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Digital picture transmission between Antarctica and India

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Abstract

The communication team of the XVI Antarctic expedition took up the task of establishing the first ever picture transmission link betweeen Antarctica and India over a band-limited telephone channel. The link was set up between the MAITRI Station and the Prime Minister's residence at New Delhi on 26''' January 1997 when inaugural pictures of the installation of the bust of Mahatma Gandhi at the Indian Antarctic Station MAITRI were transmitted in near real-time to the Prime Minister in India.

This paper describes the techniques and the steps involved in engineering the picture transmission link using a portable INMARSAT satellite terminal. The authors also highlight the problems and limitations associated in working at the fringe areas of INMARSAT footprint.

Introduction

Rapid advancements in satellite technology have made it possible to provide reliable and effective communication under stressed conditions from a remote place like Antarctica. The geographical location of the MAITRI station near the South Pole makes it difficult to fully exploit satellites in equatorial orbits for communication purposes. The INMARSAT satellite, whose designated footprint spans upto 70 South latitude is the only path for providing long-distance telephone circuits from Antarctica. Traditionally, the INMARSAT portable terminal at Antarctica has been used to handle voice traffic alongwith E-mail applications. However, in recent times, the availability of faster desktop PCs along with improvements in video compression techniques have made it possible to transmit pictures over existing band-limited telephone circuits.

Objectives

Introduction of picture transmission and multimedia services between a remote location like Antarctica and mainland India is a very important step in minimising the isolation and psychological breakdowns experienced during peak polar winters. The utility of services include

Experts in mainland India can carry out damage assessment due to structural collapse if high-resolution images can be transferred quickly form

MAITRI to India over this link.

Medical advice sought from India during an emergency can be supplemented by pictures of damaged body parts, X- ray plates, etc.

Regular exchange of photogrphs and video clips of the activites at MAITRI with families of the expedition members can help reducing the isolation and minimise psychological breakdown. Initially, it was planned to test the link in near real-time mode. The link was proposed to be set-up between the MAITRI station and the Prime Minister's residence at New Delhi on 26th January 1997 when inaugural pictures of the installation ceremony of the bust of Mahatma Gandhi at MAITRI would be sent in near real-time to New Delhi. In the later stages, pictures could be exchanged regularly over E-mail in off-line mode.

Experimental set-up

Since a semi-static INMARSAT terminal was already operational at MAITRI, connectivity options for near real-time transmission were listed as follwos.

Semi-static INMARSAT terminal at MAITRI to fixed land-line telephone at N.Delhi

- Semi-static INMARSAT terminal at MAITRI to portable INMARSAT terminal at New Delhi.

In both cases, the call routing takes place through the INMARSAT Coastal Earth Station (CES) at Arvi near Pune. However, preliminary link trials indicated that connecting through a land-line involved signal flow though multiple switching centers thereby reducing the link avilability and reliability. It was therefore decided to use mobile INMARSAT terminal at New Delhi end to ensure reliable data transfer. The complete set-up is shown in Fig-1

The process of picture transmission can be split into three stages.

- Digitisation
- Encoding and compression

Transmission and reception

Digitisation

To capture a scene, a colour CCD camera was interfaced to a PC using a digitiser card plugged into the PC motherboard. The PAL compatible analog video signal was digitised and stored in a frame buffer. The digitised picture could be viewed in the PC at a preview rate of 6 frames per second. At suitable instants, frames were freezed in 320x200 or 640x480 high resolution mode and converted to binary files. Alternatively, a slow-scan video in 256x200 resolution mode could be captured continuously over an extended time period.

Encoding and compression

Having captured a picture frame or a motion video clip, the frame buffer contents are stored in the hard disk in the form of a binary file using the standard JPEG format. Though the image can be stored in various standard file formats such as PCX, JPEG,BMP,TIFF, etc., JPEG format was preferred to ensure that the file size is minimal. The compression index was varied such that there was no perceptible loss of image quality while simultaniously reducing transmission time.

Transmission and Reception

Transmission control is very vital to effectively transfer data between Antarctica and India. End-to-end connectivity between the computers installed at the MAITRI station and the Prime minister's residence, New Delhi was accomplished using line modems connected to the PC using a standard serial port. The modern output was interfaced in asynchronous mode to the INMARSAT mobile terminal providing access to the coastal earth station at Arvi, Pune for further connectivity to the satellite terminal at New Delhi via the Indian Ocean Region Saatellite (IOR),

Standard terminal emulation software along with KERMIT ' sliding window' protocol was used to transfer binary picture files. This packet based transmission protocol using 'go back n' scheme ensures that the digital picture is transferred without a single error. Link speeds of 2400 baud was the best we could achieve under favourable path profile conditions. Software based post reception processing for image enhancement, though not essential, were also tried out. This feature is particularly useful in case of images such as weather charts where edge enhancements and contrast/brightness control algorithms can be meaningfully applied.

Results and discussion

Preliminary link trials were carried out regularly during different times of the day to access the satelite signal fading problems. Though the precise geographical location of the MAITRI station is 70° 45' South 11° 44' East, satellite coverage is optimal only upto 70° South latitude. It was observed, that though in the fringe area, fading was occasionally bursty in nature, reliable connection could be established for packet based data transmission. Also, long term fading effects were found to persist for 3-4 hours starting from 1100 UTC.

On 26'" January 1997, the link was successfully established with the remote computer connected to the satellite terminal installed at PM's residence at New Delhi. Four colour pictures of the inauguration ceremony and MAITRI surroundings were transmitted in near real-time. A digitised video clip of the unveiling ceremony was also transmitted. Simultaneously, the PM addressed the members of MAITRI over a voice channel much to the delight of everybody. The received pictures are shown in Fig. 2 - 5 .

Though the link is being used regularly in off-line mode, it is felt further enhancements should be carried out keeping in trend with the world scenario. It is suggested that a High-Speed Full Duplex 64 kbps option with INMARSAT terminals should be installed at Antarctica. However, the required Effective Isotropic Radiated Power (EIRP) for sustaining high data rate needs to be practically validated in the fringe area operation.

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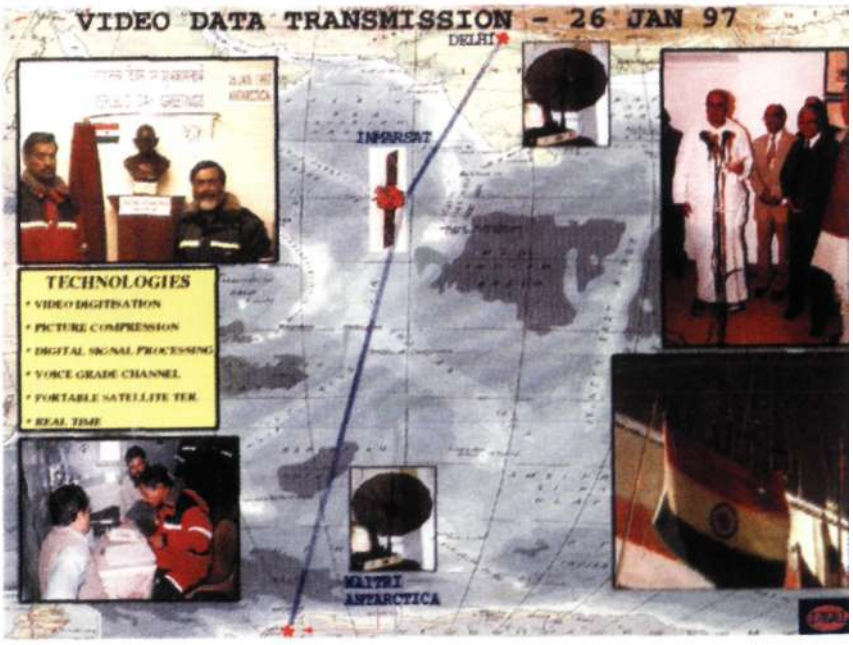
Figure Captions

Fig. 2 : Inaugural picture of the installation of the bust of Mahatma Gandhi sent from MAITRI to New Delhi. The picture with a resolution of 320 x 200 in 256 colors was compressed using JPEG standard.

Fig. 3 : Hon. Prime Minister Shri HD Deve Gowda releasing the received picture to the press.

Fig. 4: Expedition members with the bust of Mahatma Gandhi inside the MAITRI Station.

Fig. 5 : View of the INMARSAT Terminal radome on the roof of MAITRI Station.



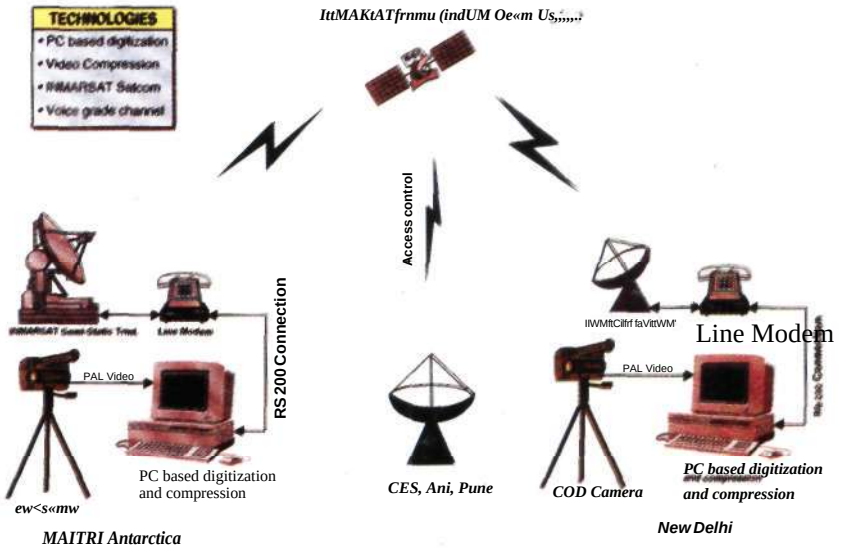


Fig. 1 :Set up of the picture transmission link.

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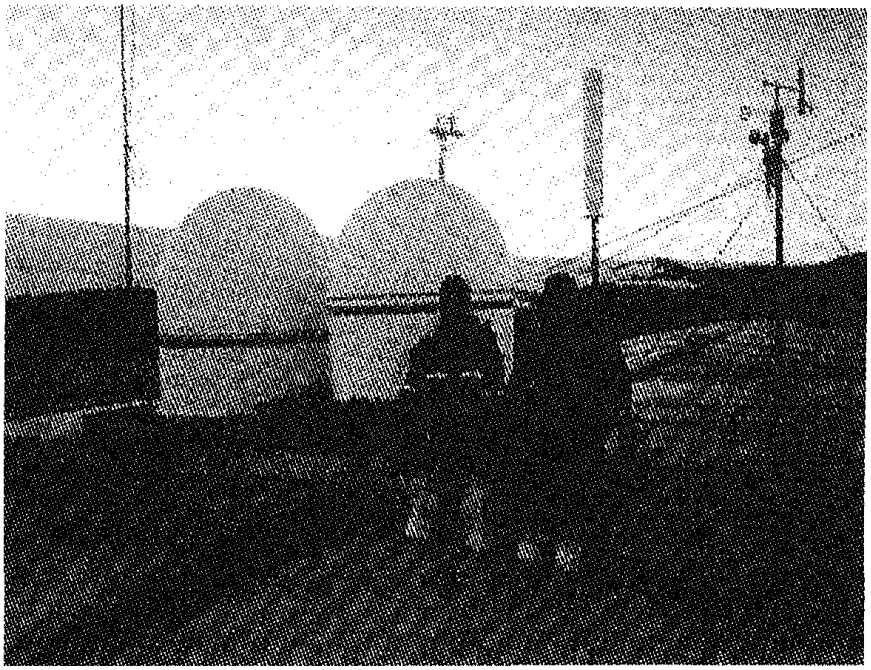

Fig. 5: View of the INMARSAT Terminal radome on the roof of MAITRI Station