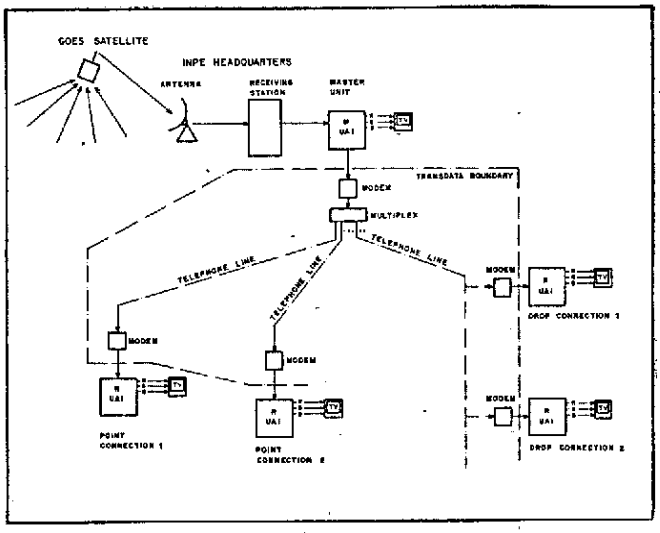

Fig. 1 - Network example for the operational dissemination of digital satellite imagery.

CONCLUSIONS

A system is being implanted in Brazil for the dissemination of digital stationary images obtained at INPE (Instituto de Pesquisas Espaciais) - CNPq.

Presently some tests are being performed between São Paulo headquarters and Rio de Janeiro. This tests indicated that communication with standard telephone lines can carry a bit rate of 2400 bps with no problem to the image quality.

At the near future, Transdata EMBRATEL "package" service will make high bit rates and low cost feasible for the whole country. Also, data compression programs are being developed to alleviate communication fees.

The systems is based on a Master Unit and a backup - installed at the Institute plant of Cachoeira Paulista, transmitting images to a network of Remote Units placed around the country.

Random access memories are used as communication buffers between the high rate satellite reception and the telephone

data rates. Since simultaneous transmission and satellite recording at the Master Unit are possible, real time images are offered to users.

When interfaces for remote sensing data and INPE image processing sistems would be available, a wide interests community would be served.