

# Virtual Reality and Microlasers Promise to Pay Greater Dividends

**I**MAGINE, being transported instantly to the surface of the moon or being transformed at will into a molecule racing through the mysterious labyrinth of the human circulatory system, reports BSS.

Though it sounds like science fiction, having the power to instantly change one's environment, may one day be as common place as riding in a car due to an exciting new technology called virtual reality — just one of over 30,000 "spin-offs" resulting from the application of space derived technology over the last 30 years.

Frank Penaranda, manager of the technology transfer programme at The National Aeronautics and Space Administration (NASA), says most people are unaware that their lives are touched by space technology every day, including such familiar consumer products as home water filters, radiation blocking sunglasses and protective candy wrappers.

"We drive cars and fly in airplanes that were designed using NASA computer software," he says. "Our office buildings carry electricity through flat conductor cables and our factories and supermarkets employ heat pipes to keep things cool both are NASA innovations."

Many spin-offs — technologies that have been transferred — uses different from their original application in the aerospace field have had a huge impact on the US economy, spawning new companies and creating thousands of jobs.

In some cases, such as highway safety grooving, miniaturized electronics and metalized insulation materials, the secondary application of NASA technology has resulted in an entirely new industry. Recent spinoff innovations, such as a virtual reality and microlasers, promise to pay even greater dividends, according to Penaranda.

Virtual reality, which was developed by NASA to study such things as the fuel flow through a rocket engine, involves wearing a headset containing two small television screens that allows the operator to virtually "step into" a

highly realistic, three-dimensional scene and interact with it.

With an electronic glove, the operator can grasp a virtual object such as a chair, for example, and move it within a simulated room. Moreover, the operator can "feel" the chair through tiny vibrators in the fingertips of the gloves. One can also don a sensorequipped suit that enables full-body interaction with the virtual reality visualizations are being increasingly used in scientific and architectural work.

For example, an architect's clients can inspect and perhaps alter a building's design before the structure is built by "walking through" a graphic replication of it. Similarly, the technology makes it possible to "tour" complex communication networks, large databases and traffic control systems.

Virtual reality is expected to revolutionize education, allowing students to feel they are travelling in time to become a Pharaoh in ancient Egypt, a tyrannosaurus cohorting with other dinosaurs, or an astronaut exploring a vast canyon on Mars.

Virtually reality technology, together with hydraulic and brake actuators originally used on the space shuttle, has led to the commercial development of motion simulators for science museums and recreational parks.

A simulator, which consists of an enclosed cabin in which seated viewers face a large movie screen, can take passengers on a realistic flight to Jupiter or a trip to the ocean depths. The actuators provide a powerful range of computer-guided motions, including a simulated free fall, heightening the sense of moving through space. The realism and feeling of motion is heightened by the three dimensional movie and a digital laser based sound system.

Technology first developed for the space programme has also led more down to earth consumer products. For example, technology originally used to sterilize drinking water aboard the Apollo spacecraft that flew to the moon has led to the development of inexpensive home water filters.

These filters, which can be mounted on a faucet, use blends of active charcoal and other ingredients to remove lead, organic chemical compounds and chlorine from the water supply. The filters can range from simple pocket devices to high capacity units serving whole communities in developing nations where water is highly contaminated.

The thin, light weight and flexible material used to fashion space suits for the Apollo astronauts has led to the manufacture of heavier-version fabrics used today as permanent covers for shopping centers, sports stadiums such as the Georgia Dome in Atlanta and Olympic Stadium in Rome, and airport terminals in Denver, Colorado and Saudi Arabia.

The space-based fabric roof, which weighs only one thirtieth as much as a conventional roof, is energy efficient, is relatively easy to maintain and can be constructed at low cost. Practical applications have

also been found for a new alloy of Nickel and Titanium, called Nitinol, which has the ability to return to its original shape after bending. It was originally used to make antennas and other hardware that could be compressed in a satellite and other spacecraft during launch and later expanded to full size during orbit. It is now used, among other things, as a new type of arch wire for dental braces. Its exceptional elasticity helps to reduce the number of brace changes.

NASA researchers also developed an anti corrosion paint to protect launch structures at the Kennedy Space Center, located on Florida's Atlantic Coast, from salt corrosion and hot rocket exhausts during the launch of space vehicles.

A commercially produced version of the paint was used in the extensive renovations of both the Statue of Liberty in New York and the Golden Gate Bridge in San Francisco, both enduring constant exposure to

the corrosive forces of salt spray, wind and fog. The coating was also used on the interior structure of the Mammoth Polin Buddha, recently constructed in Hong Kong.

An area where space technology has possibly had its biggest impact is modern medicine. Although most patients don't realize it, a lot of the technology used to treat them came from the space programme.

For example, a laser system first developed for satellite based atmospheric studies is now providing a powerful instrument for treating heart disease. The procedure, called laser angioplasty, involves a thin, fiber optic catheter being inserted into an artery in the leg and threaded to a blockage of fatty deposits in the coronary artery. A small, cone-shaped laser beam is then emitted from the catheter, vaporizing the plaque without damaging delicate tissue.

One of the most recent medical breakthroughs involves a non surgical breast biopsy technique that is based on technology developed for the orbiting Hubble Space Telescope. The biopsy technique involves an improved digital imaging device that converts light directly into an electronic or digital image, which can be enhanced by computers. The advanced imaging device is routinely used aboard the space telescope to observe stars, galaxies and other objects.

## Science Briefs

### Easy Training for Air Traffic Controllers

**T**HE Laboratoire d'Informatique pour la Mécanique et les Sciences de l'Ingénieur — LIMS (Computer Science Laboratory for Mechanics and Engineering Science) of the French National Centre for Scientific Research conducted research for the Centre d'Etudes de la



Air Traffic Control System

can train himself whenever he wishes. The system can synthesize different voice timbres, corresponding to pilots of different planes; it is bilingual (French and English) both in recognizing and synthesizing voices. Moreover, it has a module to understand natural language, the job and the hold-

Navigation Aérienne — CENA (Centre for Study on Air Navigation) in order to develop an oral dialogue system for training student air traffic controllers. This system aims to replace the person who plays the role of a pilot in the existing system. In this way, the student

## NATURBA

**T**HE NATURBA process, devised and developed by a French firm named SOVADEC, makes it possible to treat urban waste materials by first sorting the materials and then using earthworms to produce a high-quality organic soil conditioner.

Earthworms are actually able to consume any kind of organic material found in extremely mixed volumes of waste products. After the organic materials have passed through an initial microbial maturation, the worms ingest the material and produce a vermicompost in the form of small pellets.

Earthworms can only "work" properly if a specific temperature, level of aeration and degree of moisture are maintained. Rearing these conditions in mind, SOVADEC designed a set of patented materials and techniques that cover the cycles in valued in producing the final products.

## Molecule to trap methane and CFC

**R**ESearch on receptors which enable to identify and capture selectively very volatile molecules such as hydrocarbons (methane, ethane, propane) and chloro fluoro carbons (CFC) have always set a turn challenge. And it was successfully taken up by chemists from the Laboratory for Stereochemistry and Molecular Interactions. A cryptophane synthesized in the laboratory proved to be capable of capturing in its cavity a methane molecule. The physical state of methane imprisoned in this way is very particular as it resembles a gas supercompressed at a pressure

of more than 600 atmospheres! The same result was obtained with two CFC compounds, Freon 12 (CFC2Cl2) and Freon 22 (CHF2Cl) which are extremely volatile. These results show well the capacity of chemists to design molecular traps (trapped for virtually an species. There are numerous potential applications for these receptors: biomimetic catalysis, making of captors which help in detecting and in fixing the dosage of chemical species present in the environment, developing intelligent processes for depollution — elimination of chlorinated hydrocarbon traces in water wastes, for example.

## EUROCOPTER-BETTER RECORD

**D**ESPITE a sluggish market in 1993 context, Eurocopter increased its market share to a record 54% (compared with 51.5% in 1992). The French-German group, which has netted 24% of the military market (excluding the US and CIS), regained the position it had enjoyed before the Gulf war, thanks mainly to two Cougar contracts — 20 helicopters for the Turkish armed forces and 17 for the Netherlands. In all,

while its main US competitors Sikorsky and McDonnell Douglas rely on the domestic market for 80% of sales. Breaking through the murky clouds, several bright spots have appeared on the horizon in the form of healthy new programmes. On the military side, the Tiger — with three prototypes flying — is entering its weapon system and navigation phase. The German version (called UHU for Unterstutzungs Hubsc-



The New Generation European Helicopter

the group sold 166 machines last year, including 43 AS 332/and AS 532 Super Puma/Cougars, compared with 159 in 1992 (of which only ten were AS 332s).

In financial terms, these 1993 orders are worth 9.3 billion FF compared with 15.2 billion in 1992 — an exceptional figure at the time, which was fleshed out by the development contract for Europe's NH90 military helicopter programme.

1994 will be another "difficult year" to quote Eurocopter president and CEO Jean-Francois Bigay. He also worries about the potential vulnerability of his Group, since 95% of the orders it receives for new machines are for export (to countries other than France and Germany).

— Cesti Report.

## New Approach to the Mathematical Model of Back-Propagation (BP) Neural Networks

by Md Mostafizur Rahman

**T**O overcome the sequential processing hindrances in conventional computers, a new field is being introduced for massively parallel processing like the nervous system called "Neural Networks". In neural networks, input data are fed as weightage values (connection strengths between the two neuron cells) and those weights are adjusted according to some learning mathematical models or algorithms to get least error output. A new approach for mathematical model to the Back-Propagation (a very popular learning algorithm) in neural networks has been contributed in this field of research.

A wide range of approaches to highly parallel computer architectures has been proposed since the beginning of computer innovations. Computer science has been persistently unable to address several difficult problems. To reach convergence on the solution, the scientists have got one model (in part of them the human brain). For speech or pattern recognition, a conventional Von Neumann computer processes instructions one at a time, sequentially, while to mimic brain encompassing a massively parallel architecture, the brain derives its power from the sheer number of neurons rather than the complexity of each single neuron.

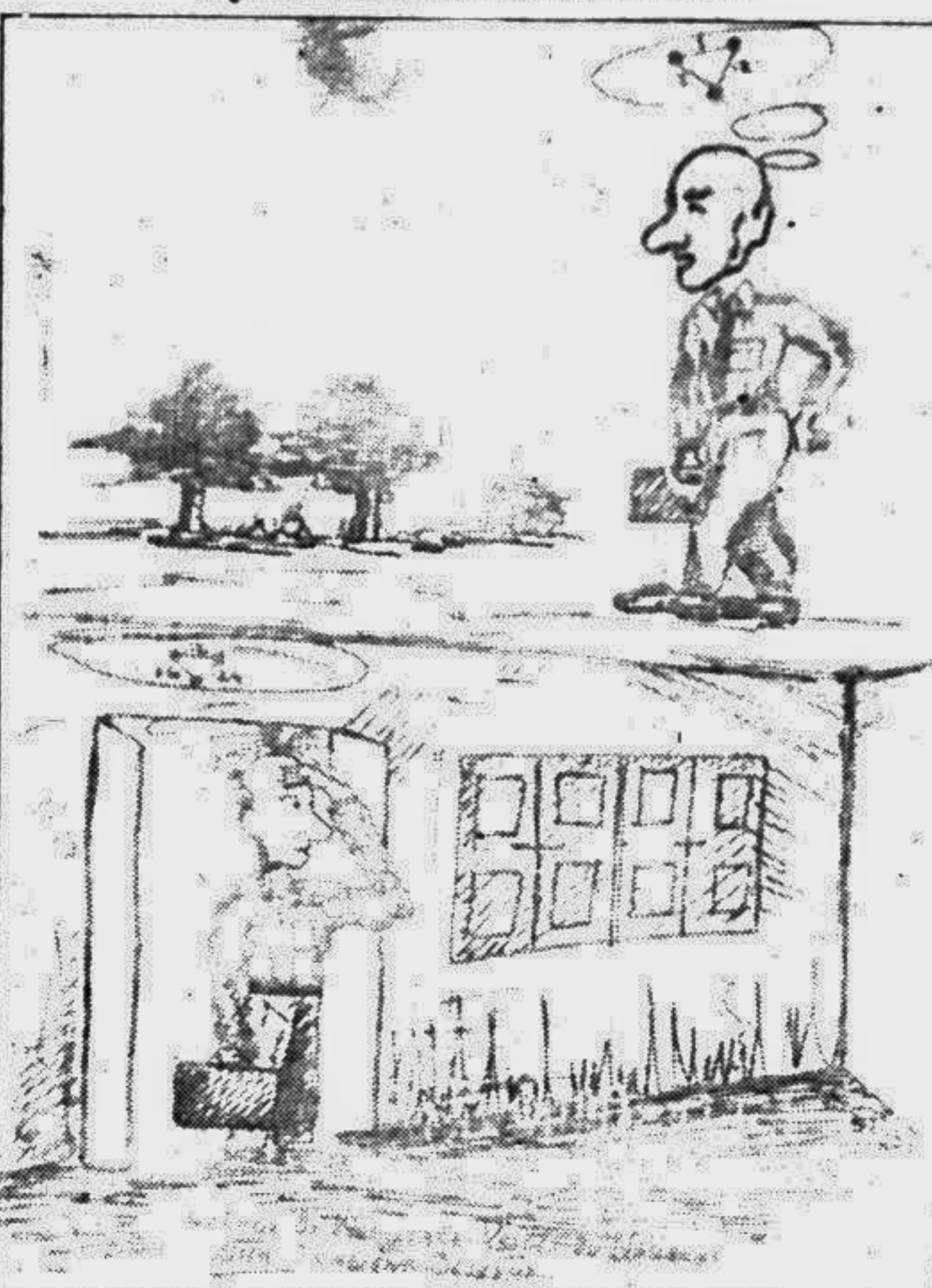
"A theory is the more impressive, the greater the simplicity of its premises, the more different kinds of things it relates, and the more extended its area of applicability". This is why, neural network being one of the most recent research fields an urge for "New approach to the mathematical model of Back-Propagation (BP) Neural Networks and its realization" has been proposed in this paper.

### WHAT IS NEURAL NETWORK?

The development of massively parallel systems has fostered a new body of research called neural networks — the heart of the neurocomputers. A neural network is an implementation of an algorithm inspired by research into the brain. This network architecture spans with nodes, connections, layers and weights with varying arrangements having associative memories based on the concept of the distributed representation of information. Neural networks are very friendly in handling imperfect or incomplete data resulting a degree of tolerance.

### DEVELOPMENT OF NEURAL NETWORK

Developing a neural network is considered an art, sufficient empirical results need to be compiled to create a preliminary development methodology and the creativity & research breakthroughs while removing unnecessary rigidity. Much of the proposed neural network development cycle is adapted from conventional software systems and places a stronger emphasis on experimentation and multiple simultaneous development tracks, iterative refining of network parameters, problem redesign and reformation beginning with general solutions and tightening the set of feasible approaches. Of particular interests to neural networks are resource constraints (time,



equipment, money); data sources (type, cost, accuracy, consistency); timing (project, training, operation); and current techniques and lessons learned.

### TRAINING OF A NEURAL NETWORK

The heart of the neural network development lies in the core of training method and hence this network is trained rather than it is programmed. The training or learning of the brains is accomplished from examples like the children pick up speech, learn to write, eat and drink. To reach this concept, it is proposed that instead of having to develop a programme to do a task, one could simply let the computer observe the task for a while, so it could learn by example.

Training strategies are the focus of the much research in neural network. The appropriate method of training for a neural network depends of data availability and timing. Three common training methods are: (a) supervised, (b) unsupervised and (c) reinforcement training. Back-propagation training or learning method focused in this paper is a supervised one.

### BACKGROUND OF THE MATHEMATICAL MODEL

The key to the Back-propagation (BP) learning method, is to implement the input patterns over which the net must be trained and the corresponding desired outputs are made available to evaluate the "error" i.e. the difference between the present outputs and the expected ones in correspondence, the new values are computed for the synaptic weights.

The weight adjustment at the node is accomplished by minimizing the errors which is based on a geometrical concept. The result follows an error-surface shaped like a bowl, whose bottom indicates the minimized error. By calculating the instantaneous slope of the error surface w.r.t. the current weights, BP achieves

So, the error function, according to the formulae, we get,

$$E = 1/2 \sum (f(y_i) - f(y_2))^2$$

$$\text{or, } E = 1/2 \sum (x_2 + y_2)^2$$

(After calculation)

From the Error function we get the Gradient Descent as follows:

$$\text{grad } h(Wx, Wy) = 1/2 (4x^3 + 4xy^2 + 2) + j/2 (4y^3 + 4yx^2)$$

By putting the previous weightage values we get,

$$\text{grad } h(Wx, Wy) = 1.0624 + j.0416$$

that means the minimized point for the weightage value is (0.624, 0.416) which proves the mathematical model absolutely.

### NEURAL NETWORK SIMULATOR DEVELOPMENT

Simulation means to model the behaviour of a system. In the case of neural network, individual nodes called neurons are connected via an interconnection structure. Each neuron, in this model, receives stimuli from the neurons feeding inputs to it and evaluates such information on the basis of a suitable function (Fig 5.0.1). As a result, it then fires a response on its output.

We have developed a neural network simulator in Turbo C (an Integrated Development Environment) through which any training can be implied for the fulfillment of neural network strategy. For the time being, three nodes are considered in this model. Different arrays are used as associative memories for describing node names, weights, stimulus conditions etc. differently. Whenever, any node is in stimulus condition, others become inactive shown in Fig. 5.0.2. Thus, for three nodes, six input weights are changed into two output weights.

### CONCLUSION:

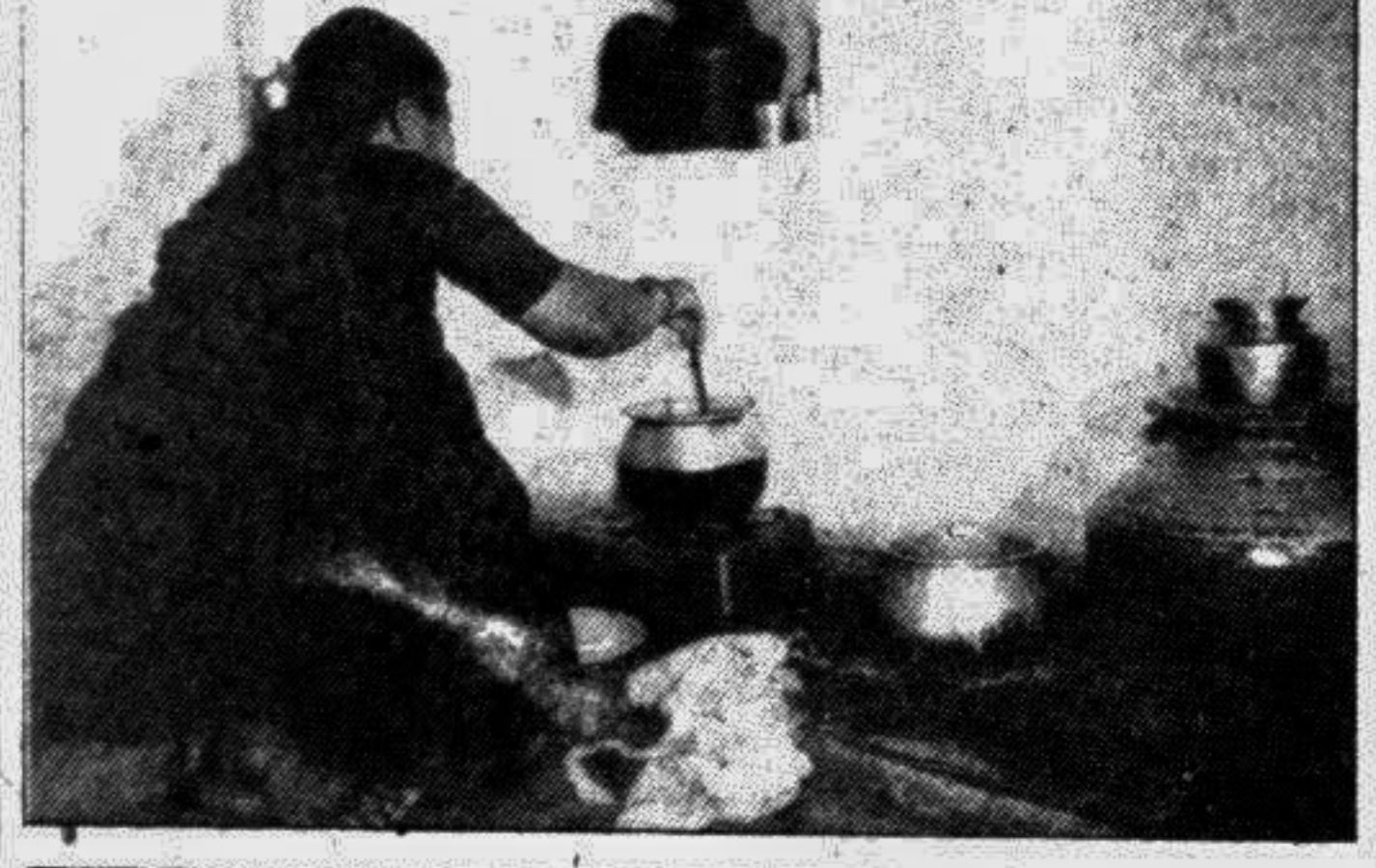
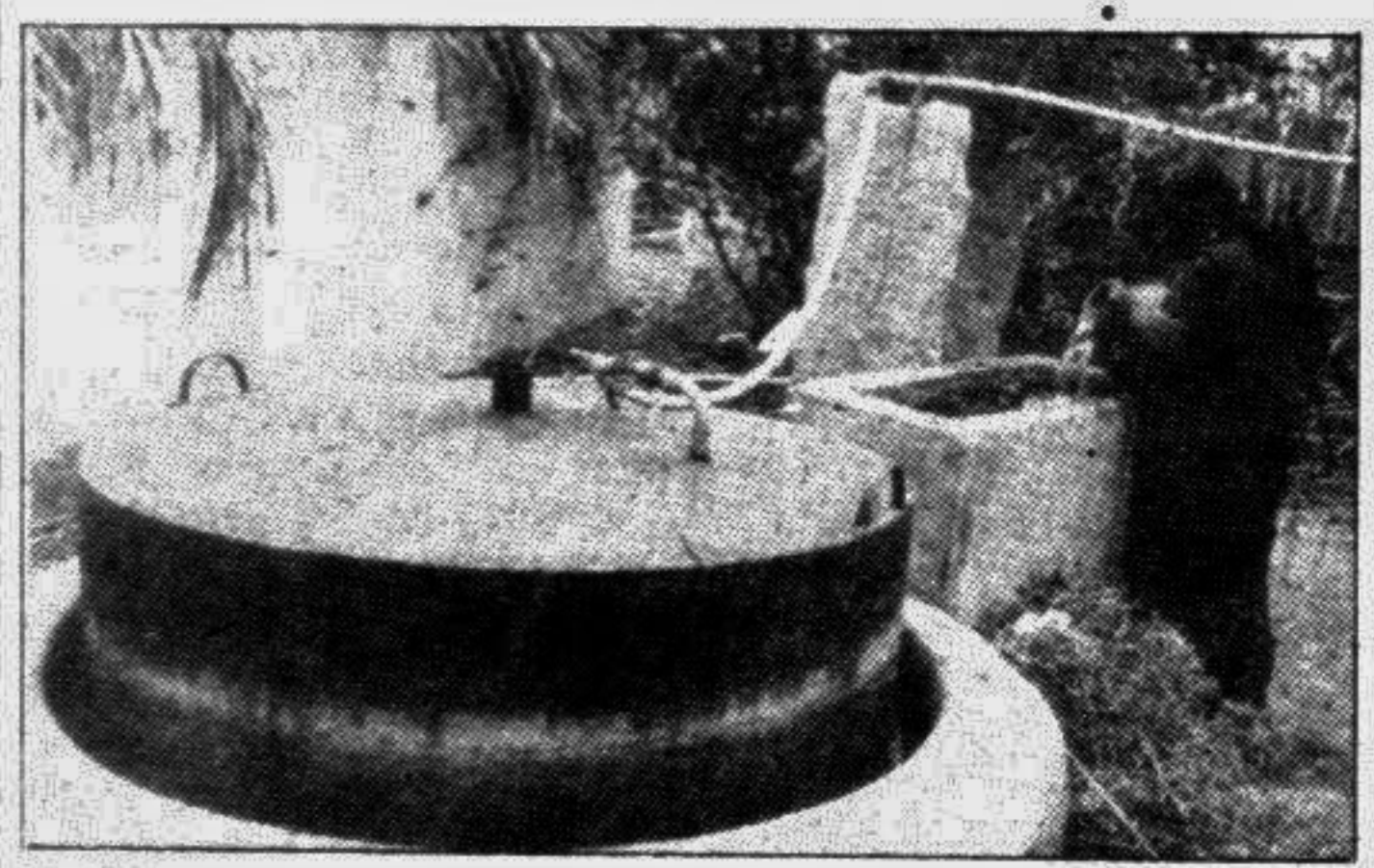
Neural network is not a technology that is coming, it's a technology that's here. Many valuable applications are fielded now, and tremendous growth and excitement is yet to come. Although knowledge is undoubtedly incorporated in the trained network, extracting it for comparison and validation can be time consuming. To overcome these boundaries, the very simplified mathematical model for 'gradient descent' and a neural network simulator have been developed for a wide field of the computer scientists, mathematicians, engineers, physicists, biologists, physiologists, cognitive scientists and even social scientists and philosophers.

This knowledge is layered into the network structure and initial connection weights, thereby simplifying neural learning. There is a wide range of conflicting opinions on the usefulness of neural nets (typically back-propagation) for classification from examples. While many studies propose a positive outlook, several comparative studies give opposite conclusions. Thus the choice of the best technique should reflect, to some extent, the general nature of the application.

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Prof. A. S. A. M. Madant Halepota supervised this research.

## Photo Feature



Biogas production on a farm in the village of Rangasatnra, Karnataka province (India). Cow dung is mixed with water in a trough from-which it is piped into a tank where it is transformed by heat into natural gas (photos 1 and 2). As a result of this easy-to-use system, gas can replace wood as domestic fuel (photo 3), thus helping to halt deforestation in this part of southern India. Courtesy — UNESCO Courier