iJET EXPLORE International Journal of Engineering & Technology
CENTRE OF PROFESSIONAL RESEARCH PUBLICATIONS
ISSN 2049-3444

International Journal of Engineering and Technology Volume 2 No. 10, October, 2012

Modelling Human Memory

Subhendu Das
CCSI, West Hills, California, 91307, USA

ABSTRACT

We know that computers cannot understand the meaning of its memory. The humans who use the computers have the meaning. Humans are the originator of the computer memory data and live outside the computer box. Therefore the same should be true for human brains also. Along that line we define human memory as a physical object. Humans perform some actions on some objects to produce the data that they need. This data is physical and becomes our memory. All actions require some motivations, reasons, or purposes. This purpose provides the meaning for the data. The human memory is therefore defined as a physical object consisting of three items {data, actions, purpose}. Since we are not alone or isolated, all human actions are performed simultaneously and interactively by many people located at many different places and over many different time periods. These joint actions produce the human memory data. Therefore this global space time (GST) environment is the originator of the human memory, contains the purpose of the memory, and the memory data. Using the laws of conservation of physics we show that the GST preserves this memory for eternity. The paper combines ideas from physics, mathematics, engineering, and neuroscience.

Keywords: *Brain, Memory, Laws of conservation, Derivative, Modelling, Space time*

1. INTRODUCTION

Merriam Webster dictionary defines memory as (a) the power or process of reproducing (b) store of things learned or retained. The first one represents a verb or an action and the second represents a noun or an object. In this paper we describe both definitions and show their interactions.

Everything in our world is physical, nothing is abstract, not even our imagination. There are only two types of objects in nature: (1) a material object and (2) a physical action, energy, or force. Our imagination is also based on only these two types of objects. Thus our memory is also not an abstract object. What we have in our memory is a static picture or a snap-shot of a physical object or a dynamic moving video of a continuous sequence of physical objects under some actions. Whenever we think of our memory we go back to that place, in our mind, where we saw the object, and see it again in our mind. Thus our memory is always about natural objects and therefore remains in nature all the time.

Every memory object has a purpose. Whenever we see a photograph, we enjoy the theme of the photo and our participation in that theme. This enjoyment is the purpose for which we captured the memory of the static object. The same is true for the dynamic video. This photo will not have any purpose to any other person. Without a purpose, memory data cannot have any meaning; the purpose is the meaning of the memory.

The human memory data can be explained using computer memory concepts. The computer does not know the meaning or purpose of the computer data; but the data has meaning to the humans, who use the computer. The humans originated and stored the data, using some special format, inside the computer [1, pp.243-291]. Thus the originator of the memory data has the meaning. The originator is outside the computer box. The same is true for human memory also. The originator has the meaning, and the data is always outside our brain and is in the nature. We show that this happens because memory is physical. We also show how we originate the data, and describe the originator.

None of us is isolated in our world. We work together simultaneously and interactively, from many different places, and over multiple time spans to create our memory data. Thus no memory data is created by a single person. Since we are not alone, we do not act alone. This space of interactions is called here as the global space time (GST) environment. This GST covers the entire universe, consisting of all objects, living and nonliving, and all actions. Every action happens by simultaneous action-reaction of many people. We show, in an analytic way, that this simultaneity law proves that the GST environment is the originator of human memory, and therefore it has the memory, and the true meaning of our memory. The existing literature does not claim that the memory is inside the brain. On the other hand if you read the book [2] on cognitive science, assuming that the memory is outside the brain, you will get a positive confirmation, although not so stated explicitly.

Mathematically, all data can be considered as generated by an equation. Consider the following simple equation (1) to clarify the concepts of data, actions, objects, purpose and the data generation process.

$$A = Bx + Cy \quad (1)$$

Physically, this equation describes the actions to be performed on objects to create the memory data. Here x and y are money invested in two different stocks. B and C are the coefficients that convert the money to a return on investments, and A is the total return. The entire right hand side, represented by A, is the total action, thus the components Bx and Cy are actions also. The objects are x and y. The data will be the solution of x and y. Thus the data is a specific instance of the objects. The purpose is to make the total return grow. Thus we perform action Bx on the object x, to make A grow. The value of x at any time is the data. We generalize (1) later to equation (13) to paint a more realistic picture.

The paper is organized in the following way. We show that human actions can be defined using physical laws of nature. That is, we are governed by nature, and our activities are not abstract. This includes the nature of our memory and the propagation of memory over time. Then we show that this entire memory and memory generation process can be treated as a system using differential equations. The foundation of this systems approach is based on the simultaneity law. This approach is quite well known in literature. But our descriptions show its connections to the laws of nature. This approach establishes that the memory is physical and remains in nature. Finally we analyze cognitive science literature to show that it does not validate the concept that the memory is inside the brain.

2. DEFINITIONS

2.1 Static Memory

Human memory is not an abstract object. It is a very real and physical quantity. Some purpose motivates us to perform some actions on some objects to produce data. This data then becomes our memory. So we define memory as a three-tuple {data, action, purpose}. Thus data is meaningful only when we associate it with an object and a purpose. Nature has only two kinds of things, some physical objects and some physical actions or forces. This physical action when applied to a physical object, moves the object, or changes the object. The data is an instantiation of this object. If an object moves then the data is a snapshot of the object at different times. Static memory is the momentary view of the object under action at a specific instant of time.

2.2 Dynamic Memory

There is another important aspect of human memory that depends on the propagation of time. As time passes the static data becomes past history. When we recollect, the static data propagates over time and reacts with many other forces or actions that we take. As a result the nature of the static data changes over time. We will not be able to recover it exactly at some future time. All these processes are also physical as we show later. We show how this propagation can be analyzed using the theory of differential equations and the concepts of system theory in engineering. Thus the concept of propagation of memory is same as trying to recollect or transform the old memory at present time under the changed environment.

2.3 Purpose in Memory

All human actions have some purposes. We do not do anything without any reason. The purpose is translated into actions on objects, which then gives the data that we want. This data is our memory data, and the purpose gives the meaning of the memory. That is, purpose, reason, desire, objective, goal etc. are all same and give a meaning to our data. All purposes can be defined as {birth, maturity, death} processes. Each one of these processes is a series of actions. Every purpose has a beginning; it remains useful for certain period, and then becomes useless or does not serve any more needs.

3. EXAMPLE OF HUMAN MEMORY

We give an example to illustrate the concept of GST and the memory generation process. When a baby is born in a hospital room, that baby senses all the sounds of instruments, nurses, doctors; effects of lights, fans, temperature, air conditioning; and all the details of the environment that create the memory of the incident. At some later time when the baby thinks about that memory she mentally enters the room and gets the feelings of her senses again. Every other person in that room also does the same thing to access the memory of that incident. Thus the total memory data is inside that room or inside that environment and has been created by all the objects and activities of all the people in that room. Every individual present in that room can explore only a different and a partial aspect of that environment. The environment for that particular moment lives forever in nature and anyone who was present there at that time, will be able to access it at anytime in future. Clearly, it is possible to associate data, objects, actions, and purposes for all of the things that happened in this hospital room. This concept of simultaneous action is the key idea behind memory definition, memory location, and memory generation process. Individual actions and memory views are only partially correct and cannot possibly describe the total memory. The total memory of this room at that instant is not known, and cannot be known, by any single person, because it was created simultaneously by many people and by many actions.

We have experienced the effect of GST in our personal lives also. In many cases we thought that we have the correct understanding of facts based on our memories. But

once we hear the facts from another person, who was also present at the time of the incident, we get a better view of the incident. This shows that we can only get partial knowledge of any incident, because it is multidimensional, it is created simultaneously and interactively by many people. Total memory is the collection of the views of all people inside the GST. Observe that this idea of memory is at the foundation of our judicial system. The system tries to get many eye-witness accounts to estimate global memory picture.

Before we discuss memory as a physical object we want to introduce the tools that we will be using in this paper. These include some laws of nature, theories from mathematics, and the system engineering methodology. We cover them briefly because they are all available in public domain. We make some changes in them, however, because of the simultaneity or the GST concept.

4. LAWS OF NATURE

The following are some basic laws of nature. But we make some changes in these laws in view of the GST concept introduced before. These modifications show how in a complicated way the human memory is generated and preserved inside the nature.

4.1 Simultaneity Law

A very important characteristic of nature is its simultaneity. Everything in nature occurs simultaneously and interactively. All humans are interacting constantly, simultaneously, all over the world, and for all time. So is true for all physical objects. We are never isolated. This simultaneity is the foundation of the GST concept presented in this paper.

4.2 Complexity Law

Before we proceed we want to remind our readers the complexity and indescribability of nature using the example of Grand Canyon. You ask the best author of the world to describe Grand Canyon in written language. You will find that the description will be no match with your experience when you see it. This written document is a model of the Grand Canyon. The Grand Canyon is an example of static complexity. Things that are dynamic, which are changing with time, are more complex. If we cannot express nature using our natural language, then it will be impossible to express our observations, feelings, and experiences using a symbolic language like mathematics. The complexity law states that everything in nature is immensely complex and nothing can be described by simple statements.

We illustrate the simultaneity and complexity laws using the Newton's second law of motion as in (2).

$$f = m * a \tag{2}$$

Here f is the net force acting on an object of mass m. And the resultant acceleration of the object is a. Such simple equation cannot describe nature that will be useful for today's complex requirements. This law is based on the assumption of isolated environment [3] which cannot exist. In view of the GST concept, it must be expanded. Assuming that the mass is one, and replacing the acceleration by the second derivative of position x, we can rewrite (2) as:

$$\frac{d^2x}{dt^2} = f$$

The gravitational force g(x) is always present. We write g as a function of x, because gravity depends on the position. Note that the quantity x is a three dimensional vector in space, it has North, East, and Up (NEU) coordinates, near earth. The earth has been modeled as an ellipsoid, like the World Geodetic System 1984, (WGS84), and then extensive formulae have been developed by mathematicians, physicist, and engineers to define g(x) as a function of NEU coordinates. These expressions of g are quite complex and can be found in [4, Ch. 7].

Since the earth is rotating around its axis, there is always a force, called Coriolis force that acts on all moving objects near the earth space. This force has been shown to be dependent on the velocity of the object. Thus the expression (2) should be modified to (3) following [5, p. 76]. Here Ω is related to the earth's angular velocity, which is a constant. A derivation of the formula can be found in [6].

$$\frac{d^2x}{dt^2} = f - \Omega * \frac{dx}{dt} + g(x) \tag{3}$$

We have just added two of the complexities to the original Newton's equation. We should recognize that (2) is not an approximation of (3). The law (2) says that an object will move in a straight line but the expression (3) says it can never move in a straight line. The difference is due to the fact that (2) makes an assumption of isolated environment, which violates both complexity and simultaneity laws. Gravity and Coriolis forces are acting simultaneously on every object near earth.

4.3 Conservation Law

There are many laws of conservation. The conservation of mass law says that mass cannot be destroyed or created, it can only be transformed. The same is true for energy; energy cannot be created or destroyed. If a mass m_1 is used to produce several items of masses $\{m_2, m_3, \ldots m_n\}$ then the law of conservation says:

$$m_1 = m_2 + m_3 + \cdots + m_n$$

Or it can be written as in (4).

$$\sum_1^n m_i = 0 \qquad (4)$$

In (4) we have absorbed the signs inside the variables. In general for any physical quantity (4) will be correct. So we can call (4) as the sigma law. Similar expression is valid for energy also.

4.4 Action-Reaction Law

Newton's third law can be found in [3, p.120] and it says that the forces always occur in pairs or that a single isolated force cannot exist. Any one of these two forces can be called the action force, and the other one then can be called the reaction force. The reaction force is equal in magnitude of the action force and of opposite in direction. Thus the sum of the two forces is always zero and can be written as in (5).

$$F_1 + F_2 = 0 \qquad (5)$$

This law also makes an assumption of isolated environment. Because of the simultaneity law we are all globally connected over space, and therefore for every action there will always be more than one reaction $\{F_2, F_3, \ldots F_N\}$. It is not possible to create an isolated system and produce a single reaction. However the summation of all reactions must still be equal to the original action that produced all the reactions. Thus

$$F_1 = -(F_2 + F_3 + \cdots + F_N) \qquad \text{Or} \qquad (6)$$

$$\sum_{i=1}^N F_i = 0 \qquad (7)$$

We can now see that the expression (7) is a sigma law. The expression (5) requires an assumption of isolated environment, which is not possible, and also nature does not make any assumptions.

Observe that since everything is globally connected in space and over time, all the reactions generated by (6) will continue to interact with many other objects and produce more reactions over time. The total number of reactions from F_1 will increase in number and spread all over the space as time progresses and will change the GST in every moment. But at all instants in time the sigma law (7) must hold. The expression (7) really demonstrates the complexity law of nature, because N is very large, all forces cannot be found in practice, and the forces keep on interacting over time. Thus (7) should be considered as a conceptual or theoretical expression. It only demonstrates the existence of a law of nature that we cannot compute practically.

5. HUMAN ACTIONS AND THE LAWS

It may appear that law (7) is valid for physical objects only and not for humans. A little thinking, however, will clarify that humans are also physical objects, tightly integrated with the physical world, and therefore are subject to the laws of nature.

First, we have been created using elements of nature, taken from the periodic table of chemistry. Thus the inside part of our body, including brain, is entirely physical. Second, humans have several physical sensors, like, hands, eyes, ears, skin etc. These sensors can sense all physical forces or energy of nature. For example when we work with our hands we create a physical force. When we see things we accept optical energy through our eye lenses, which is a physical quantity. So we are tightly integrated with our physical world using the law (7), and human brain works only as an input output processor. The brain takes information from our body input sensors, processes them, and produces physical actions using our body.

The expression (7) is defined for any specific time instant. At any time instant the law is valid for humans also. If I touch you, you will immediately feel the reaction. This reaction on your skin is a physical reaction and therefore it will satisfy (7). However, the touch action will propagate physically inside our body and will create many more reactions just the way it happens in nature which is outside our body. We can see the delayed versions of reactions, as a smile in your face, or a glow in your eyes. Observe that these are all physical reactions. We must not confuse or compare the totality of all reactions with the instantaneous effects, because there is a time element in it.

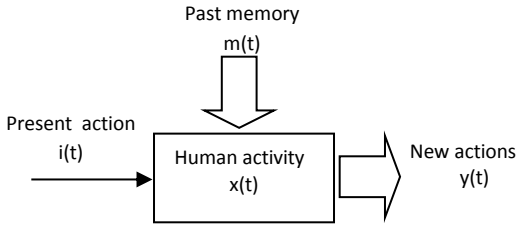

Figure1. Human action-reaction abstract model

Everything inside our brain consists of physical objects and physical actions. The neurons and the glial cells are all physical objects and they are constantly interacting with each other. There are many bio-electrical and bio-chemical actions and reactions happening which are also physical quantities. There are propagation delays inside the body. These activities can all be modeled [7] using concepts of system theory. Nothing is abstract in this physical world, they are only immensely complex. The complexity may make them appear like abstract quantities. If we break everything into atomic level, then we will find them all as physicals.

The other aspect of human action is the ability to retrieve past memory and its interactions with present physical

input. This past memory is also a result of many physical actions, starting from day one in the hospital room. Thus all the outputs due to human actions represent a transformation of present physical input and its interactions with past memories. This scheme of activities, as shown in Figure 1, is quite well known. The internal activities of all human actions can be abstractly represented by a sate vector, probably of millions of variables, denoted as x(t) in the figure. These represent many functions of human body, and activities of neurons, glial cells etc. of the brain. The figure is valid for a specific time instant only. Every time we perform memory retrieval the same memory will appear differently, because the environment is changing every time, as shown in the figure.

The model in Figure 1 is not unique to human memory only. Physical world also can be modeled in the same way. The physical world also has past memory. Everything that we do, changes the world and its environment. Our next activity works only on the new changed environment. The environment remembers the past memories. Thus past memory can also be modeled in the same way as in Figure 1. The dynamic equations representing the figure, given later, will represent all possibilities of memory concepts, retrievals, and inferences etc.

Our purpose here is not to demonstrate or write out a real analytical model of a single human body as part of physical object. There are some research publications [8] available in this direction. Our model describes the dynamic memory generation process using physical actions of all humans. The model is for the collective society of entire humanity and the entire material universe, which we call here as GST. Again, we remind the reader, that this concept is needed because of the simultaneity law. The goal here is to show the feasibility or existence of such a model, so that we can meaningfully think of analyzing memory data, in terms of human actions and the laws of nature.

The idea of global influence on a single human was also confirmed [9] by Karl Marx, who wrote in 1857 "… the human essence is no abstraction inherent in each single individual. In its reality it is the ensemble of social relations". Thus there is nothing like "I am" or "I did it". Every action is the result of long chain of actions and reactions of many people over a long period of time.

6. PROPAGATION AND MEMORY LAW

Memory is not just a static physical photograph or a dynamic video of certain duration; it is also the nature of those images after recollecting mentally at some later date. This recollection phenomenon can be considered as propagation of the images or static memory over time.

Let us say that an action is performed at time t on some object and the reaction appears at time t+dt. Here dt is a very small time, usually called delta time. The time dt can be considered as the observation delay time. If the reaction is only one force or only one reaction, then from knowing this reaction at t+dt, you can predict the action that happened in time t. This is because the action and reaction must be same, as shown by (5). If the reactions are many at time t+dt, then from analyzing all the reactions we can also predict the action that happened at time t. This can be done, because the summation of all reactions at t+dt is constant and is equal to the action at time t, which originated everything, as shown in (6). This analysis shows that knowing the present at t+dt we can predict the past at t. In other words the present holds the memory of the past. The concept that the memory of the past is embedded in the present time is a major contribution of the Newton's third law. The force or action at time t becomes the history or past memory for time t+dt.

It is easy to see that the future is also predictable using this action-reaction law. The logic that we have just used can be repeated by replacing t+dt by t and vice versa. That is, if we know the action at time t, then we know what will happen at time t+dt, which is nothing but the reaction, and this reaction will be same as the action at time t with opposite character. If there are multiple reactions due to one action then we will have to make more mathematical modeling to find the share of the action force for each reaction. This is very much like the billiard ball game, when one ball hits many balls then we can find the track of any one of the balls by finding its input actions.

What we have described is the dynamic changes or propagation of the forces or actions over time in both direction of present time, that is, past and future. We have shown how we can predict what will happen to the forces as time passes by knowing their status at any time.
Since we have defined, purpose as an action, the trajectory of purpose can be propagated. Similarly the trajectory of all objects under these actions can also be predicted. Therefore the data, which is the consequence of the other two items in memory, {data, action, purpose}, can also be predicted. Thus entire memory can be predicted, showing that the memory is not only a physical object, its evolution in time is also physical. Since all actions, objects are in the GST, this propagated memory will also be in GST. We will extend this microscopic propagation model in more systematic way using calculus and system theory in the following sections.

Thus events can be predicted and therefore these laws, the sigma laws, are also called the memory laws. Clearly and for simple situations, like throwing a stone; we can predict its trajectory fairly well [10]. One day in future we may achieve this prediction technology. But for now we only know the existence of its feasibility.

This determinism of our nature is not a philosophy or a fantasy. It is, as shown above, based on pure physical laws of action and reaction. But we should not confuse it to mean that we can predict future. This cannot happen, because of the complexity law, which is hidden in N in expression (7). The number N is very large and cannot be found, but it exists and is finite. Einstein and Newton both believed in this deterministic law of nature [11]. The literature on the theory of relativity also talks about the predictability of future. It has been written in the physics book [12, p. 46] "Events do not happen; they are just there, and we come across them".

7. DERIVATIVE IS A MEMORY LAW

We show that the derivative in calculus is nothing but the Newton's third law and therefore is a memory law or a law of conservation. The derivative is a mathematical tool that we will use to propagate the memory over time in both past and future direction. Thus memory will not be lost in propagation, it will only be distorted.

The derivative theory says that a small change in one thing will produce a small change in another thing. According to action-reaction law, these two changes must be same also. Therefore Δy, a small change or reaction in something, say y, divided by Δx, a similarly small change or action in something else, say x, must always be one. We are neglecting the sign for simplification, and without loss of generality. This ratio is called the derivative. When these delta values are very small, the ratio is denoted as dy/dx, and therefore according to the action reaction law, this is same as dy/dx = 1.

But in the theory of differential equations the derivatives are not always equal to one. This happens because x and y are normally not the same kind of variables or do not have same units. If we convert both variables to the same unit then the derivative will always be same and will be equal to one. In many cases we take derivative with respect to time. In these cases the derivatives will not be one. We should note that the things do not change due to passage of time; they change because of actions only. For more analytical details please examine [13].

8. HUMAN MEMORY IS A SYSTEM

Our definition for memory, {data, action, purpose}, shows that everything in nature and in our manmade world can create memory through actions on objects and our memory is a physical quantity. From another angle, everything in this universe is also a system. The subject of system theory gives a very well defined constructive approach for building models of systems. These models can then be analyzed using the theory of differential equations. Therefore memory is a system and system theory can be used for analysis of memory, creation of memory, and in particular, the propagation of memory over time or equivalently the retrieval of past memory. Thus this system structure maps a structure on the space of memory or the GST.

This section highlights the existence of a model [14] of type (13) for any system, including memory, and the existence of its solution. This well known modeling approach is constructive, so it will be easier to understand its existence. The objective is to get a feeling of the feasibility of such a model and its ability to propagate our definition of memory. We reiterate that we are not trying to create a usable model.

Every system has many components. All these components are interconnected by some interfaces, to form a network, through which actions happen interactively in a system. All systems have some purposes. They are not created for arbitrary reasons or objectives. We briefly present this well known modeling approach highlighting the embedded simultaneity and conservation laws.

Every component in a system can be described by through and across variables. Every network of such components can be modeled using a set of simultaneous equations similar to (8-9) with the help of these across (x) and through (y) variables as shown below:

$$\sum_{n=1}^{M} x_n = 0 \tag{8}$$

$$\sum_{n=1}^{N} y_n = 0 \tag{9}$$

In (8-9) N is the number of components attached to any node of a network, and M is the number of components in a closed loop of a network. Similarly all components can also be modeled, individually, using these variables by one of the following equations:

$$x = R\,y, \quad x = L\frac{dy}{dt}, \quad y = C\frac{dx}{dt} \tag{10}$$

Expressions (8-10) can then be combined to create the following equation, representing the model for a general system.

$$\dot{x} = Ax \tag{11}$$

Here x is a vector of all through and across variables taken from a selection of dynamic expressions in (10). A is an appropriate size of square matrix. In more general case the model (11) can become nonlinear like in (12).

$$\dot{x} = f(x) \tag{12}$$

Expression (13) shows an expanded form of (11). We point out that (8-10) represent the laws of conservation;

therefore the equations (11-14) must also obey the same laws.

We have kept the model (13) linear for simplicity. It is possible to make it as complex as we want. But as we have mentioned our goal is to demonstrate the feasibility of a model. We demonstrate this feasibility by using this constructive methodology for any system. In (13) we have included all systems and therefore it does not have any independent control variable. When we consider the entire universe, we assume it is a closed system, with no influence from outside; in fact there is no outside. This is basically the model of x(t) of figure 1. Therefore it shows how our memory is generated by actions on objects. In (13) $\{x_i\}$ are the objects and $\{a_j x_i\}$ are the actions on those objects, just like in equation (1).

$$
\begin{array}{cccccccc}
\dot{x}_1 & = & a_{11}x_1 & +a_{12}x_2 & +a_{13}x_3 & \cdots & +a_{1,15}x_{15} & +a_{1,16}x_{16} \\
\dot{x}_2 & = & a_{21}x_1 & +a_{22}x_2 & +a_{23}x_3 & \cdots & +a_{2,15}x_{15} & +a_{2,16}x_{16} \\
\cdot & = & \cdot & \cdot & \cdot & \cdots & \cdot & \cdot \\
\cdot & = & \cdot & \cdot & \cdot & \cdots & \cdot & \cdot \\
\dot{x}_{71} & = & a_{71,1}x_1 & +a_{71,2}x_2 & +a_{71,3}x_3 & & +a_{71,15}x_{15} & +a_{71,16}x_{16} \\
\cdot & = & \cdot & \cdot & \cdot & \cdots & \cdot & \cdot \\
\cdot & = & \cdot & \cdot & \cdot & \cdots & \cdot & \cdot \\
\dot{x}_{251} & = & a_{251,1}x_1 & +a_{251,2}x_2 & +a_{251,3}x_3 & & +a_{251,15}x_{15} & +a_{251,16}x_{16} \\
\cdot & = & \cdot & \cdot & \cdot & \cdots & \cdot & \cdot \\
\cdot & = & \cdot & \cdot & \cdot & \cdots & \cdot & \cdot
\end{array}
\qquad (13)
$$

The simple model (11) has a simple closed form solution also and is given, for a finite but very large dimensional system, by (14):

$$x(t - t_0) = e^{A(t-t_0)}x(t_0) \qquad (14)$$

Here t_0 is the present time. The mathematical theory of differential equations ensures the existence of solution even for more complicated versions like (12) under fairly realistic conditions [15]. It has also been shown that the solution is unique under a given set of initial conditions. The theory says that the solution can be extended from minus infinity to plus infinity on time scale. We should understand that the expression (13) is merely for illustration of concepts related to memory generation, propagation, and data. In realty things will be significantly more complex and beyond our comprehension. Our emphasis in this paper is to present the existence of a theoretical concept and not a practical method for representing a memory data.

Some concepts of general system theory have been discussed in the paper [16] and the laws of nature in economic theory in [17]. The methodology for details of modeling approach is given in [18]. A more detailed overview can be found in [13].

9. GST HAS MEMORY

The global space time (GST) is the collection of all systems, and since all systems are integrated also, therefore the GST itself is a system, and can be described by the simultaneous differential equation of type (13). Expression (13) shows simultaneity, interactivity, and global state variables. From (13) then we can see that the GST is the originator of all memory data. The example of the hospital room is a miniature scenario of the GST. The GST integrates our life activities, that is, all of our actions with all objects, over time and over space.

Memory generation by (13) is very similar to that of (1). Like in (1) every x is an object and every term in the right hand side (RHS) of (13) is an elemental action performed by some person. All the terms in RHS of any one equation, therefore represents the summation of all actions that all of us have performed together, simultaneously, and interactively. Since we are all changing all the time, each object is also changing all the time. This change is represented by the derivative of each elemental object in the left hand side of (13). The complete contribution of one person's actions in one of the equations is highlighted. The contribution of a second person is also highlighted similarly. Expression (13) is very large; there are more than millions of equations in millions of variables. The highlighted portions may even contain thousands of actions.

Expression (13) represents the actions we perform on objects to create the memory. Actual memory data is given by the solution vector x(t) in equation (14). Each component of the vector x(t) represents a data item as a value of an object. The RHS of (14) shows how every data-item is related to all the values of all objects taken at present time. Or in other words, it shows how each memory component is dependent on the values of all objects used by the entire population and not just by you and me. Since (13) is based on the law of conservation the solution (14) also represents that law, showing that the memory is preserved for eternity inside the GST. Thus the GST is not only the originator of the memory, it is the preserver of the memory also.

All of us simultaneously contributed to create the total memory defined by (14), so the complete solution, which is the total memory, cannot exist inside any one brain.

Also, the solution of any one variable of (14) is dependent on all other variables associated with all actions of all other persons. Therefore we cannot even create our own solutions; we can only contribute as actions via (13). Therefore the memory of any one variable cannot also be inside our brain. That is we cannot know the memory data completely.

Since the GST is outside the brain, the human memory cannot be inside our brain. We created the memory using (13), it must be outside us. The whole cannot be inside the part. It is inconsistent for the creation to remain inside the creator. The statement that seed contains the tree is very confusing. It takes land, water, sun, and time to produce the tree from the seed. The seed does not have the physical tree inside it. Thus the brain is only an input output processor and not the originator of total memory. It receives information from GST through our body sensors and performs actions accordingly, using our body sensors.

Thus we will never know what the true memory is. It is beyond even our comprehension, it is guided by the simultaneity and the complexity laws. All we can see or understand is the projection of a large multidimensional space on a very small hyper plane defined by you or me.

Using the theories of mathematics, physics, and system engineering, we have created a large scale global model of memory in GST starting from the microscopic definition and design of memory data element. The main results is that memory is outside our brain, it is inside nature, and is preserved for eternity. Our brain only helps to propagate the physical data; it only acts as an input output processing physical computer. The key idea of simultaneity law led to this concept of global memory in GST. Philosophically speaking, this concept has a profound impact in understanding of our behavior and the design of our society.

10. THE HUMAN BRAIN

There are few basic limitations we have in the exploration of human brain. First, we do not have meaningful access to human brains while it is in operation. We cannot layout the brain on a table, and use all different kinds of instruments to examine it thoroughly at all different test points. Without such an ability to test, we cannot really know anything about human brain. The human brain is filled with nerve cells, called Neurons [19]; more than hundred billions of them are there. In addition to neurons, the brain has almost ten times glial [20] [21] [22] cells. So the brain is far more complex than anything physical we can imagine in this universe. It is the best example of the complexity law. Thus all tests on brain will violate the simultaneity law.

Second, all the tools used in brain research are based only on electrical, electronic, or electromagnetic phenomenon of nature. We do not have tools that are chemical or biological in nature. The biological and chemical signals must be converted completely to electrical signals to derive information. We will never know how well we are converting all the features of these signals to electrical signals. Third, we are looking for the meaning of the memory data in this paper, and not just flow of electrical signals or dynamic activities of the brain, or the chemical composition of brain cells.

Fourth, the humans as subjects of experiments are inconsistent with the man-made technologies and associated test plans. A person may not try to remember things, may not want to remember things, and may not be interested in seeing the details [23] based on their philosophies and life time experiences with the GST. Thus all researches on human subjects may fail to show how the memory is generated and where it is located.

Mental imagery activates parietal areas, particularly intra-parietal sulcus [24]. It is believed also that brain operations are governed by both local activities and distributed networked activities [25]. These researches do not claim that the memory resides in that active region of brain, they only claim brain activities.

Some researches show that brain has short and long term memory storage space. But they have not identified any places inside the brain where these memory items are stored. Thus this storage categorization is functional and not brain hardware or structure related. This research cannot exclude the possibility that the memory is outside the brain. The research [26] shows that the storage capacity of long term memory is huge, which is consistent with the idea that the memory is outside the brain, therefore has infinite capacity. This will not deny the concept that our brain is only an input output processor like normal digital computers [27, pp. 207-213].

The paper [28] summarizes the confusions in research reports on the results of locations, localized vs distributed memory inside the brain. It has also been known that every human brain is physically and structurally unique for every person, that is, no two brains are same [29]. The author in [30] says that the human brain is a social organ; its physiological and neurological reactions are directly and profoundly shaped by social interactions which confirm our definition of memory and the GST concept of memory.

We see high correlation [31] between the size of brain volume of interests (VOI) and IQ, apparently indicating that intelligence is inside the brain. However this is related to only the electrical activity of the brain VOI. This experiment is inconclusive due to the fact that the

brain activity is not local as VOI, the spontaneous activity at rest [32] is an important contributor. Just to be clear, the brain memory scan images, like fMRI, only shows [33] how activities move inside the brain, bottom up, networked, constructive etc. It does not show any meaning of the memory data. It also does not indicate that the memory is stored in the brain.

The paper [34] reports an experiment where several electrodes were implanted bilaterally in the ventral hypothalamus. Once an electrode is stimulated the patient reported a perception of being in a park with friends. Standard perception of this experiment is that the image is stored in that specific location of the brain. However, it does not contradict the idea that brain is only accessing the image from the GST using our body sensors. Moreover, the reports also show that these experiments are not consistent and repeatable for other human subjects.

It appears that in cognitive science and in medical disciplines the word memory is used in a different context than the way we are using in this paper. The brain cells are considered as memory devices, but we have shown that they are physical objects and cannot store any abstract concepts. We have also considered the fact that memory is never generated by one person; therefore memory cannot reside inside our brain. In addition, we considered that every memory item has a meaning, which is defined using the simultaneity law. Without such a meaning, memory is meaningless.

11. CONCLUSIONS

Human memory has been defined as physical objects consisting of {data, action, purpose}. A purpose motivates us to perform some actions on some objects which generate the data. This data is the memory content and the purpose is its meaning. Without a purpose memory is meaningless. Every action we perform is linked, directly and indirectly, to the actions of many people of the world. We are not alone. The collection of all these actions and the corresponding global purpose creates the global memory and gives its meaning. Thus global space time (GST) environment is the originator of our memory and has the complete meaning. This GST is outside our brain. Thus our brain cannot know the meaning and therefore it cannot also have the memory. Our experiences show that we get a better meaning only when we exchange information with others.

ACKNOWLEDGMENT

The author wishes to thank our colleague and friend Hari Sankar Basak for his time and energy in reviewing the first version of the manuscript and giving many helpful suggestions and comments on the subject matter.

REFERENCES

[1] Murdocca, M. J. and Hearing, V. P. (2000), Principles of computer architecture, Prentice Hall, NJ.

[2] Sobel, C. P. (2001), The cognitive science, an interdisciplinary approach, Mayfield publishing, California

[3] Serway, R. A., & Jewett, J. W. (2004), Physics, for scientists and engineers with modern physics, 6th edition, Thomson, California.

[4] Chatfield, A. B., (1997), "Fundamentals of high accuracy inertial navigation", Progress in Astronautics and Aeronautics, Volume 174, Virginia, USA.

[5] Roger, R. M., (2003), "Applied mathematics in integrated navigation systems", second edition, AIAA, Virginia, USA.

[6] Christensen, R. & N. Fogh, (2008) "Inertial navigation systems", masters project, department of electronic systems, Aalborg University, Denmark, available at: http://www.control.aau.dk/uav/reports/08gr1030a/08gr1030a_student_report.pdf

[7] Hines,M.L. & Carneval,N.T. (2002), "The neuron simulation environment", handbook of brain theory and neural networks, MIT Press.

[8] Pentland,A. & Liu, A, (1999), "Modeling and prediction of human behavior", Neural computation,11, pp 229-242.

[9] Elwell, F. (2003), "The sociology of Karl Marx", Rogers State University, available free from: http://andromeda.rutgers.edu/~aristim/IMAGERY/Sociology%20of%20Marx.pdf

[10] White, A (2009), "Fighting fire with fire: technology finds a solution to sniper attacks", Jane's international defense review, June, available at:http://boomerang.bbn.com/docs/jane_june2009.pdf

[11] Kaku, Dr., YouTube, "Why Quantum Physics Ends the Free Will Debate" http://www.youtube.com/watch?v=lFLR5vNKiS&feature=related

[12] Eddington, A. S., *Space time and gravitation*, Cambridge university press, 1920.

[13] Das, S. (2012), "Conservation laws of nature", Journal of Applied Global Research, Vol. 5, Issue 12, pp. 21-41.

[14] Caldwell, J. & Ram, Y. M. (1999), Mathematical modeling, concepts and case studies, Kulwer academic publication, Netherlands, 1999.

[15] Farlow, J. et al. (2002), Differential equations & linear algebra, Prentice hall, New Jersey, US

[16] Bertalaffy, L. (1950), "An outline of general system theory", available free at: http://www.isnature.org/events/2009/Summer/r/Bertalanffy1950-GST_Outline_SELECT.pdf

[17] Halls, C. et al.(2001)The need to reintegrate the natural science into economics, see internet site: http://dieoff.org/page228.pdf

[18] Rowel, D. (2004), MIT, "Linear graph modeling: state equation formulation", department of mechanical engineering, advanced system dynamics and control, 2004, available at: http://web.mit.edu/2.151/www/Handouts/EqFormulation.pdf

[19] Discovery,(2007), Neurons, How they work, Discovery channel video, http://www.youtube.com/watch?v=c5cab4hgmoE

[20] Byron, J. R. (2009), "Glial Cell Function Vital for Learning", Articlesbase, http://www.articlesbase.com/mental-health-articles/glial-cell-function-vital-for-learning-1291345.html

[21] Kast, B. (2001), "The best supporting actors", News feature, Nature, 16 August, Vol-412.

[22] Noback, C. R. et al. (2005), The human nervous system, structure and functions, sixth edition, Humana Press, NJ.

[23] Desimone, R. (2007), "How the brain pays attention", MIT, Published in Forum for the future of higher education, Cambridge, Mass.

[24] Just, M. A, (2008), "What brain imaging can tell us about embodies meaning", Carnegie Mellon, published in Symbol, and embodiment, Oxford Univ. Press

[25] Edwards, S. et al. (2009), "Cognitive neuroscience: Understanding complex human behavior and the brain", Published in - On the brain, Harvard Mahoney neuroscience institute, Winter, Vol. 15, No. 1.

[26] Brady, T. F, et al., (2008), "Visual long-term memory has a massive storage capacity for object details", MIT, Published in PNAS, Vol. 105, No. 38, pp 14325-14329.

[27] Comer, D. E. (2005), Essentials of computer architecture, Prentice Hall, NJ.

[28] Motah, M (2006), "The ontogeny of memory and learning: natural intelligence versus artificial intelligence in information technology education", Univ. Tech, Mauritius, Published in Proc. Info. Sc. & IT Edu. Conference, Salford, UK.

[29] Kirchhoff, B. A., et al. (2006), "Functional-anatomic correlates of individual differences in memory", Washington Univ., Published in Neuron, July 20, pp 263-274.

[30] Rock, D. (2009), "Managing with the brain in mind", Oxford leadership journal, December, Vol.1, Issue 1.

[31] Haier, R. j., et al. (2004), "Structural brain variation and general intelligence", UC Irvine, Published in NeuroImage, Vol. 23, pp. 425-433.

[32] Song, M. et al. (2008), "Brain spontaneous functional connectivity and intelligence", Chinese Academy of Science, Published in NeuroImage, Vol 41, pp. 1168-1176.

[33] Strauss, S. L., et al. (2009), "Brain research and reading: how emerging concepts in neuroscience support a meaning construction view of the reading process", Educational research and review, Vol. 4(2), pp. 021-033, February.

[34] Hamani, C. et al. (2008), "Memory enhancement induced by hypothalamic/fornix deep brain stimulation", Univ. Toronto, Canada, Wiley Interscience, DOI 10.1002/ana.21295.