The theory and application of Biological Computing and design of a Bio-Visual selecting system for the paralytic

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***Abstract*: This paper deals with the basic meaning of Biological computing and its nuances as well as dwells into its present application and research. Recent Biological computers can use a single strand of DNA to fulfill its fuel needs and can be programmed at the molecular level. It underlines the future prospects of this unique dimension. The application towards a medical approach is also studied. The authors discuss various issues for optimization and realization of various innate possibilities hidden in its minuscule attributes. The design of a Bio-visual selecting system built upon present standards is suggested which would be of remarkable help to paralytics and patients of Amyotrophic lateral sclerosis (ALS).**

Keywords: DNA, ALS, Slow Cortical Potential, Transreceiver

Introduction

This is the era of research on Biological Computing. Combing the two dimensions of Biology and Computing to integrate their attributes for solving Biological issues with the Computation ability of computer is one aspect of Biological Computing. The other way around, designing a computer based on biological substances is another aspect of Biological Computing. We will discuss both these aspects in this paper. Taking into account the minuscule nature of such a computer and its minimal energy needs, the Biological Computer promises to be a key factor of tomorrow’s world.

The birth of the DNA Computer

Though the possibility of designing a computer based on Biological substances was being conceived for a long time, very recently a startling discovery has been made. Researchers have demonstrated a DNA computer which can perform simple addition operation. This computer that can perform 330 trillion operations per second, more than 100,000 times the speed of the fastest PC. A DNA strand is the basic unit of life which is responsible for the passing of traits from the ancestors to the progeny. The DNA can act as a self replicating unit under favorable circumstances. This DNA unit contains all the energy it needs for its proliferation. This DNA can be used to supply fuel to the Biological Computer. This DNA molecule can also be programmed and mutated by external influence. The Biological Computer uses these possibilities and extracts fuel from the DNA molecule. The molecule can be programmed in a Petri dish by dipping electrodes to the solution and applying a simulated voltage for a control time. This input data is assimilated by the DNA molecule which can act upon the hardware. The hardware in these dimensions is the enzymes and the external environment is the test tube. The added DNA molecule acts on the enzymes and brings about the preprogrammed change to the chemical properties of the hardware i.e. the enzymes. While scientists say silicon chips cannot be scaled down much further, the DNA molecule found in the nucleus of all cells can hold more information in a cubic centimeter than a trillion music CDs. A spoonful of this “computer soup" contains 15,000 trillion computers. And its energy-efficiency is more than a million times that of a PC.

Another way to code the software

Though the original implementation of the DNA computer involved the electrical stimulus, we suggest that there can be a still more efficient way for programming the DNA molecule which will nullify even this infinitesimally small energy requirement. Since the DNA molecule is a biological entity which is composed of nucleic acids, the mutation can be easily induced by manipulating the pH value of the solution. Hence the acidity or the basicity of the solution can easily govern the reactions that the strand will make with the enzymatic solution.

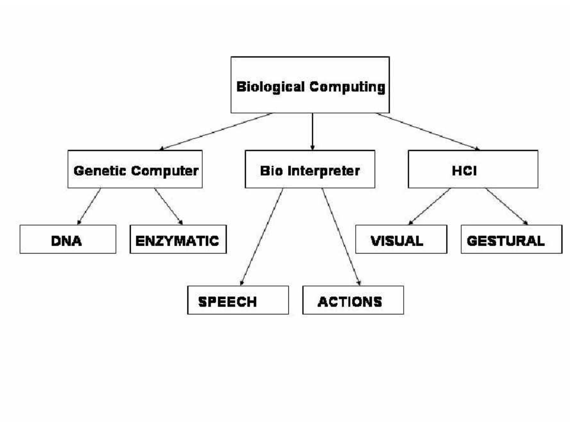

Figure 1

These devices can be told what to do by controlling the composition of the DNA software molecules. The device can check whether a list of zeros and ones has an even number of ones. The computer cannot count how many ones are in a list, since it has a finite memory and the number of ones might exceed its memory size. Also, it can only answer yes or no to a question. It can't, for example, correct a misspelled word. Research continues to increase the potential of this device.

Applications of the DNA computer

Since it is clear that that the mutated version of the DNA molecule can be used as a software element, it gives rise to a number of implications that me can get from it. We will highlight our viewpoints in this regard.

The DNA is the central entity of the cell nuclei and controls its all activities including the transport of materials within the cell and the way the cell interacts in the external environment. The DNA hence acts as software for a cell which takes the job of a computer. Using the mutated DNA, it is feasible to direct the cell to produce certain enzymes or antibodies. These cells which could be aptly called as the arsenals on move can easily flow through the blood steam to reach specified areas of the body. These cells when reach a certain target portion of the body which has some malady can be directed to produce the enzymes or antibodies which have a curative effect. This can track down malignancies and growths like tumors. They can de used to dissolve the blood clots in the blood vessels and hence reduce the risk of a heart attack. Such microsurgery can be used to perform curative efforts on minuscule entities of the body and provide a fast and dependable healing measure. So as to hit the enemy in its concentration camp after deep penetrating into its regime!

The DNA can also enhance the attributes of the host cell to make it a battery on the move. It is possible to send these moving batteries to the limbs of the paralytic. These cells can also easily go in the brain and can impart electrical stimulus to the neurons. Experiments with leech neuron cells have shown response to electrical activity. They are reported to form certain interconnections among themselves when an electrical pulse is passed through the Petri dish in which they are harnessed. Using the same technique it is quite possible to stimulate those human neuron cells which have lost their activity to rekindle the electrical life among them. This can be a ray of hope for the paralytic and the sufferers of amyotrophic lateral sclerosis (ALS), a neurodegenerative disease which often leads to total paralysis.

The other way around

Now we will highlight the usage of latest computing principles in the field of Bioelectrical Engineering and build upon the current scenario to assimilate the principles highlighted above.

Research is going on to harness the electrical energy of the brain to help the paralytics to put forward their thoughts. A computer system has been designed which depends on an individual's ability to control their brainwaves. Two electrodes, the size of contact lenses, are taped on to the head. This allows an electroencephalogram to detect brain signals, which can be passed to a computer. By using the power of thought alone, patients can then drive a cursor on a video screen that selects letters of the alphabet. The device works by measuring a particular kind of brain activity called the slow cortical potential. The patients have to undergo a lot of practice to manage to control this neural potential. Various simulations have been devised where a person drives a car on the computer screen and competes with others in a virtual race. The difference lies in the fact that the controller does not use a joystick. He can accelerate the car only by concentrating and controlling his slow cortical potential. These devices can be used for the patients to convey their thoughts. In an experimental device, the paralytic sits in the front of the monitor and gazes over it. The electrodes attached to his head measure his brain activity to move the cursor over the screen. The person can choose a character from an array of characters on display and make his selection by blinking. Hence his ideas can be conveyed.

A Bio-Visual Selector

In this section we are going to design a new system which will make life easier for this invalid patient. In this regard we add a new feature to the commonly worn contact lens. This contact lens will be designed with an embedded transreceiver in it. The lens can be made of a transparent biological material and the transreceiver embedded on it can be charged by the DNA manipulate power cells that we have discussed. The paralytic sits in front of the monitor and just needs to gaze at the alphabet on the display. The monitor is such designed that it can also act as a receiver of infrared rays. The transreceiver embedded in the contact lens continuously emits infrared rays. To select a word the user needs to gaze at the alphabet on display and wink (in a way that is other than the normal wink, say wink twice) or gaze at the alphabet for a particular time such than it can be selected. The software program installed on the computer matches the selection pattern precoded in the memory and hence selects the alphabet.

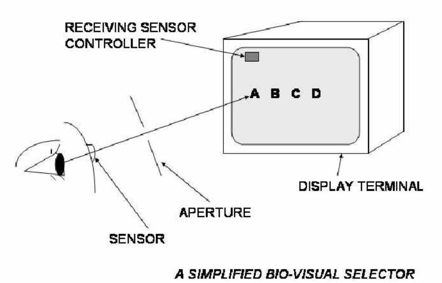

Figure 2

This usage can be extended greatly. The embedded systems can be installed in the household items. The person can open the door by just looking at it and winking. The washing machine can be started by a mere gaze. The fridge can order the grocery store if we can only look at its empty compartment and wink. Doesn't magic seem to be a reality!

Of course there are anomalies and digressions. It would take considerable efforts in the design and fabrication industry to design such an integrated contact lens. It has to be taken care that the infrared ray should not damage the eyes of the user. The inner surface should be made totally reflective. The device should be easy to use. The selection procedure should be properly coded into the software component of the receiver so that it does not select something unintentionally. The processing software must also be easily modifiable.

We also extend the thoughts and research conducted related to the slow cortical potential. Combining the electrodes with our bio-visual recognizer system, we can extend the efficiency of both the systems. The lenses can be used to point to the object whereas the measure of the slow cortical potential can give the magnitude of the particular selection. An air conditioner can be started by looking at it and its degree of coldness can be adjusted by concentrating. Eyeball movements can control the direction of the wheelchair and the slow cortical potential as measured by the electrodes can control the movement. Such effective software controlling these devices can be written easily and many of the symbian operating systems for such dedicated applications can be evolved or inherited. There are infinite such possibilities and diverse applications and we have just pointed out a minute subset.

Conclusion

There is a lot scope in the field of Biological Computing and the research is still going on. The DNA computer holds the key to solve many of the most intriguing maladies of the contemporary world. We have discussed and suggested many ways in which the performance can be optimized. The effective way of harnessing the inherent potentialities of this device has also been considered. We have also delved deeply into other aspect of Biological Computing. The design of the bio-visual recognizer is built upon those trends which are key research areas these days. The underlined principles and techniques can be used by the industry to bring more comfort to people.

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