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Short Communication

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New Solution to Nonlinear, Dynamic, Systematic Problems in Statistical Physics by Control Theory in Engineering Science

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Abstract

This paper presents as advanced solution for nonlinear, dynamic, systematical problems involving complexity, multidisciplinary sciences, such as prediction of stock prices, food chain in ecological systems, and mechanical disturbances. This study proposes an idea for a systematical solution to these problems. Most scientist misunderstand it as a black box, but it can be solve based on the control theory of engineering science; hence, it is not different from the old chaos theory, moreover, are not relevant to determinism. However, the chaos theory developed by classical physics in the 17th century, it is a banal and degenerate theory because it was developed new solution in the 20th century by engineers. Nevertheless, physicists do not welcome the advanced solution because it is against determinism. Hence, it is separated from physics and adopted by engineering science. Scientists can apply either solution to their discipline. To prove this solution, four application examples, such as Kuhn's innovation theory and Lorenz's butterfly effect, are provided.

KEYWORDS

nonlinear dynamics; indeterminism; MATLAB, butterfly effect, control theory

1. INTRODUCTION

This study presents an interesting finding on an advanced solution for nonlinear, dynamic, systematical phenomena involving complexity in modern science. Such multidisciplinary problems have remained unsolved for approximately three hundred years because these are systematical problems with negative (positive) feedback element, for example, quantum theory, ice age, three-body problem, stock market predictions, food chains in ecology, mechanical disturbances, climate change, nuclear reactor dynamics, and turbulence. We need to consider the reason why physicists have been unable to solve these problems, there is a serious problem behind their discipline. In this paper, the author will easily describe the reason and proposed a solution this paper. Please read carefully.

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(Background) – In 2015, the author discovered a secret problem in traditional physics: modern physicists misunderstood the unsolved, nonlinear systems as a **black box**; refer to reference [3]. Classical physicists in the 17th century solved the nonlinear systematical problems mentioned above using algebraic logical solutions, such as the existing chaos theory from statistical physics, but it is imperfect, vague, and difficult for some scientists. However, it is not their mistake as there is no perfect solution for systematical problems at that time. Surprisingly, the author was achieved perfect solution in 2015 and released it [3], In addition, he proposed a novel simulator as shown in Figure 1(a); it has not ever seen before. Anyone always is able to confirm the validity by their hand. Therefore, it need not the verification.

Unfortunately, there is no response on the report from physicists. Because the new solution has not only ever seen it before like the Copernican Theory but also, they have information about the modern control theory in systems science; moreover, it did not follow determinism. Moreover, if they accepted it, they must withdraw the chaos theory; it is not pleasure and disadvantage to them. However, other scientists have no reason to reject this solution, but they hesitate to adopt it because they are unfamiliar to the control theory including simulation program MATLAB; moreover, they have no experience of successful application example. Therefore, to help other scientists understanding, this paper will present practical application examples in herein.

There is the other problem behind them, if they adopted the new solution, they discarded the chaos theory; but it is a damage to their pride like Galileo's wok. Such is an unexpected problem, so that the author changes the assertion that all scientists can be applied both the old chaos theory and the new solution to their unsolved problems. Because both solutions are not contradictory to each other and it has no risk. Accordingly, physicists have no reason to ignore and object this solution because they should be solved above mentioned challenges; it is very advantage solution to physicists, as well as, engineering scientists and other scientists can be utilized both solutions. In order to, if the physicists agreed with, the new solution is separated from physical science and transfer to systems science or engineering science. Because most physicists are not familiar to the control theory it is not based on determinism.

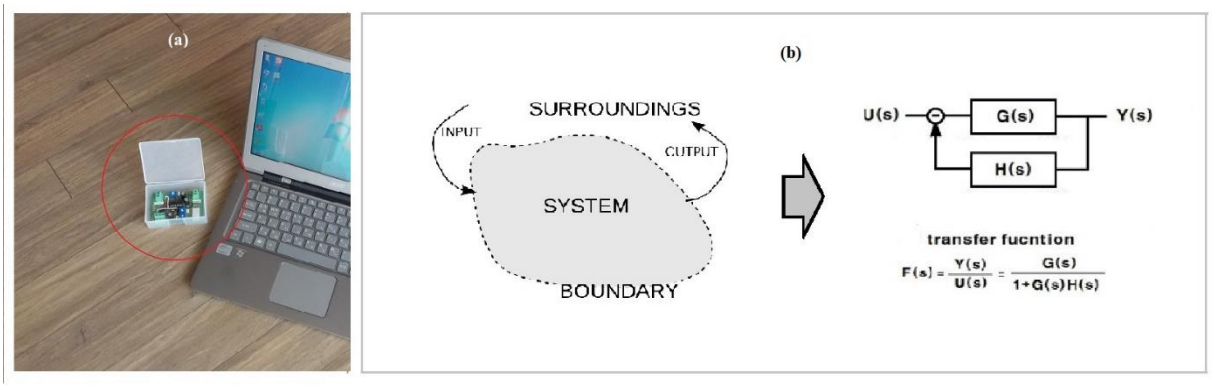

Figure 1 (a) Mechanism of Systems and Basic Block Diagram (b) Control Theory Textbook

Summarized above description; 1) presentation of application examples; 2) allowance of applied both solutions; 3) separation of both solutions. Meanwhile, the reader pays attention to the Figure 1(a) and 1(b). The basic concept in this paper is shown in Figure 1(b) and it can be solved by the reference book as shown in Figure 2(a). Then, anyone can be reproduced the behavior of nonlinear systematical problems though the simulator shown in Figure 1(a). In addition, this paper has three sections. Section 2 is an overview of the solution, Section 3 details four application results: the logistic curve in ecology, Lorenz's butterfly effect [5], random walk in stock market, and Kuhn's innovation theory. In addition, discussion prospects are

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found in Section 4. The readers read carefully, if necessary, advice from control engineers was sought.

2. MATERIALS AND METHODS

2.1 SCIENTIFIC BACKGROUND

While this study is an incredible solution for physicists, but it has not any argument with physicists. Because they have no disadvantage to them, so that the other scientists such as engineering scientists and humanities have no reason to reject this solution. Meanwhile, we need to review the reasons why classical physicists in the 17th century could not solve the nonlinear systematical problems involving complexity. Unfortunately, there is no solving method such as the modern control theory at the time. Therefore, they treat the problem as a black box and attempt to solve using algebraic logical solution such as chaos theory in statistical physics for a long time, hence, it is very imperfect and vague and difficult to scientists. Unfortunately, the control theory including algorithmic theory and computer program MATLAB is developed in the 20th century during the Second World War by engineering scientists, such as Nyquist (1976).

Paradoxically, if the control theory developed early, they, including the great Newton, could have completely solved the nonlinear systematical problems. Ironically, determinists strongly reject the fundamental control theory, because the control theory is out of scope of determinism, but it is not reasonable practice. We have known the reason that statistics is introduced into physics by physicist Maxwell (1897) for thermo dynamical problems involving nonlinearity. The other side, the author has introduced the control theory into physics; hence, if anyone attempt to solve with new solution, they must be learning the control theory, including the computer program MATLAB, as shown in Figures 2(b) and 2(c). These are very accurate and convenient devices for scientists. Now, it can be solved following four steps: system modeling – computer simulation – verification – return.

Surprisingly, here is a serious result to the readers. Generally, macroscopic, static, linear, logical problems (phenomena) in the paradigm of determinism are proven through formal experimentation and analysis without time function, the other side, microscopic, nonlinear, dynamic, systematical problems in real time within indeterminism are proven through simulation with real time function by simulator. Because the dynamic systems cannot be fixed or stopped its process, moreover, it is fluctuating endlessly; it is the difference between a formal physical report and this report. Accordingly, it need not verification from others as defined in formal science. The other word, this study has finished verification because anybody can confirm the result as it can be reproduced at any time by anyone, without restriction.

2.2 EXPLANATION OF SOLUTION

Surprisingly, the control theory in engineering science is alike the chaos theory in statistical physics; both theories are very difficult to study to scientists, so that it cannot be studied in a short time, likewise, it cannot be fully described theoretical detail to the readers. Rather, we need to receive supports from computer and program MATLB. More detail, refer to [3]. First of all, we must build a modeling system as mentioned above. For a representative example as food chain in ecology, it is a closed loop system with negative (positive) feedback element, it can be converted into a typical feedback system as shown in Figure 1(b). If anyone understand this algorithm, they can easily solve the problems using the control theory as shown in Figure 2(a). We did not determine the component G(s) and H(s) yet; in this case, the parameter (transfer function) is expressed as blow. [2][3]

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$$F(s) = \frac{output\ Y(s)}{input\ U(s)} = \frac{G(s)}{1+G(s)H(s)} \Rightarrow \frac{\omega^2}{s^2+2\beta\omega s+\omega^2} \quad (1)$$

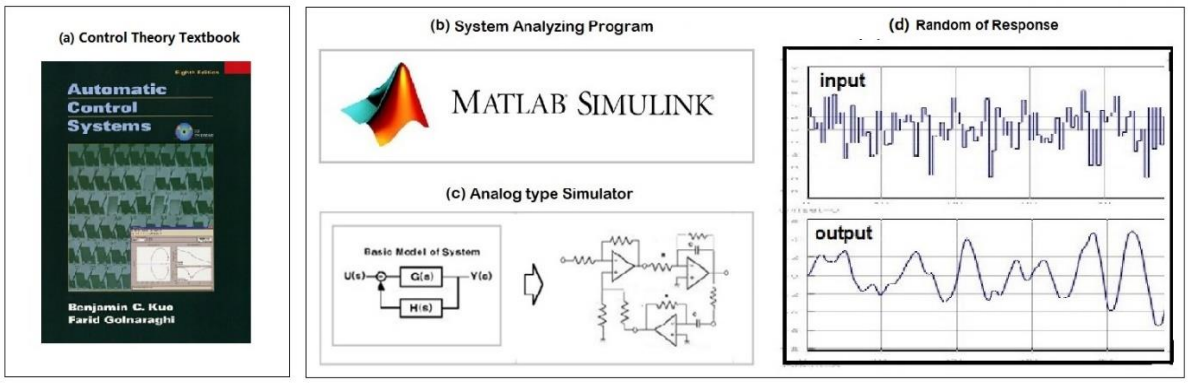
where [s] is the Laplace operator, U(s) is input source, Y(s) is output function, ω is a constant, and β is damping factor. In addition, the response of function of basic input y(t) is determined as below.

$$y(t) = 1 - A \cdot e^{-B \cdot t}\ sin\ (W \cdot t + \varphi) \quad (2)$$

Particularly, Equation (2) is a decreasing periodicity and converging to saturation as shown in Figure 3(b) To help the readers understanding, assuming a virtual system is existing and Equation (1) is determined as ω = 1 and β = 0.2, it become

$$F(s) = \frac{1}{s^2+0.4s+1} \quad (3)$$

We add this data into MATLAB, and we observed the behavior of output in the computer screen. If random source in real time adds into the MATLAB, we can observe the result in real time as shown in Figure 2(d) and the same as analog simulator is reproduced the result in real time as shown in Figure 3(c). If physicists, they would be solved it using the chaos they in statistical physics including statistics and SPSS. Thus, we must be solved the nonlinear dynamic systematic problem appeared in all sciences by systematical solution as above, and it cannot solve without preliminary knowledge of control theory including MATLAB. To prove



the validity of solution, this study provides four successful application examples in below. The examples have not ever seen before, but is a novelty results for physicaal science.

Figure 2 (a) Control Theory Textbook (b) Commercial Program MATLAB (c) Analog Simulator (d) Reproduced Result – Response of Random Function by MATLAB

3 RESULT – PRACTICAL APPLICATION RESULT

3.1 LOGISTIC CURVE IN FOOD CHAIN

It is designed by mathematician Verhulst. [6] He discovered that the population in earth is increasing and decreasing repeatedly by time, the other word, the correlation between predator and prey in grassland is expressed 'S' as shown in Figure 4(a). In this case, we need to understand the mechanism of food chain in ecology. (Modeling); assuming the individuals of predator and prey are defined as G(s) and H(s) as shown in Figure 1(b). We build a system with transfer function as Equation (1). In this state, if the food supplied is constantly and there is no limitation, its damping factor β is closely zero; we can simulate this situation through the

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MATLAB. (Simulation); consequently, the output as the Equation (2) become y(t)=1-sin(ωt) as shown in Figure 4(b). (Verification); it is a sine wave; therefore, the population is repeated increasing and decreasing continuously. And then, if someone draws the result again without dimension, we can easily obtain the logistic curve as shown in Figure 4(a). Therefore, the food chain in ecosystem is a systematical problem, which cannot be solved by algebraic logical solution based on determinism, Paradoxically, if he has known this systematical solution, he did not make this theory. Ironically, the physicists follow complex and difficult solution.

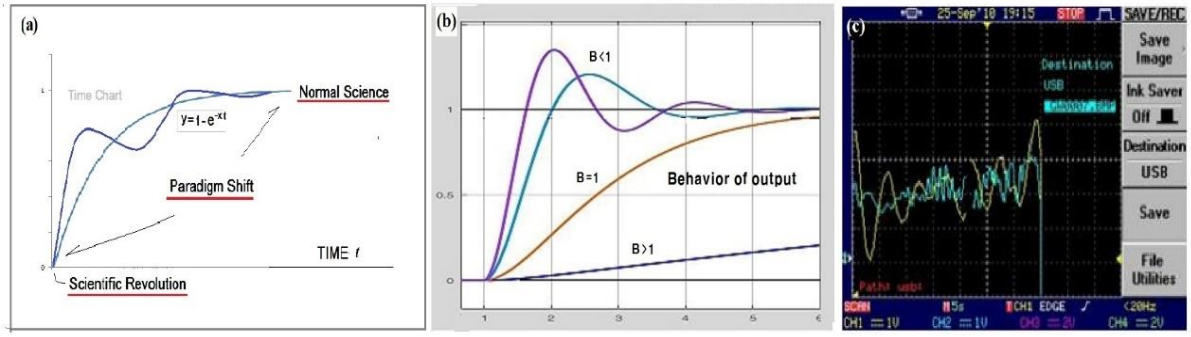

Figure 3 (a) Time chart of Kuhn's Scientific Revolution; Scientific Revolution – Paradigm Shift - Normal Science (b) Basic Response of Output according to Damping Factor (c) Response of Random Function in Simulator Display

3.2 LORENZ'S BUTTERFLY-EFFECT

It was first claimed in 1963 by Edward Norton Lorenz, who was not a physicist, but a meteorologist. He found that a small numerical variation (0.506127 > 0.5016) in an iterative calculation process for weather forecast leads to a completely different result, and defined it as butterfly effect which makes an appeal to the public and welcomed from many determinists. Unfortunately, meteorologist Lorenz, he has misunderstood the initial phenomenon in his own experiment. In this case, we need not model systems but we pay attention to Figure 4(c); it is a typical initial phenomenon such as electrical impulse. The reason is the damping factor in the systems, if the factor in Equation (1) is less zero, it is rapid increasing and overshooting. Nevertheless, it has not scientific background. Therefore, his assertion seems a fiction or an overstate idea or an illusion. Paradoxically, if a meteorologist Lorenz has known his assertion as systematical problems, he did not make such assertion.

3.3 KUHN'S INNOVATION THEORY

We have known the history of technical invention; he asserts science innovation will be advanced as following step; scientific revolution – paradigm shift – normal science as shown in Figure 3(a). For instance, gunpowder was invented in 1880. Its utility is increasing, as soon broke war. Therefore, they spent huge money to restoration. Repeatedly, the demand is increasing and broke war again, he is defined it as paradigm shift. Finally, it is saturated and settled a normal state. In this case, we defined the process as systematical problems and we can express a time series function as Equation (2) as shown in Figure 3(a). There are many same examples such as automobile, television, fertilizer, computer, chemistry, etc. Ironically, many scientists have been solved simple problems in difficult ways.

3.4 PREDICTION OF STOCK MARKET

It is a representative nonlinear dynamics problem, physicists in Wall Street already has been determined the daily stock price as 'random walk'. If the Q(s) and H(s) are defined a seller

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and a buyer in stock market, the amount Y(s) is converged to zero (equilibrium) as shown in Figure 1(b), but it has same mechanism the food chain in above logistic curve. Generally, the stock information (utility) flowed into the stock market, it fluctuates constantly. Likewise, if we add random function into simulator, daily stock price as output is extremely fluctuated as shown in Figure 3(c). Furthermore, if the damping factor in internal stock market condition is not fixed, anyone is impossible to predict the daily stock price absolutely. For instance, circuit break in stock market is meant the increasing damping factor during short time by outsider. Therefore, the market as economic systems are merely a com plex system. The other word, random walk defined by physicists is not perfect expression.

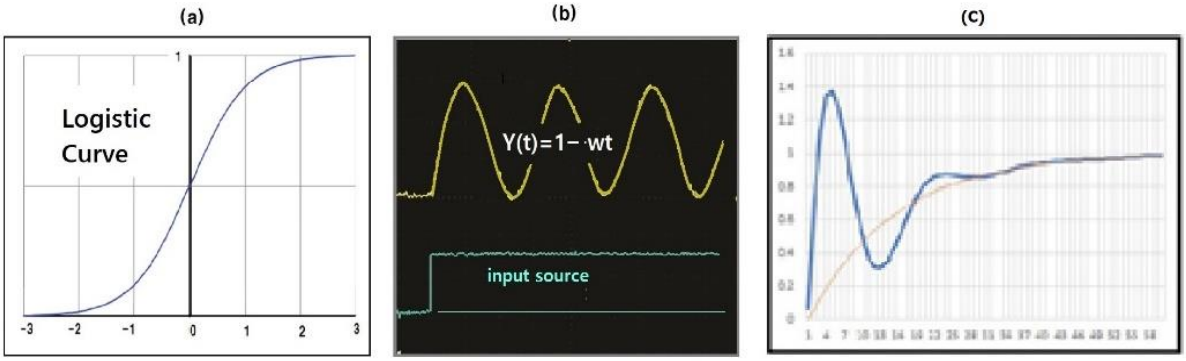

Figure 4 (a) Logistic Curve (b) Simulation result Food Chain (c) Initial Phenomenon Example

4. DISCUSSIONS

Ironically, most scientists except control engineers are not familiar to the control theory as well as chaos theory. Paradoxically, if classical physicists have been known the control theory and chaos theory, physicists have successfully solved the unsolved nonlinear systematical problem such as from quantum theory to ecosystems including complex systems in today. In spite of, do many scientists worldwide throw out this solution without testing and without money and time, it is not wise idea. However, most scientists misunderstand the complex systems as a black box and impossible problem, the author propose this solution as above including practical application results in Section; it notes the reference [3]. In addition, the analog simulator as shown in Figure 1(a) can be reproduced any type of nonlinear dynamics problems in real time; it is magnificent scientific result such as Copernican theory. Meanwhile, the author makes a suggestion to physicists.

(Suggestion) – The author present both the old chaos theory and the new control theory in this paper, if physicists in modern science did not welcome the new solution, we must be separated from statistical physics because it is not based on statistics in deterministic physics and other scientists have no reason to reject the new solution. Therefore, in case of physicists agree with this idea, this new solution will separate from current physics and transfer to engineering science; and they cooperated with each other it is reasonable idea for other science and people. Because they have no experience with the control theory in systems science, and, this new solution is relevant to indeterminism. Thus, anyone choose a solution what they want. If suggestion avoid, physicists must be adopted this new solution.

Meanwhile, many scientists await advanced solution for above mentioned unsolved systematic problems. For instance, physicist Neil Johnson, he talked that numerous nonlinear dynamic problems are hidden around us through his book. [9] Paradoxically, if he has known this solution, he did not make the work no more. Particularly, there is the same case in scientific community, famous Santa Fe Institute [8] in the USA has attempted to study multidisciplinary sciences between economics and physics using statistical physics. The author has a doubt about

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their research because macroeconomics cannot solve logical solution, so that SFI should seek other systematical solution in other science.

5. CONCLUSION

This study revealed the nonlinear systematical problems involving complexity is a solvable problem, not a black box, the new solution is achieved based on the fundamental control theory instead of existing chaos theory. Further, it can be proved by the control theory including MATLAB program. Hence, it is more perfect and precise and easy rather than the old chaos theory. Unfortunately, physicists are not welcomed it, so that it will be moved to engineering science or systems science without risks. Nevertheless, we allow both the old and new solutions to apply to all science in their unsolved problems. Therefore, the author encourages to every scientist need a learning on the control theory like chaos theory. However, this solution will be solved many unsolved problems in modern science, so that it is a revolutionary scientific achievement to modern science. Hence, nonlinear dynamics is not black box.

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Conflict of interest

I decalare there is no conflict of interest

REFERENCES

[1] Casti, J. L., 1995. Complexification: explaining a paradoxical world through the science of surprise. Harper Perennial. (1995) DDC 003.7 21 ISBN 0060925876

[2] Golnaraghi, F. and Kuo, B.C., 1998. Automatic Control Systems, 10th Edition, McGraw-Hill Education 2017, ISBN-10: 1259643832

[3] Cha. D.S, Establishment of New Solution for Complex Systems in Multidisciplinary Science Based on Feedback System Analysis Method and Proven by Simulator, Open Journal of Modern Physics. ISSN Print: 1927-1934 DOI: 10.4236/jmp.2015.613198 https://www.scirp.org/journal/paperinformation.aspx?paperid=60738

[4] MATLAB; https://kr.mathworks.com/support/learn-with-matlab-tutorials.html?s_tid=srchtitle

[5] Lorenz, E, 1963. Deterministic Non periodic Flow, JAS, 20(2): URL: https://journals.ametsoc.org/doi/abs/10.1175/1520-0469%281963%29020%3C0130%3ADNF%3E2.0.CO%3B2

[6] wolfram-math world/ Logistic function http://mathworld.wolfram.com/LogisticEquation.html

[7] Video clip in YouTube https://www.youtube.com/watch?v=-EnU4L5uH5o

[8] Santa Fe Institute https://santafe.edu/

[9] Neil Johnson, 2009, Simply Complexity: A Clear Guide to Complexity Theory, One world Publications (2009) ISBN-10: 9781851686308 ISBN-13: 978-1851686308

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Cha is conceptualized the research and execute experiment and writing; Jun is verified the mathematical process.