Reconsideration of the Functions to Explain a Kind of New Information Amount and a Functional Model of Neural and Brain System Taking Account of the Philosophical Existence and the Hyperfunction

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Abstract. In this paper, there is described a consideration of the functions to explain the new information system and the neural and brain functional system models. In this consideration it is proposed to introduce the hyperfunction as the base functions to explain the new information system and the neural and brain functional system model. For this proposal here firstly the brief history of this research is described and in this description the philosophical methods of this research are discussed and the adaption of interpretant (the element of Peirce’s Semiotics) is explained as the philosophical existence. Secondly the compartment system is described as a basic system for synthesizing the new information system model and the neural and brain functional system model. And there the consideration of functions to explain these systems is extended and the meaning of hyperfunction is expressed and as a result the proposal that on analyzing these systems the introduction of the hyperfunctions as the explaining functions of these systems is useful and should be used is described. And finally, the conclusion and future works are described.

Introduction

Firstly, through researching the communication systems among the blind deaf persons and others (of course, including ordinary persons) the studies and developments of the information systems themselves which are the basic element systems of communication systems, especially communication tool systems have been needed. Especially as the communication system a mobile communicating system was developed, and at same time it was discussed for it to be embedded into the Life Support System that came from the original expanded EMR(electric or electronic medical record). By the way we now call the EMR which has some expanded functions in it as the expanded EMR, and this expanded system has been still studied. Therefore, totally to unify these systems as the basic theory the study of consideration and theory of the information system itself became important and was needed. And the functions of neural and brain system to be obtained from the study of the dementia situation were additonally researched. Through these subjects the studies of new information theory have been developed. This cosideration of new information theory needs the discussion with regard to the inner and essential meaning of information itself, and needs the discussion over the ordinary Shannon’s information theory. Therefore in previous papers the following three consideration methods of these new information theories and the neural and brain functional system models were discussed.[1-5]

That is:
1. Discussing freely and voluntarily some entire different models of new information system and amount and the neural and brain functional system models from the ordinary Shannon’s information theory models.
2. Considering some philosophical existences for deriving some new information systen and amount and the neural and brain functional system models.
3. Structuring some expanded models of new information system and amount and the neural and brain functional system models from the base of ordinary Shannon’s information theory.
In this paper the discussion to be mixed with two methods is performed, that is; the discussion to be mixed with two methods of the consideration of the philosophical existences and the expansion of ordinary Shannon’s information theory is performed. On this mixed method the Peirce’s semiotics was adapted for the consideration of philosophical existence. Namely, considering Peirce’s semiotics, the compartment system models are applied to the interpretant that is a philosophical existence of Peirce’s semiotics. Then in the following chapters the brief description about mobile communication system and information system are given and the function of interpretant of Peirce’s semiotics and the application of the new information system models and the neural and brain functional system models to it are briefly described with explaining compartment system models and their expanded circuit models. After that, the functions that are used on the applied system models are discussed and the usefulness and necessity of introduction of hyperfunctions are considered. As a result, the proposal that the introduction of hyperfunctions to analyze basic characters of these system models is useful and should be performed is described. Finally the conclusion and future works are expressed. [1-5]

The Brief Sequence to this Researches

A. The Expanded EMR and The Mobile Communication System

For the blind deaf persons the communication system has been studied. This research was firstly the development of electronic devices to communicate among these handicapped persons and ordinary peoples. There these devices were developed on the information system taking account of the ordinary Shannon’s theory. Concretely speaking, as communication tools the mobile tools to be embedded into the Life Support System to be expanded from the EMR were developed on the Finger Braille system structured from ordinary Braille system. These systems are shown at the following figures; Figure 1, Figure 2, Figure 3.

![Figure 1. The correspondence of Braille and the Finger Braille.](image1)

![Figure 2. The Finger Braille.](image2)

![Figure 3. The Mobile Tools (Left:Ver.1, Right: Ver.2).](image3)

But, such system and techniques on communication were not sufficient ones in order to communicate among these handicapped persons and ordinary peoples, and therefore the necessity of the consideration about information itself arose. Then, the Peirce’s semiotics was adapted with regard to consideration of the philosophical existences, especially, the interpretants of the Peirce’s semiotics were discussed. Of course, until now this system has continuously improved. [1-3]
B. The Interpretants of the Peirce’s Semiotics

Taking account of the philosophical existences, in this paper, the Peirce’s semiotics and the consideration of the concept of Triadic relations of it are adapted as same as previous papers. Therefore, at the following a brief explanation of the Peirce’s semiotics and the Triadic relations and an expansion method of them are described. That is:

In the Triadic relations, a sign is something to stand to somebody (interpretant) for something (an object). The triadic relations are shown in the following Figure 4. From this figure 4 it can be understood that when a hunter finds a damaged certain tree in a forest he supposes that a deer is in his neighborhood. Namely the triadic relations are synthesized by the three elements of the "a wound (a sign) of a tree", the "deer (an object)" and the "knowledge / experience (interpretant) of a hunter". Here the new characters are applied to the interpretants to derive a new system theory. Especially at this time the characters of hyperfunctions are given to the functions that explain this new information system characters and the neural and brain functional systems models. In previous papers for explaining these functions of these system characters the simple probability factors and some probability distribution characters were applied, here including those concepts the hyperfunctions are introduced, for considering the real physiological and physical situation of neural and brain works, the effect of the quantum theory and the theory of relativity and Dirac equation influences this system working even if it is very few because these theories are the fundamental theories of the Universe that exists now. Therefore, it is meaningful and useful that as an analogy the functions to be used in those theories are introduced into the new information system theories and the neural and brain functional system models. Then the hyperfunctions are introduced to analyze the researching systems of this time. [3-5]

![Figure 4. Triadic relations of a sign process.](image)

C. Application of Compartment System to the Information and Brain Functional Model

In this paper, the compartment system concepts are introduced into the new information system theories and the neural and brain functional system models as same as introduced in the previous papers. Therefore, the brief description of the compartment system concepts and the general and ordinary compartment system expression are given as the following formulas.

\[
d x/dt = A x, \quad \text{or} \quad d x/dt = A x + Bu
\]

...(1)

Here \( A \) is a transfer matrix, \( x \) is the state variable vector, \( Bu \) is controllable term and \( t \) is time.

Using the Laplace transformation of formula (1) the expansion of compartment system to a circuit-like model is obtained as the following Figure 5.

![Figure 5. The model of the circuit-like elements.](image)
Here this circuit-like model is discussed on the following assumptions.

1. Every \( i(t) \) satisfies the Ohm’s Law and the characteristics of capacitance on the every node.
2. Every \( i(t) \) satisfies the Kirchhoff’s current Law on the every node. And generally \( g_{ik} \neq g_{ki} \) (the conductance-likes) is defined.

In the previous papers the compartment model was applied to the interpretants and the probability was distributed to the elements that structured the circuit-like models. In this paper the hyperfunctions are introduced to analyze the applied characters of the circuit-like elements and information system models, for considering the analogy of the quantum theory and the theory of relativity that rule the today’s now universe it can be estimated that not only the ordinary continuous functions but also the hyperfunctions are able to explain such a working situation of applied factors to above systems and models as the functional dynamics of these systems.

**Introduce of Hyperfunctions**

In order to analyze and synthesize the new information system theory and the neural and brain functional system models the concept of hyperfunctions is introduced. When physical analysis is performed the \( \delta \) function that was proposed by Dirac is very convenient and useful in mathematical calculation, for instance, considering the Laplace transformation

\[
L[\delta(t)] = \int_{-\infty}^{+\infty} e^{-st} \delta(t) dt = \int_{-\infty}^{+\infty} \delta(t) e^{-st} dt = 1
\]

…..(2)

and if the transfer function is \( T(s); s \) is the complex valuable“ and input function \( v_i(t) \) is \( \delta(t) \), as the Laplace transformation of output function \( v_o(t) \); \( L[v_o(t)] = v_o(s) = L[\delta(t)]T(s) = T(s) \), the output function \( v_o(t) \) is able to be obtained from Laplace inverse transformation of \( T(s) \). That is;

The output function \( v_o(t) \) can be calculated by the following Bromwich integral.

\[
v_o(t) = L^{-1}[v_o(s)] = L^{-1}[T(s)] = \frac{1}{2\pi j} \int_{a-j\infty}^{a+j\infty} e^{st}T(s)ds
\]

…..(3)

Although this example is most simple case, even such \( \delta \) function is able to make the structure of the system expressed with some transfer function clear on the meaning of time response. As being able to understand from such a instance the introduce and use of the hyperfunctions are useful especially on the analysis of these circuit-like systems. And at the following the hyperfunction’s characters able to be introduced as simple \( \delta \) function are described.

**A. Hyperfunction and Derivative of Discontinuous Function.**

Here the derivatives of discontinuous functions are defined, and the relations among the hyperfunctions and them are discussed. Now a simple discontinuous function “Unit Step Function” and its derivative are discussed at the following.

Unit Step Function:

\[
U(t) = \begin{cases} 
0, & t < 0 \\
\frac{1}{2}, & t = 0 \\
1, & t > 0 
\end{cases}
\]

…..(4)

And the derivative of the unit step function is defined as following.

\[
\frac{d}{dt} U(t) = \delta(t)
\]

…..(5)

Therefore next formulas can be obtained. When \( f(t) \) is discontinuous at \( t=a \) as follows
\[ f(t), t < a \]
\[ f(t) = \begin{cases} 
\frac{1}{2} \{ f(a+0) + f(a-0) \}, & t = a \\ 0, & t > a \end{cases} \]  
(6)

\[ f(t), t > a \]

Then in \( f'(t) \) the \( \delta \) function; \( \delta(t-a) \) appears. Consequently, for \( t = a_k; k = 1 \sim n \), \( b_k; k = 1 \sim n \)

\[ g(t) \equiv f(t) - \sum_{k=1}^{n} b_k U(t-a_k), \quad f(t) = g(t) + \sum_{k=1}^{n} b_k U(t-a_k) \]  
(7)

then

\[ \frac{d}{dt} f(t) = \frac{d}{dt} g(t) + \sum_{k=1}^{n} b_k \delta(t-a_k) \]  
(8)

is derived. And usually noting,

\[ f'(t) = f'(t) + \sum_{k=1}^{n} b_k \delta(t-a_k) \]  
(9)

is able to be noted. Here is the notice; \( f'(t) \) of left side \( \neq \) \( f'(t) \) of right side in formula (9). Therefore when the circuit-like models, especially for the differential circuits to be emmbeded in them are considered, not only simple \( \delta \) function but also the discontinuous function too can be introduced into the discussion of analysis of these systems and models.

### Conclusion and the Future Works

The continuous subjects about new information theory have been solved little by little. In this paper, it is described that the functions applicable to the new information theories and the neural and brain functional system models were extended to the hyperfunctions and such a consideration as expanding functions is useful and should be developed for understanding the dynamics behind these systems. As a result, the consideration of hyperfunctions is proposed on above meaning. And the future work needs the discussion of expanding the area of hyperfunctions applicable to these systems and the consideration of the more useful characteristics of hyperfunctions.

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### References


