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Evaluation of the Validity of Chaos Theory Based on Systems Thinking for Non-Physicists

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Abstract

Chaos theory was born in the 18th century, physicists still solve the nonlinear dynamic systematic problems within closed-loop systems such as ecosystems, three-body problems involving complexity, and others. Moreover, it has been resolved these problems based on logical thinking using logical solutions with algebra and statistics such as chaos theory. The reason is determinism. Nevertheless, other scientists do not welcome the old chaos theory because the chaos theory is very imperfect and vague. Amazingly, in 2021, there is emerged, and an advanced and systematic solution based on system thinking; it was resolved by a non-physicist on behalf of physicists through interdisciplinary science and it is more perfect than the old chaos theory. Therefore, it is similar to the New World discovered by Columbus. This paper will prove that the existing chaos theory is invalid as a new solution emerges. Nevertheless, current physicists avoid approaching this study as much as possible. Therefore, other scientists have no reason to follow their invalid chaos theory unless physicists prove the validity of chaos theory.

Keywords

Nonlinear Dynamics, Control Theory, MATLAB, Systems Thinking

1. Introduction

This study is concerned with the validity of the chaos theory in modern science. In general, chaos theory has been used to solve nonlinear dynamic systematic problems such as ecosystems and others involving complexity [1] for a long time. It has been arranged and made by classical physicists based on logical thinking using algebra and statistics. However, no one has doubted its validity because other scientists have no choice. Nevertheless, non-physicists did not welcome it be-

cause it is imperfect and ambiguous. In 2021, an advanced systematic solution emerged in modern science, as shown in Table 1 [2] [3]. It will be replaced the chaos theory. It is similar to the New World discovered by Columbus. Hence, this study will examine and evaluate the validity of chaos theory in Table 1 from the point of view of a non-physicist.

Please non-physicists read carefully. The new solution in Table 1 was resolved by a non-physicist on behalf of a physicist via interdisciplinary research between physics and engineering. It is shocking to physicists and other scientists because it has not ever been seen before such as in the New World discovered by Columbus. Because there is no perfect systematic solution in modern science. Unfortunately, determinists have not known another systematic solution except their chaos theory based on logical thinking. However, it does not matter, because physicists' thoughts suddenly turned into silence. In other words, they do not deny but also do not adopt. Why do physicists not deny and reject it? This study will explain the reason to the readers here.

(Topic): Regrettably, this study is unwelcomed by physicists, but there is no problem because this study is not written for physicists. In Table 1, the left column is on the existing solution (chaos theory), and the right column is the new solution, it is an achievement in modern science. Remarkably, the new solution shown in Table 1 was not relevant to traditional physics and its basic concept of the solution lies in engineering. Hence, it must be resolved through interdisciplinary science; moreover, it is finished to be proved and verified using experiments in real circumstances. It is a New World if it is true, we need not chaos theory anymore. For more details, please refer to Subsection 2.4.

For a long time, physical scientists have not classified physical phenomena in nature into logical and systematic problems but both problems as the same logical problems. Accordingly, there is no perfect systematical solution in modern science, because it depends on determinism. However, no physicists think it is weird; this is a mistake for physicists, and it has nothing to do with other scientists. Moreover, physicists never tried to find a systematic solution. Therefore,

Table 1. Comparison of the old and new solution for nonlinear dynamics.

Solution	Existing Solution (Chaos theory)	The New Solution (Subsection 2.4) ← old systematic solution
Solving Process	Approaching **the systematic problems** based on logical thinking with macroscopic linear static viewpoints, and then, it is solved by logical solution such as algebra and statistics	Approaching the systematic problems based on system thinking with microscopic nonlinear dynamic viewpoints, and then, it is solved by systematic solution such as systems analysis theory
Paradigm	Paradigm of the Logical Thinking in Determinism	Paradigm of the Systematic Thinking in Non-Determinism

classical physicists have attempted to solve systematic problems such as ecological systems using algebra and statistics such as chaos theory. Therefore, determinists still do not comprehend what is the paradigm of system thinking.

(Issues): Lately, most physicists have suddenly suspended criticizing this solution; moreover, they do not deny nor approach this research from 2022. Here is a peculiar reason for it. Recently, the author has received several rejection comments from influential physical journals. Ironically, most physicists around the world regard this research as a third science that has nothing to do with deterministic physics, and they want to remain outsiders and a third party, the reason is to want to avoid any risk. What is the above-mentioned reason? And why do they change their thinking about the new solution? Because they are confirmed the real evidence, which is indirectly proved the practical application example such as the science of system dynamics (SD science) [4] in modern science; it is presented in Subsection 2.3.

Regrettably, this is similar to the medieval Galileo assertion. It was proved by Kepler's telescope. While all physicists believe that the chaos theory is widely used in all disciplines, but SD science does not only use chaos theory, but also does it have no relation to physics. Amazingly, the reason is that they have their own smart systematical solution. Thus, it is proven the new above solution, it is like medieval Magellan's work in proving that the Earth is round Furthermore, it proved the invalidity of chaos theory. Because of, most physicists fell into silence continuously without objection. If so, what value does the new theory hold? It is the same as the discovery of the New World by medieval Columbus; it will be expanded academic fields.

Paradoxically, determinists make silent and remain the third party, they want to avoid the risk. Nevertheless, other scientists in the world already know what they want. If current physicists intentionally avoid adopting the new solution, other scientists would build an independent academic discipline, such as SD science on behalf of physicists in the future.

2. Materials and Methods

2.1. Scientific Background

This section will explain the differences between the scientific background of the existing chaos theory and the above new solutions. In particular, non-physicists should not approach this research result thesis emotionally, because the new solution will be a revolutionary achievement for modern science. For instance, this study will invalidate the famous chaos theory and butterfly effect, but other scientists have no reason to follow them with sympathy, because it has nothing to do with non-physicists. On the other hand, we have a question in modern physics, why do physicists solve systematical problems such as ecosystems within closed-loop systems algebraically? It is because of determinism. Determinists decompose nonlinear phenomena into multiple pieces based on determinism, solve them using algebra and statistics, and do not consider their mechanisms

hidden within. It is like a surgeon treating an internal patient with surgery and without medication.

(Chaos Theory) [5]: Chaos theory was made using algebra by classical physicists in the 17th century when there was no mathematical tool to problems such as food chain in ecological systems (circulatory system) or the three-body problems [6], and it is still being used. [Remark; the historical background of chaos theory began in the 1880s. Henri Poincaré studying the three-body problem is considered the founding father of the chaos theory.] Classical physicists approached nonlinear dynamics such as ecological systems or the three-body problem based on logical thinking with macroscopic linear static viewpoints and then solved it using logical solutions such as chaos theory, which is composed of algebra and statistics. It is because of determinism. Otherwise, if the chaos theory is perfect, they would have already resolved the unsolved three-body problem, quantum mechanics, or uncertainty theory, including food chains in ecological systems.

2.2. Overview of the New Solution

However, we can compare both the old and new solutions in Table 1. Although physicists have solved nonlinear dynamics using chaos theory algebraically, we will solve these problems systematically in the future. While physicists have treated these problems as a black box as shown in Figure 1(b) lower but the new solution is different from deterministic physics. The new solution is approached based on system thinking [7] with microscopic nonlinear dynamic viewpoints, and then, solve using systematic solution such as the systems analysis theory as shown in Figure 1(a) [8] [9]; it has not used in physical science.

Therefore, the above mentioned the systems analyzing theory in engineering science is not familiar with all scientists except control engineers. It has been developed for designing of factory automation in the 20th century by engineers. Thus, it only is resolved via an interdisciplinary science between physics and
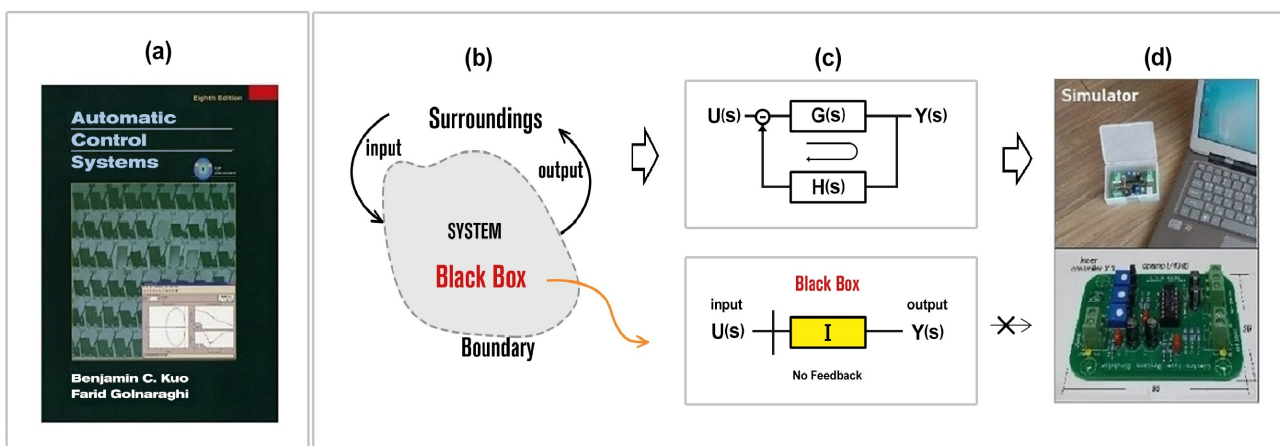

Figure 1. (a) Textbook on control theory; (b) Basic system; (c) Block diagram of internal mechanism of feedback system; (d) Analog type simulator.

engineering. In addition, it is proved the validity by experiment with a computer program MATLAB [10] and a novel analog simulator, as shown in **Figure 1(d)**. If someone wants to confirm the validity of the new solution, they can do it at any time.

(Problems): Chaos theory is just an algebraic solution for nonlinear dynamics such as ecological systems based on determinism; it has expressed as Irregularities, regularities, self-organizations and the initial phenomena. Thus, it is not entirely systematical solution. If a non-physicist fully understands this reason, then, no one would like to use the chaos theory. However, physicists will know the problem, and the representative evidence is SD science. Amazingly, they have no relation with determinism, nor do they use chaos theory. Because they solve their problems based on systems thinking. However, no physicists are not welcome, so this study will be published in non-physical journals.

2.3. Overview of Simplified Solution in SD Science

How can SD science solve it systematically? They have their own a smart simplified systematic solution. Usually, tradition physics has treated such ecological systems as a black box in logical problem as shown in **Figure 1(b)**. However, the SD science intentionally divided the causal relation into two elements as if a positive element $Q(s)$ and negative element $H(s)$, as well as, active element and reactive element at first; it is like seller and buyer in stock market. In this case, its internal mechanism can explain it with the time chart as shown in **Figure 2(a)**.

Next, we find the original function of each element $q(t)$ and $h(t-d)$ with dynamic properties, then, they subtract the two functions as follow; [Positive element function $Q(s)$ – Negative elopement function $H(s) = Y(s) \to 0$]. If so, the output function $Y(s)$ will converge to 1 (equilibrium) while repeatedly increasing and decreasing. We can observe it in **Figure 2(a)**. In addition, we can transform the causal relation into **Figure 1(c)** and we can survey the sum $Y(s)$ in real
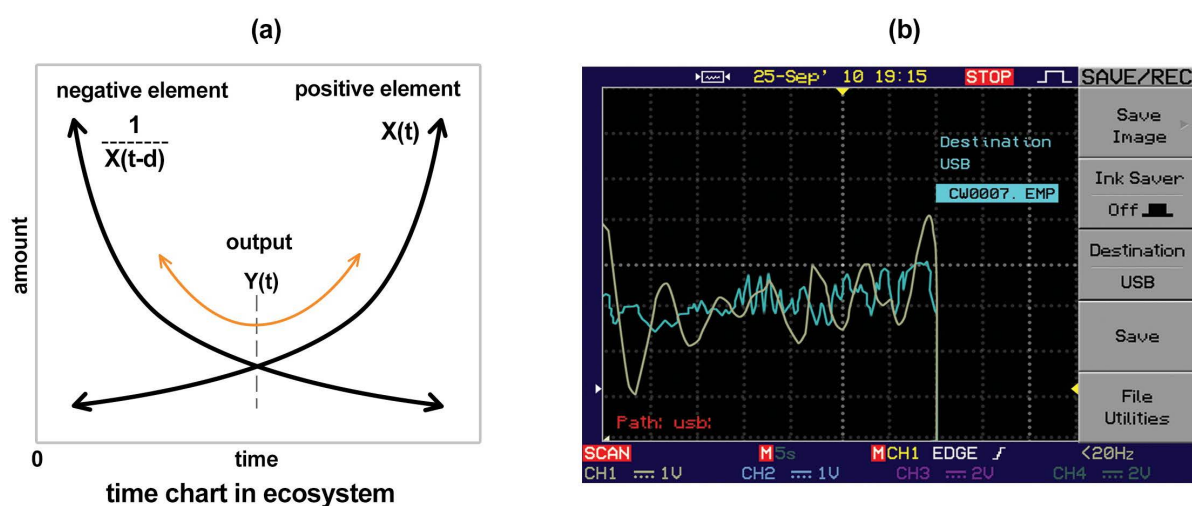

Figure 2. (a) Time chart in ecosystem; (b) Computer screen; behavior of output of nonlinear dynamics systems (blue line is input, yellow line is output) Video clip; ULR https://www.youtube.com/watch?v=DrfyX9o3x7A&feature=youtu.be.

time. It means that SD science is to approach by systems thinking. If so, they obtained to derive the results (tendency) they wanted. Thus, it is a very reasonable idea for them.

To help the readers understanding, this study resolves a logistic function of population growth [11]; it is expressed as Equation (1), its first term is positive element and the second term is negative element.

$$\frac{dP}{dt} = aP - bP^2 \quad [a \text{ and } b \text{ is constant}, P \text{ is population}] \tag{1}$$

Thus, it is the same concept as shown in **Figure 2(a)**. It will be converged to saturation in time by itself. In here, we can understand why SD science does not to use the chaos theory. It means that SD science is like the Magellan who proved that the earth is round by circumnavigating the world. If other scientists understand above description, they have no reason to follow their chaos theory.

2.4. Overview of Truly Original Systematic Solution

This section introduces only the systematic solution. Problems with nonlinear dynamic dynamics such as ecosystems or market should be regarding and approached as a loop feedback system as shown in **Figure 1(c)**. This is the basic concept. If so, we can easily analyze **Figure 1(c)** using the systems analysis theory in other science. If someone wants to solve the three-body problems or ecosystems, we need to build a model system as shown in **Figure 1(c)**, and then, we can analyze the model systems by the systems analysis theory as mentioned above. If physicists do not study through interdisciplinary science, they are impossible to solve the problem eternally. However, non-physicists have no reason to avoid it. To help their understanding, this study presents the mathematical result as below. The real output function $y(t)$ in **Figure 1(c)** is determined as Equation (2). In convenience, only the output equation is quoted here, please do not misunderstand.

$$y(t) = 1 - A \cdot e^{-B \cdot t} \sin(W \cdot t + \varphi)$$
$$\left[A = \frac{1}{\sqrt{1 - \beta^2}}, B = \beta\omega, W = \omega\sqrt{1 - \beta^2}, \varphi = \cos^{-1}\beta \right] \tag{2}$$

where $y(t)$ is the real output, $[t]$ is the time, and β denotes the damping factor. However, some scientists are not familiar to Equation (2); it is very esoteric and technical; so it needs explanation. We must notice the damping factor β in Equation (2). If we can control the factor β, we can easily reproduce all types of the nonlinear dynamics by adjusting β. We can obtain the simulation result as shown in **Figure 2(b)** in screen display; it can be observed by computer or simulator. Amazingly, **Figure 2(b)** has presented what complexity's characteristics are. Therefore, we can explain what the origin of the chaos [12] is through Equation (2).

This study detailed for the reader. It has included an exponential function and a periodic function, and both functions are overlapped. And then, the time $[t]$ is

past, the output become gradually saturation and equilibrium state. Thus, it is a time series function, moreover, it is realized the behaviors of irregularities, regularities (fractal), self-organization, and initial phenomena (butterfly effect) in real time in screen as shown in Figure 2(b); please refer to attached video clip. If someone wants to confirm the result, he/she can do it with the devices [13]. To prove the above description, this study presents a practical application example in Subsection 2.5. It will prove that the Lorenz's assertion invalidated with the new solution.

To return, we have a question. Why physicists do not solve systematically? The reason is originated from determinism. Ironically, determinists do not adopt the systematical solution other science. It has nothing to do with other scientists. Nevertheless, if they keep on using chaos theory to the end, other scientists on behalf of them will solve the unsolved nonlinear dynamics including physics.

2.5. Proof of Imperfection of Lorenz's Butterfly-Effect

In here, this study presents the butterfly effect [14] as an application example to non-physicists. And this study will prove that the butterfly effect is invalid, but this will be very shocking to all scientists as if medieval the heliocentric theory; thus, it is not an emotional problem. It is related with the achievement of meteorologist Lorenz. Ironically, other scientists have known Lorenz's assertions as physical law.

In this study, it will be examined the validity of his assertion. In this case, it can examined following four steps; modeling, simulation, verification, and return.

(Modeling): In general, physical phenomena such as ecological systems can be defined as systematical problems within open or closed loop systems, it can be transformed into Figure 1(c). For instance, if there is no feedback element $H(s)$, it is open loop systems; it is algebraic logical problems. Otherwise, if it has feedback elements $H(s)$ as if the food chain (circulation system) or stock market, we can solve Figure 1(c) using the systems analysis theory in above Subsection 2.4. As the result, we are easily obtained the output such as Equation (2) through computer MATLAB or analog simulator as shown in Figure 1(d).

(Simulation): The answer to this problem depends on the damping factor β in Equation (2) above. If we can use the program MATLAB as mentioned above, we can reproduce the butterfly effect. The initial phenomenon is a rapid increase in a short time and promptly disappeared. When the damping factor β is smaller than 1 (critical damping) and close to zero, it is reproduced. Thus, it is similar to an overshooting or an electrical impulse, which is appeared and promptly disappears. We can observe it in Figure 2(b). Thus, it is only appeared in systematic problems, such as stock market or other complex systems.

(Verification): Regrettably, meteorologist Lorenz, who is not an engineer, has misunderstood the overshooting in the initial phenomenon as a butterfly-effect

without theoretical background because he did not consider the energy conservation in nature. He thought that it was appeared accidentally. Therefore, there is no existed Brazilian butterfly in nature. It seems his fabrication

3. Results

From the summary above, the following results can be made.

- In modern science based on determinism, there is no perfect systematic solution based on systems thinking for resolving nonlinear dynamics.
- It is unsuitable for systematical problems because it is a logical solution using algebra and statistics based on logical thinking. It depends on determinism.
- In 2021, an advanced new solution emerged, as shown in Table 1, which will replace the old chaos theory. Hence, chaos theory is invalid.
- Thus, non-physicists should be resolved by the new solution. It is revolutionary to physicists, and it is similar to the New World.
- If physicists avoid it, other scientists will build an independent academic discipline like SD science in modern science.

4. Discussions

In this study, the old chaos theory based on logical thinking and a new systematic solution based on systems thinking were presented, as shown in Table 1. Furthermore, regardless of the proposed new solution, the existing chaos theory has proved imperfect and invalid. To prove the result, the author this is presented evidence such as SD science including the smart systematic solution. Moreover, presented the theoretical background and a practical application example to all scientists, and that is evidence that can never be hidden.

Because of, physicists changed their thinking suddenly, because they are unable to deny the above evidence. Instead, they argue and recommend research in other fields of science other such as metaphysics than current physics, arguing that the above new solutions are not suitable for physics. However, it is an absurd response. It means that physicists want to remain as a third party; further, it is to run away to avoid academic responsibility. If so, non-physicists in all fields will not be followed the chaos theory and support their determinism no more. Especially, if physicists hide the problems of the chaos theory from other scientists.

If a physicist adheres to the current chaos theory, refuses to adopt a new solution to protect it, and wishes to treat it as a third science or metaphysics, then this solution has nothing to do with the physicist anymore. Therefore, it should be independently studied according to the intentions of non-physicists. So, in the future, non-physicists will study on behalf of physicists even physical phenomena such as three-body problems, quantum mechanics, or uncertain theories; moreover, metaphysical problems in other science.

On the other hand, here is a suggestion to other scientists. Meanwhile, physicists are trying to bring physics into other disciplines, including economics, and

there are institutions that support it. There is already a well-known Santa Fe Institute [15], which uses physics to study complexity for a long time. It would be nice to have physicists solve for nonlinear dynamics based on the new solution. Nevertheless, if physicists avoid it, there is another way. Other scientists will build an independent academic discipline in modern science, such as SD science. It has no risk and also no relation to physicists.

5. Conclusions

The final goal of this paper is to prove the invalidity of the chaos theory and to propose the above-mentioned new systematic solution to all scientists. Physicists in 2021 strongly opposed this, but in 2022, they do not oppose it but are silent. Then, there would be no more argument with the author and any non-physicist would be free to use both solutions. This is the New World we are looking for, moreover, it will contribute to the advance of physics. Finally, the author makes the following declaration:

(Declaration): This study declares to all non-physicists as following; the chaos theory in traditional physics has been solved by algebra and statistics based on determinism. However, it is not resolved based on systems thinking but on logical thinking. Hence, the old chaos theory is invalid. Nevertheless, if physicists avoid adopting the new solution, this study encourages other scientists to build a new independent academic discipline such as SD science. It will be a New World in science.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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