India entered into the field of space research with the setting up of the Indian National Committee for Space Research in 1962. Later this grew into the Indian Space Research Organisation (ISRO). The objective was to develop space technology for the welfare of the common man.

Dr. Vikram Sarabhai said in 1969 that India did not want to compete with the developed countries but it should be second to none in the application of space technology to the real problems of the citizens of the country. Today, we have become a force to reckon with among the space-faring nations of the world. But more than that, Sarabhai’s vision has also come true with space technology, especially satellite communication technology, being widely used in education, health care, disaster management, communication, etc. benefiting every strata of society.

Let’s take a look at some of these societal applications of satellite technology especially with regard to communication satellites.

Tele Education
Providing education to people in distant locations in the country can be traced back to the year 1975-76 when 2400 villages in six states were provided educational information regarding health, family welfare, hygiene and farming via satellite. During those years, when many cities did not even have television coverage, people in these 2400 villages could watch TV!

The programmes were transmitted from Ahmedabad and Delhi using ATS-6 (Applications Technology Satellite-6) and were received in the villages using a 12 feet chicken mesh antenna mounted with front-end converter whose output was given to a tail-end converter located in a room. The entire setup was installed in the panchayat board office or in a community hall from where local people could watch the programme. The programmes were one-way and there was no interaction.

Along with necessary educational tips, entertainment programmes were also mixed so that people did not get...
bored. This project was known as the Satellite Instructional Television Experiment (SITE) and was conducted for one year. It was a huge success and social research surveys showed that the project made a good impact among the people with regard to health, hygiene and family welfare. The Govt. of India, therefore, sanctioned the INSAT programme.

After the launch of INSAT satellites a separate channel known as Technology Development Communication Channel (TDCC) was conceived for distant education programmes. In the early 90s, digital TV broadcast was not very popular. Analogue TV transmission was used.

A small studio was set up in a classroom from where expert teachers gave lectures. This was transmitted to the satellite. In distant classrooms approximately 4-metre-diameter antennas were installed to watch the programme on the TV. There was an interactive session during which the students could ask questions using a telephone line. The questions as well as the answers were fed into the TV audio so that students at all distant locations could listen to them. This was a one-way video and two-way audio interactive programme. It was also called the talk-back experiment.

It was widely used by the All India Management Association (AIMA). The studio at IGNOU Delhi was used for the teaching-end and programmes were transmitted to the satellite from a transportable terminal parked at IGNOU. The centres located at different parts of India received the programme.
and interaction was through telephone lines from distant locations. Later, digital transmission was used. Because of digital modulation, a smaller diameter antenna was used (1.2 metre) in the remote classrooms. A normal set-top box was used in the classroom. Students from remote classrooms interacted with teachers via telephone.

This was used by the Rehabilitation Council of India for training differently abled persons. Transmission was done from RCI-New Delhi and the classrooms were at different locations of RCI throughout India. It was also used by the Rehabilitation Council of India for training differently abled persons. Transmission was done from RCI-New Delhi and the classrooms were at different locations of RCI throughout India. It was also

**NAVIGATING & POSITIONING**

**GPS Aided GEO Augmented Navigation (GAGAN):** Satellite Based Augmentation System (SBAS) implemented by ISRO jointly with the Airports Authority of India (AAI). GAGAN will provide satellite-based navigation services with accuracy and integrity required for civil aviation applications and to provide better Air Traffic Management over the Indian airspace. The system will be interoperable with other international systems and provide seamless navigation across regional boundaries. The GAGAN Signal-In-Space (SIS) is available through GSAT-8 and GSAT-10.

**Indian Regional Navigation Satellite System (IRNSS):** Also known as NavIC, this is an independent Indian satellite-based positioning system for critical national applications. The main objective is to provide Reliable Position, Navigation and Timing services over India and its neighbourhood, to provide fairly good accuracy to the user. The IRNSS will provide two types of services:

- Standard Positioning Service (SPS)
- Restricted Service (RS)

The space segment consists of seven satellites – three satellites in geostationary orbit and four satellites in geosynchronous orbit. This constellation of seven satellites was named as “NavIC” (Navigation Indian Constellation) by the Honourable Prime Minister of India, Mr. Narendra Modi and dedicated to the Nation on the occasion of successful launch of IRNSS-1G, the seventh and last satellite of NavIC.

All the seven satellites of NavIC, namely, IRNSS-1A, 1B, 1C, 1D, 1E, 1F and 1G have been successfully launched and are functioning satisfactorily from their designated orbital positions.

And now, a NAVIC-based mobile application strives to ensure the safety of Indian fishermen and prevent them from straying into international waters. The application to be developed in regional languages would give information on international boundaries to prevent fishermen getting caught for crossing international boundaries.
used by Anna University for delivering lectures in engineering subjects.

With the success of the above programmes, a satellite dedicated for educational service, named Edusat, was launched in 2004 which led to a revolution in the utilization of Satcom network for providing curriculum-based education. With advancement of digital transmission and VSAT technology, IP based communication network was used for distant learning programme. In VSAT technology, the teaching end transmits the video programme to the satellite in TDM channel. This teaching end is called the hub, which also has the learning management software/server and network management system.

The distant classrooms were equipped with a smaller antenna and RF electronics and modems for transmitting and receiving. The classrooms could log on to the teaching end and register for interactive sessions. They can raise a “virtual hand” by clicking an icon on their computer to request permission to interact. The teacher at the teaching end selects the classroom and the students can interact with the teacher and ask questions. Thus, two way audio and video interactions are possible.

The students in the distant classrooms can also send email and chat with the teaching end. The terminals at the classrooms where such interactive facility exists are called Satellite Interactive Terminals (SIT). Some class rooms can only listen and cannot interact and the terminals at such classrooms are called Receive Only Terminal and their antenna size is still smaller.

This type of technology is used widely for conducting educational programmes. Anna University, IGNOU, Centre for Education Consortium, and Vigyan Prasar are some of the users of this technology apart from many universities.

Thus, an expert professor’s lecture can be heard by many students sitting at remote places; they can even interact with the professor to clear their doubts. The teacher can give lectures, make power point presentations, make projections using visual presenter and send notes by mail.

**Telemedicine**

Another societal application of satellite technology is telemedicine. Most specialist doctors practice in urban or semi-urban areas whereas small towns and villages lack expert medical practitioners. The telemedicine programme bridges this gap.

The telemedicine system consists of patient end nodes, doctor end nodes, servers and VSAT-based
ENSURING WATER SECURITY

Over the years, spatial analysis of temporal satellite data has been facilitating the performance evaluation of irrigation commands, reservoir capacity surveys, assessing gaps in potential irrigation and utilization, etc.

While studies of water supplies for irrigation in command areas has helped in performance evaluation in terms of cropping pattern, cropping intensity and the efficiency of water-use in the command areas, high-resolution satellite data has also been utilized to map the irrigation infrastructure in the command area and monitor its progress.

Similarly, mapping and monitoring of thousands of surface water bodies has been carried out using an automatic feature extraction tool from satellite remote sensing data. Water reservoirs are fast losing their storage capacity due to higher rate of siltation than their designed value. Satellite data has been used to aid the reservoir capacity survey of 124 reservoirs for the Central Water Commission.

Satellite data is also used to identify potential ground water sources and recharge sites in the country. Recognizing the need for judicious planning of water conservation, and its distribution, another spin-off based from the Indian space programme is the “Web Enabled Water Resources Information System (India-WRIS)”, which is a ‘Single Window’ solution for comprehensive data on India’s water resources along with other natural resources information in a GIS framework.

communication system. IP-based video conferencing can be established between remote hospitals and super speciality hospitals. While the patient is sitting in a remote hospital, her or his diagnostic information like ECG, ultrasound, echo are acquired and transmitted along with demographic data to the doctor sitting in the speciality hospital. The specialist doctor then suggests the line of treatment.

The doctor and patient can interact through video conferencing also. A server is also located at the speciality hospital which stores all the information about the patient including his past illness, the treatment undertaken, his previous visits and medical images. When the specialist is giving tele consultation, the patient information is accessed through the server.

The patient end equipment generally consists of a computer, video conferencing camera, X-Ray digitizer, ECG machine, TV monitor and furniture for keeping these. This is interfaced with a VSAT modem. The
VSAT terminal consists of antenna, power amplifier, low noise block converter, etc. along with an adequate capacity UPS.

The doctor’s end also consists of video conferencing equipment, TV monitor and VSAT electronics and UPS. Mobile telemedicine vans are also available which can be taken to any remote village where permanent telemedicine setup is not there. Once the van is positioned at a particular location, the antenna mounted on the top of the vehicle can be oriented towards the satellite position and connectivity can be established.

The telemedicine network has enabled many poor rural villagers hitherto denied high quality medical services to get the best of medical services available in the country. Many hospitals like Ganga Ram Hospital, Apollo Hospital, Arvind Eye Hospital, etc. use the telemedicine network.

Disaster Warning System
Natural disasters like cyclones, floods and earthquakes cause huge loss of property and life. The occurrence of disasters cannot be prevented but the losses can be minimised by the use of technology. They can be predicted and early warnings can be issued so that the concerned officials take preventive measures to reduce human losses. Rescue and relief operations can be speeded up by the use of technology.

Satellites provide images of weather, cyclone, sea surface and cloud top temperatures using VHRR instruments operating in visible and infra red regions. Data collection platforms located at various places send data about temperature, humidity, wind speed, etc. to the satellites. The automatic weather stations located at various stations also send weather data to the satellites. These are transmitted back from satellite to the ground station. These data are analyzed by the meteorological department along with cloud pictures. After analysis the meteorological department issues weather bulletins.

The position and intensity of cyclonic storms is watched continuously and the direction in which the cyclonic storm moves is also watched continuously and sent to the cyclone warning centres. Information about the cyclone, areas likely to be affected, time of reaching the coast, etc. are prepared at the area cyclone warning centres. These centres transmit information to the satellite.

Receiving terminals are located at various places along the coastal areas that are cyclone prone. Each receiving terminal will have an ID number so that they can be selectively addressed. In the transmit station at the cyclone warning centres, a PC generates a warning message, normally a siren, followed by a message in local language. This audio signal is encoded in MPEG-2 format and station IDs are added and transmitted to the satellite.

The receive terminals receive the signal from the satellite and after demodulation, if the station ID matches with their IDs the receiver outputs the siren and warning messages. The receivers can be addressed individually or in groups.

The receivers consist of a small antenna, receive equipment and UPS. Since there may not be power supply during a cyclone the receive equipment is provided with a UPS that can work for 48 hours.

A DTH-based disaster warning system can give warning to every individual household having a specially designed set-top box. In this system a VSAT is installed at the DTH transmission station. This also has a Network Management System (NMS) which contains a database of all DTH receivers in the network along with their unique identification numbers and locations. It also contains stored files of warning messages in different languages.

The receivers are specially modified set-top boxes. Thus warning messages can be sent to any receiver or to a group of receivers. These DTH receivers are generally at the Relief Commissioner’s office and once the warning messages are received necessary precautionary measures can be taken.
Relief and Rescue Systems

Once a disaster like a cyclone or earthquake or flood occurs, the communication link is affected and even mobile towers are affected and hence no landline or mobile network is available. The entire site becomes cut off from the rest of the world. Even for assessing the damage, requirement of necessary relief materials like food, medicine etc. communication link is required.

Satellite communication is the only viability in such circumstances. Vehicle-mounted terminals can be immediately sent to the affected places by road or container-based terminals can be airlifted. These terminals have 1.8 m diameter antenna transmit and receive equipments and IP-based modems. A petrol generator supplies the necessary power.

Once the terminal reaches the affected location, the antenna can be installed and other equipments can be commissioned within one hour. Similar systems can be stationed at the Relief Commissioner’s place and communication can be established between the affected location and the relief commissioner’s office via VSAT hub.

Voice communication and video conferencing and data transfers are also possible. Satellite Interactive Terminal of Edusat network can also be taken to the affected area and another similar one can be kept at the Relief Commissioner’s office. This will be the only communication mode till other communication channels are restored.

Many private TV channels take their Satellite News Gathering Terminal to the affected area and immediately transmit live details of the situation at the affected location. These terminals are nothing but transmit and receive equipments along with antenna mounted on a vehicle.

Satellite phones provide immediate communication link from the disaster-affected locations. Satellite phones directly transmit to the satellite and the signal is received at the hub station. Calls can be made from the satellite phone to any landline number. From the landline the signal will go to the hub station for transmission to the satellite and is received by the satellite phone.

Satellites can also save the lives of fishermen. Distress alert terminals are used by fishermen. In case of any emergency, they can press a button and a signal is transmitted to the satellite along with the terminal’s position. This is received by the earth station and by knowing the terminal number and the position coast guards are alerted about the location of the trapped fishermen. This unit is light weight and portable and carried by the fishermen when they go out into the deep sea.

Satellite technology is not a luxury for India but is essential for human benefit and empowerment.

Mr R. Gopalakrishnan retired from ISRO, Delhi Earth Station, New Delhi after putting 38 years of service. He has vast experience in the field of Satellite Communication. Address: B-1/141, Kendriya Vihar, Velappanchavadi, Chennai-600077.