Archaeology Goes Hi-Tech

By T V Padma

IN a reversal of tracks, the present is trying to catch up with the past, with satellites and computers lending a helping hand to shovels to help archaeology go hi-tech.

Digging nowadays begins and ends with electronics and computers which have become a routine part of all excavations in some western countries.

Archaeologists are resorting to electronic surveying and metal detecting before digging begins, and computer-aided design and three-dimensional animation programmes to reconstruct the image of the site when digging ends.

Low-altitude aerial photography is already a powerful tool for modern scientific archaeology and there is growing interest in the possible use of satellite imagery for archaeological research.

Aerial photography helps detect structures that have been lost over time and exist now as "hidden landscapes", according to a report in the journal "Spaceflight". Such structures include shadows and land and crop covers of varying sizes.

Conventional archaeological remote sensing is done from light aircraft at about 750-1000 metres above ground level. These aircraft mainly use passive sensors, though some also use active microwave sensors.

The passive sensors comprise oblique or vertical cameras using black and white, colour or colour-infrared films. Other systems in use include multispectral systems and infrared scanner imaging systems.

The active remote sensing systems include a synthetic aperture radar (SAR) system which was originally used to image the surface of Venus.

Such a system has already been used successfully to penetrate dense jungle canopies in Belize and Guatemala and obtain images of agricultural patterns that gave new insights into the Mayan civilisation.

Grid-like patterns thought to be ancient Maya canals were found by archaeologists studying radar photographs of rain forests in Guatemala's central lowland. Ground explorations later confirmed that the lattice-like lines revealed by the radar are remnants of irrigation canals dug by the Mayas between 250 BC and 900 AD.

Several satellite remote sensing systems, such as the LANDSAT, SIR and SPOT series, are of considerable potential use to archaeologists. They are equipped with passive or active sensors that can operate both during day and night and are unaffected by weather conditions. Some active sensors can also penetrate the earth surface, giving data on structures below the ground surface.

Of the various satellites, LANDSAT has been used most extensively for archaeological purposes, owing to its relatively low ground resolution. It has been used to identify areas of potential archaeological interest, including the San Juan Basin in New Mexico, and Alaska.

LANDSAT imagery has also helped trace ancient water courses in the alluvial plain between the Tigris and the Euphrates rivers, which formed part of what was once Mesopotamia. Many months of ground survey confirmed the findings of the satellite data.

LANDSAT-1 imagery has been used in Egypt to delineate land features and large geological structures of archaeological importance dating to pre-historic or historic times. These structures include the early Eocene limestones near Thebes, where the underground tombs of the Pharaos were cut, and the Middle Eocene limestones of the Pyramids Plateau which provided the foundations and cores of the great pyramids.

LANDSAT-2 imagery has been used in Greece in an attempt to determine the spatial organisation of ancient occupation sites in the lower Enipeus valley.

One of the most exciting success stories in recent times in this field is the use of active sensors from the Shuttle Imaging Radar (SIR) systems covering the east Sahara Desert which demonstrated the existence of riverine channels and alluvial deposits lying under desert sand.

Field work in the area produced pre-historic handaxes and other artefacts such as hearths and milling stones along the now-buried banks of what were once major rivers.

The archaeological finds show that water flowed along these river banks 100,000 to 200,000 years ago and have helped scientists recreate a river system that existed for at least 20 million years in the African continent.

Plans are also afoot to use high-resolution imagery from SPOT to study Roman and pre-Roman roadways in Burgundy.

Archaeology recently took another stride forward in the hi-tech arena with the use of a unique Gridpad computer which can be, in the simplest terms, described as an electronic clipboard.

The Gridpad computer is a hand-held computer without a keyboard. Instead it uses a brass stylus to enter data, text or sketches simply by writing on the screen. It recognises handwriting and can store drawings and signatures as bitmaps in its 1 Mbyte memory, according to a report in Electronics World + Wireless World.

A waterproof and fairly rugged machine that manages to survive even after being dropped the Gridpad has a nine-pin serial port which can collect data automatically from electronic instruments.

Its manufacturers believe it could be used to collect data from theodolites, optical instruments consisting of a sighting telescope that can rotate freely on both horizontal and vertical axes and a graduated scale that measures the angle of rotation.

Theodolites are used extensively to measure distances of test points. Nowadays some projects use electronic distance measurers (EDMs), and a few use electronic theodolites.

Simple hand-held computers that cost only 80 dollars and can be used as programmable calculators which calculate 3D coordinates and store them once the raw data is fed in, are beginning to represent the first stage of automation of theodolites.

The next step is software programme for the Gridpad which plots a map on its screen as the raw data is collected and not just the coordinates. It is much easier to spot mistakes on the map than from a set of coordinates — and spotting mistakes is vital as you can dig only once, and once you have dug, there is no scope for rectifying any mistakes.

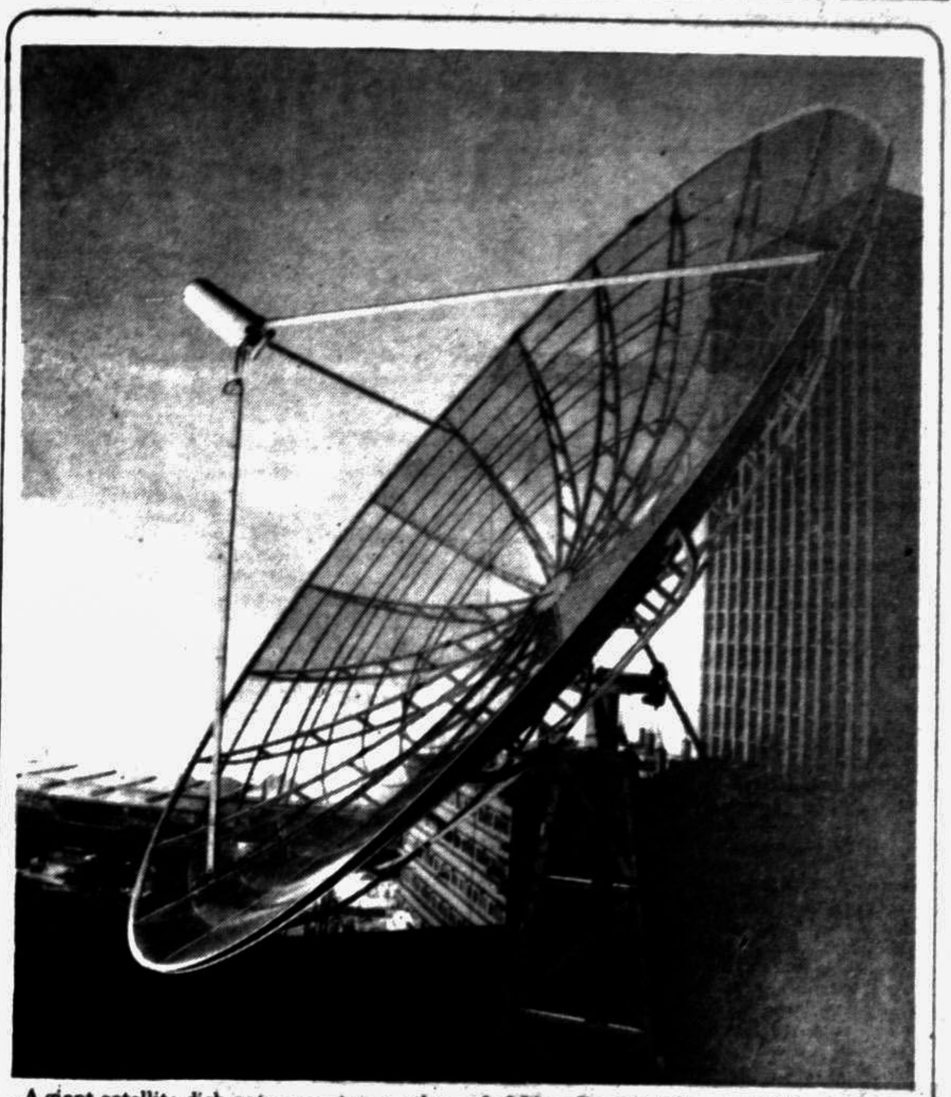
Another useful aspect of automation relates to recording the finds. Usually, archaeologists only record the layer of earth from where the bulk finds have been made and put the finds in a marked plastic bag for cleaning and cataloguing.

Gridpad can mark the position of a find directly on the map plotted on the screen, write its description and then store the information in the file.

So far, the Gridpad is being tested in Israel and Gloucester. In Israel archaeologist are working on a large and complex excavation site that is 200m by 600m. The site belongs to he Iron Age, with a palace which is mentioned in the Bible, and a chalocolithic village. Gridpad helped the team survey the site in just three days instead of the months that it would have normally taken.

In Gloucester, Gridpad came to the rescue of archaeologists surveying a portion of the countryside, who armed with this hi-tech device did not have to wander all over the fields with tape measure.

— PTI.



A giant satellite dish antenna set up on the roof of Jiban Bima building at Motijheel. The antenna links USIS-American Centre with Worldnet, first international TV network.
Photo: Dr. Shahidul Alam.

Indian Floptical Disks to Hit World Market

By C Chitti Pantulu

INDIAN scientists hope to roll out soon an indigenous magneto-optic (MO), disk for mass data storage which will give the country a competitive edge over foreign companies out to tap a burgeoning world market.

Successful labouratory tests at the Centre for Development of Telematics (C-DoT) show that such a disk, which threatens to render conventional floppies and hard disks redundant, can be manufactured in the country within two years enabling India to compete for worldwide sales projected to cross six billion dollars by 1995.

The magnetic storage media, namely, floppies, tapes and hard disks, have been the most popular devices so far, particularly in the case of personal computers.

However, developments based on optical technology, like compact disks (CD-ROM), write once; read many time (WORM) devices, digital paper and the MO disk, promise to revolutionise data storage. Of these, the MO disk appears to be the best bet at the moment considering its erasability and ruggedness. Apart from this, the disk is the only rewritable device, with the other three being 'read-only' media.

This technology has attained considerable popularity with several research centres in USA, Japan and Europe trying to develop a cheap MO disk for the past several years now. However, problems like access time and stability of the media have been some of the stumbling blocks in this direction. It is in this respect that Indian scientists appear to have achieved some success.

Work on the project started in February 1989 after formal approval by the Department of Science and Technology (DST), for funding with C-DoT as the host organisation and institutions like the Tata Institute of Fundamental Research, Bombay, Indian Association for Cultivation of Science, Calcutta, Indian Institute of Technology, New Delhi and Solid State Physics Laboratory, New Delhi as participating institutions.

The MO disk, also called the floptical disk, like all optical storage devices uses lasers which are the only light source capable of producing focussed dots of sufficient smallness and uniformity to read and write information with sufficient density to make the whole exercise economical.

Th floptical disk makes use of two characteristics peculiar to magnetic materials, in the present case Terbium-Iron-Cobalt (Tb-Fe-Co). The first, known as the Curie-Weisse effect, is that they lose their magnetic organisation (and thus their magnetism), above a certain temperature called the Curie point. The second is that light changes its polarisation when it passes through a magnetic field.

Recording and erasure in the MO disk is achieved by laser induced local heating of the media which results in the formation or annihilation of small magnetic domains. Readout is by detection of variations in the state of polarisation of light upon reflection from the surface of these spots.

As a consequence, writing on to a floptical disk takes two stages. First, an entire area of the disk, a sector usually, is heated by the laser and allowed to cool in a constant magnetic field. As it cools, the area picks up the constant magnetism and becomes set at zero.

The magnetic field is then switched and the laser selectively heats the bits corresponding to the one of the data to be written. As these cool they have the opposite magnetic orientation.

To read the data, a lower power laser beam is focussed at the backing plate and the changes in its polarisation, while being reflected back, are decoded into a stream of electrical pulses corresponding to the binary language understandable by the computer.

Thin films of amorphous rare earth transition metal (RE-TE) alloy are used as the recording medium on MO disks. It has been observed that within a certain range the RE-TE composition, when prepared under certain conditions, exhibits magneto-optic qualities. The advantage of using amorphous materials is that they are free from grains and crystalline materials resulting in lower noise in read-back signals.

These magneto-optic films are being deposited on special corning glass substrates which are treated with ultra violet light before being sputtered in an argon atmosphere. Four layers of different amorphous films are deposited onto the substrate to give the disk the required characteristics.

The most important is the media Tb-Fe-Co, which is somewhat translucent to laser light and is also magnetic. It is the media which stores information in much the same way as an ordinary floppy. The next layer, beneath the media, is the reflecting layer which is either aluminium or gold film. This contains no information and exists only to bounce back laser beams out of the disk. The other two layers are of either silicon dioxide or aluminium nitride, to separate the media from the reflective layer and to give a protective covering on the surface of the disk.

SCIENCE BRIEFS

SAFE HANDLING OF OILY MATERIALS

A new product that absorbs and holds oil spilled on a shop or factory floor is now available from Petro Free Int., a company based in Chicago in the United States, reports the American Ceramic Society Bulletin.

The product is a granular solid called Petro Free that could find use in manufacturing plants and other areas where accumulation of oily materials is a problem or a safety hazard, the journal reports.

After is absorbs oils, Petro Free is dry to the touch and it can be vacuumed or swept away. Another product developed by PFI absorbs and holds oil floating on water. In water, Petro Free removes 98 per cent of the oil from the surface before sinking.

PFI has also developed a prototype recovery vessel to collect the oil-laden material and plans to market the vessel this year. Petro Free was developed with help from the US Argonne National Laboratory's Technology Commercialisation Centre.

OPTICAL FIBRES FROM GLASS-POLYMER COMPOSITES

Researchers at the Centre for Research in Electro-Optics and Lasers at the University of Central Florida in the United States have produced all-solid-state Christiansen filters which potentially can function as optical switches in addition to being filters, reports the American Ceramic Society Bulletin.

The new optical filters were produced with a variety of glass in the SK series from Schott Optical Glass Inc. In styrene, polystyrene, and styrene-acrylo-nitrile matrix, the journal said.

The researchers fabricated these filters by photo-polymerisation from the liquid phase, thermosetting or casting, and injection molding, with the most success coming from the injection-molding method.

These composites can be tailored to produce devices like lenses, prisms, gratings IR filters, sensors and fast optical switches. Research has until now only been restricted to glass particles greater than 50 micrometres, however particles with sizes comparable to the wavelength of light will show considerably different scattering properties and would be interesting from both fundamental and applications point of view, according to the researchers.

NEW METHOD FOR NATURAL PRODUCT EXTRACTION

Microwaves are the basis of a new technique developed by Canadian researchers for extracting natural products such as essential oils, fatty acids, and pigments, reports Chemical and Engineering News.

The technique is the brainchild of researcher JR Jocelyn Pare and former coworkers M Sigouin and Jacques Lapointe at the Canadian Department of Environment's River Road Environmental Technology Centre, Ottawa, Canada.

The process consists of disrupting the ultrastructural properties of the material to be extracted by irradiating it with microwaves while immersed in an extractant that is relatively transparent to microwaves.

Microwaves pass freely through the extractant and quickly heat residual water in the inner glandular and vascular systems of the materials to be extracted.

SELECTIVE CHEMICAL REMOVAL OF METALS

A British company, Selectrons Ltd. that developed the process of electrochemical depositing metals from solution has now developed a new solution that will remove metals, and chromium in particular without the process attacking underlying metals such as iron, copper or nickel, reports Engineering Designer.

Previously all solutions employed to strip metals whether from Selectrons or its competitors, attacked the base metals. Consequently, the stripping process required considerable expertise and diligence to avoid disruption of the surface of valuable components.

The Rural Radio Payphone

NEW DELHI: The GPT network systems group has designed and engineered a Rural Radio Payphone to provide a cost-effective means of extending a payphone facility to remote areas or rural communities around the world.

The system is easy to install and maintain and its modular construction allows it to be tailored to suit individual customer requirements.

The payphone and radio equipment have low power consumptions so that it is possible to operate from solar power. The extended temperature range of -20 degrees to +55 degrees celsius allows it to be operated in most areas of the world. The use of the pre-pay cardphone eliminates the need for coins, and so reduces any attempts to vandalize the phone.

The GPT rural radio payphone is a 'standalone', solar-powered system, which provides a communications link through a radio path to a remote area or rural community.

At the remote subscriber location the rural radio payphone comprises a conventional payphone booth, a GPT pre-pay cardphone, a duplex radio terminal with an extended temperature range of -20 degrees to + 55 degrees celsius, a solar power supply, and a support structure on which to mount the solar panels with a Yagi antenna for transmission of the signals to exchange, reports GEC Review.

The pre-pay cardphone is connected to the signal channel radio terminal via a two-wire interface, and is powered from a 48V direct current (d.c.) supply generated by the radio terminal. In turn, the solar panels and batteries provide a 24V d.c. supply to the radio equipment.

The signal is transmitted via a Yagi antenna to a radio repeater station, or directly to the telephone exchange where a corresponding radio terminal is located. The output of this radio terminal interfaces with the exchange line.

Typically, the system would be able to extend a telephone line by some 50 km. The system would require near line-of-sight propagation for the radio path, but a repeater station could be added to extend the service even further, or to take the route round an obstruction in the terrain.

The radio repeater consists of two single channel radio terminals within a single rack framework. It is powered from solar panels and batteries, and amplifies the received signal before retransmitting.

The telephone which is installed at the subscriber location is a pre-pay cardphone, not a coin operated payphone.

This requires the telephone user to purchase, in advance cards which have been inscribed with a specified unit value, (for example 10, 20, 50 units), except in the case of emergency and free-call facilities. The use of the pre-pay card removes the need to revalue the price of telephone calls frequently in countries where inflation is running at a high level.

This product has been aimed at remote rural locations where vandalism is a prominent problem; an advantage of using the pre-pay card is that the use of cash is eliminated, so reducing the vandalism which results from attempts to steal the coins.

The actual telephone has a front panel of diecast aluminium with a cast stainless steel handset cradle. The key pad is protected by a brushed stainless steel panel which is recessed in such a way that tools cannot be inserted. User instructions in a pictogram format are also provided on this panel.

The liquid crystal display is protected by a toughened glass window designed to resist vandals. The card transport (the module which accepts the pre-aid card) is secured to a cast, stainless steel, modular insert, and is retained in place using electro-welded, toughened steel studs. This is also recessed in such a way that tools cannot be easily inserted.

A card aperture shutter protects the transport mechanism from the insertion of foreign objects.

The pre-pay cards used with the equipment are rugged and extremely resistant to mass copying, direct copying, and refreshing. The card information is encoded onto a magnetic medium which is printed on to the rear of the plastic card. The printing process and high coercivity of the magnetic strip allow a protective laminate to be bonded onto the card; this increases its life and makes it less susceptible to surface wear and scratches.

The magnetic strip is located in the centre of the card and is divided into three areas. The two end sections contain permanent security data, and the centre section contains encrypted information concerning the card value and the authority code.

The cards can be embossed or printed, using a four colour printing process, with graphics to suit the administration's own requirements. The face values are printed on each card. There is a notch in one side of the card, which has been included so that a blind person can determine the correct way to insert the card into the payphone.

Once the card has been accepted and validated by the card transporter, the number of units remaining on the card is displayed. When the call is answered, the initial fee is deducted and the call units are decremented. The remaining credit units are then written on the card before it is returned to the user.

Attempts to defraud the system by removing the card result in an immediate termination of call, and the user is left with a completely worthless card; any remaining units on the card are automatically deleted.

The payphone is 'intelligent' with a central processor unit (CPU), controlled by an erasable programmable read-only memory (EPROM) with a supporting random access memory (RAM).

The RAM is powered by a nickel cadmium battery charged from the line current, and (optionally) a lithium cell to prevent data loss. In this case the 'line current' is generated by the radio equipment.

Information contained in the EPROM includes metering methods, tariff data, and instructions for using the phone (for example 'INSERT CARD') which are displayed on liquid crystal display on the front panel. The caller can be prompted in ten different languages by key O to 9.

A range of automatic fault reports is also available in addition to several maintenance reports programmed into the payphone to indicate to the maintenance centre that a service is required.

A solar power supply comprises a solar panel, or panels a battery, and a regulator.

(PTI Science Service)

Ribozymes : New Tools of Genetic Engineering

A new class of molecular scissors, ribozymes, are being heralded as the antibiotics of the nineties. They can be designed to clip out an essential sequence from the genetic code of a virus and may well eradicate viral diseases that are resistant to conventional treatment.

Ribozymes are a special form of ribonucleic acid or RNA which relays genetic messages from the chromosome inside a cell's nucleus to ribosomes and finally the cell protein factories.

Until recently, researchers thought that only RNA acted as a carrier of genetic information from the chromosome to the sites of protein synthesis.

In 1981, they began to have the first inkling that some RNAs do something more — they act as enzymes which can snip or edit out stretches of RNA and direct the cell's chemistry. These ribonucleic acids that could act as enzymes began to be referred to as "ribozymes".

Scientists are predicting far-reaching practical applications of ribozymes in diverse fields such as medicine, agriculture and molecular biology.

For example, ribozymes, by snipping out pieces of ribonucleic acid from viruses, may well disarm such dangerous pathogens as the human immuno-deficiency virus (HIV), herpes simplex, hepatitis and cytomegalo-virus (CMV).

They can also stop leukemias and cancers of the lung, colon, breast and ovary and arrest the progress of autoimmune disorders such as rheumatoid arthritis and diabetes.

In agriculture, they hold the promise of attacking plant viruses such as the tobacco mosaic virus and citrus viruses, halting post-harvest fruit-rot, maximising disease resistance in crops, and genetically engineering plants.

Ribozyme technology owes its inception to two scientists — Thomas R Cech, professor of biology at the University of Colorado, and Sidney Altman, professor at Yale University, who jointly received the 1989 Nobel Prize in Chemistry for this work. Cech discovered that RNA can self-edit, while Altman found that it acts as an enzyme that could snip our parts of an RNA message.

Scientists predict that ribozymes may represent a new generation of genetic engineering that manipulates RNA instead of the traditional deoxyribose nucleic acid or DNA.

While conventional therapies inhibit an enzyme or a protein, ribozymes can smother genetic messages, arresting the production of disease-inducing proteins. Thus the target is not the protein but the messenger RNA which carries the code for the disease-causing protein.

Ribozymes offer the hope of targeting specific pathogens without affecting the host cell. A major problem in medicine is that viruses, unlike bacteria, use the host cell for multiplication. So therapeutic agents designed to attack the virus also end up harming the host, particularly after long-term use, as is the case with the AIDS drug AZT (Azidothymidine).

Scientists at the Beckman Research Institute in California have now shown in laboratory studies that ribozymes can cleave that RNA of the AIDS virus and inhibit it in cultured cells.

The first ribozyme product was introduced in the market in June 1989 by the United States Biochemical Corp. This ribozyme is designed to cleave RNA at specific four-nucleotide sequences of cytosine and uridine (CUCU). The firm is also working on a ribozyme that can treat herpes skin lesions.

A Delaware-based firm Innovir is proposing the development of a ribozyme that may be effective against hepatitis B, human papilloma and herpes simplex viruses.

Considering that a rather large number of diseases (more than two-thirds) are related to malfunctioning of genes, ribozyme technology has a broad market appeal, reports Futuretech. The pharmaceutical market of the technology is currently being estimated at 20 billion US dollars.

Similarly, the US market for insect-resistant seeds, one of the expected off-shoots of agricultural applications of ribozyme technology, is being estimated at 1.5 billion dollars by 1995. The US retail market for genetically modified plant seeds, trees and shrubs may touch six billion dollars in the next ten years and for rot-resistant fruits and vegetables about 63 billion dollars by the turn of the century.

One of the most powerful applications of ribozymes is their ability to cut other RNA strands in a sequence-specific manner.

They, in fact, represent a new technology called "antisense" technology which has been evolving over the past eight years. Antisense technology essentially allows scientists to introduce complementary man-made oligonucleotide sequences to the messenger RNA before the latter carries the genetic message to the ribosome. Scientists say ribozymes can be considered as naturally occurring antisense molecules that can self-edit.

— PTI.