

5G Smart Classroom Construction Based on Linear System Mathematical Model

Xiaoling Wan¹, Xinqun Huang^{2, *}

¹ Public Basic Teaching and Research Section, Shangrao Health School, Jiangxi, 334600, China

² Department of Primary Education, Shangrao Preschool Education College, Jiangxi, 334000, China

* Corresponding Author Email: wztgeducation@sina.com

Abstract. The mathematical model is to abstract the actual problem in mathematical language, and then reflect or approximate the mathematical description of the actual problem from the mathematical point of view. The whole process of establishing the mathematical model is called mathematical modeling. The article aims to discuss the function of mathematical modeling in the construction of smart classroom under 5G techniques. Relying on 5G technology to create a smart classroom based on holographic technology, which is used in schools to connect with famous teachers from all over the world to teach, teachers and students can participate in interactive teaching, improve the quality of teaching, and enhance the learning experience.

Keywords: Smart classroom, mathematical model, 5G

1. Introduction

The mathematical expression of the dynamic relationship between the input and output of the control system is the mathematical model. And its purpose is to 1) Analyze the actual system; 2) Predict physical quantities; 3) Design control system. The mathematical model is to abstract the actual problem in mathematical language, and then reflect or approximate the mathematical description of the actual problem from the mathematical point of view (Figure 1). Modeling methods are mechanism analysis method and experimental identification method. Mechanism analysis method is suitable for relatively simple systems; while experimental identification method is suitable for complex systems.

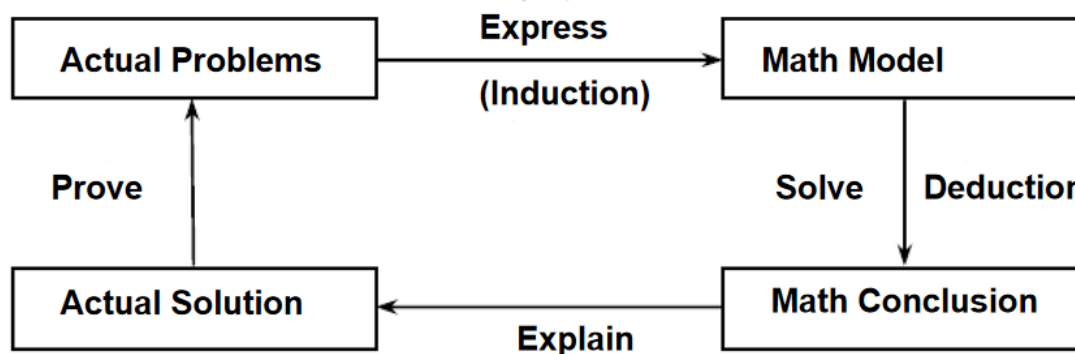


Figure 1. The Mathematical Modeling Process Diagram.

The generality of the mathematical model can be proven in many fields. Many seemingly completely different systems (such as mechanical systems, electrical systems, hydraulic systems, and economic systems) may sometimes have exactly the same mathematical model. The mathematical model expresses the commonality of these systems. After the mathematical model is established, the research system is mainly based on the mathematical model to analyze and synthesize the performance of the system, instead of involving the physical properties and specific characteristics of the actual system (Figure 2). And the forms of expression in mathematics model are presented as:

- A. Time domain: differential equation, difference equation, state equation (internal description).
- B. Complex domain: transfer function (external description), dynamic structure diagram.
- C. Frequency domain: frequency characteristics.

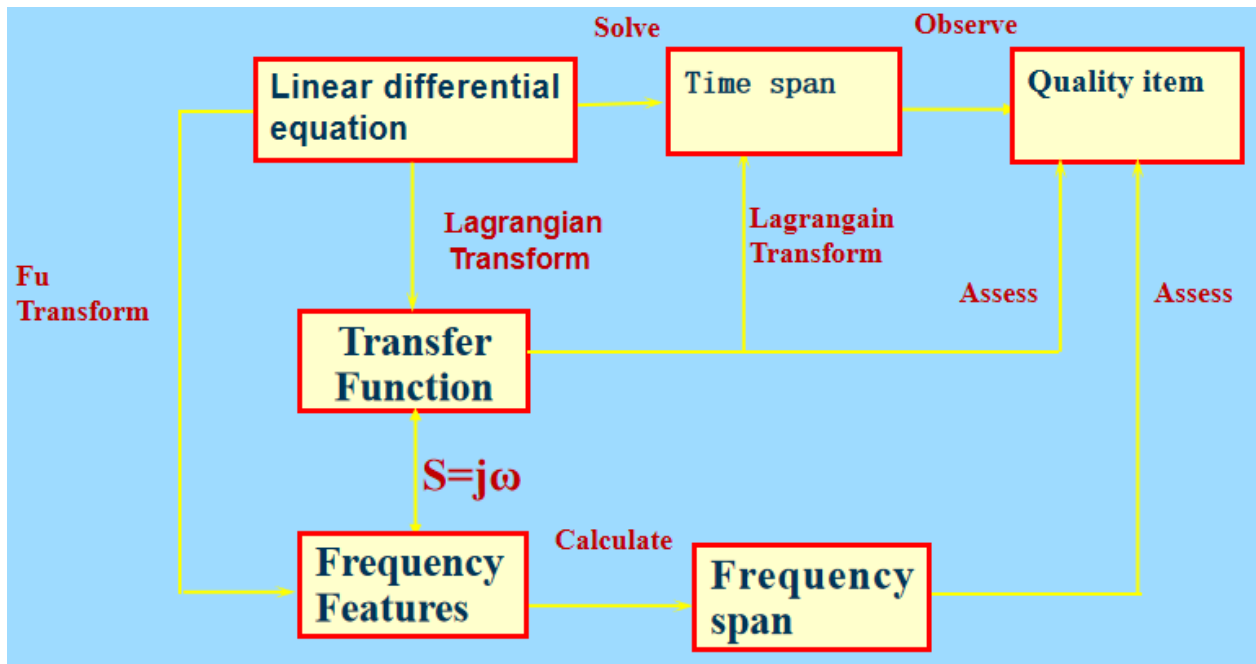


Figure 2. The main way to determine system performance by mathematical model.

2. The Linear System

The input-output time function of the linear system (Figure 4) describes the purpose, from the perspective of the time domain, is to establish the relationship between the system input (given value) and the system output (controlled variable). And differential equation description, as well as unit impulse response description are the two main forms.

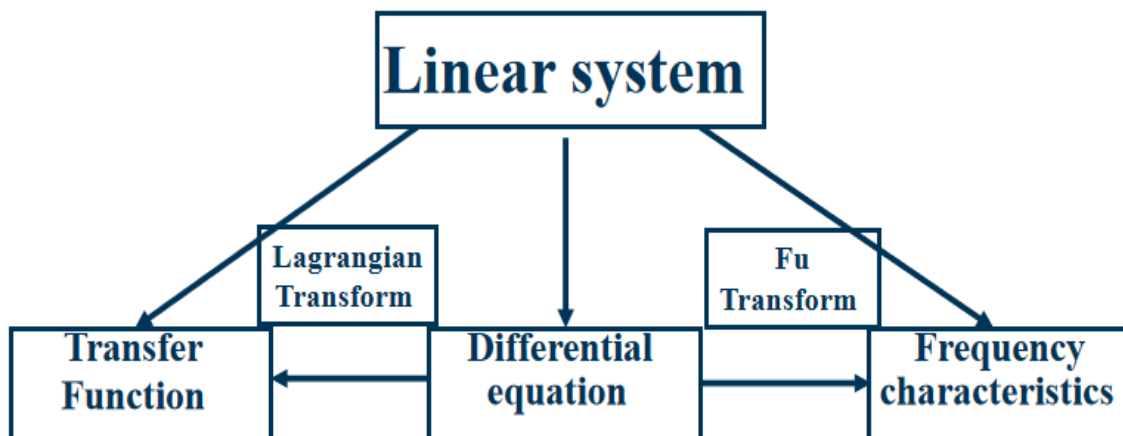


Figure 3. The Linear System Expression Form.

Differential equation description of linear system (mechanism modeling method):

(A) The standard form of SISO linear time-invariant system's input-output relationship description by differential equation $r(t)$: input signal of the system; $c(t)$: output signal; $a_i (i=1,2,...,n)$ and $b_j (j=0,1,...,m)$ are coefficients determined by the structural parameters of the systems

$$\begin{aligned} & c^{(n)}(t) + a_1 c^{(n-1)}(t) + a_2 c^{(n-2)}(t) + \dots + a_{n-1} \dot{c}(t) + a_n c(t) \\ & = b_0 r^{(m)}(t) + b_1 r^{(m-1)}(t) + b_2 r^{(m-2)}(t) + \dots + b_{m-1} \dot{r}(t) + b_m r(t) \end{aligned} \quad (1)$$

The output and input in the control system are usually functions of time; the relationship between the output and input of many common components or systems can be expressed by a differential equation. The equation contains the output, input, and their respective derivatives or integrals with

respect to time; this differential equation is also called dynamic equation or equation of motion. The order of a differential equation generally refers to the order of the highest derivative term in the equation, also known as the order of the system.

(B) List the steps for the differential equations of the system. Divide different links to determine the input and output of the system; write the equations of motion for each link (component); eliminate intermediate variables, and find equations that only contain the input and output variables of the system and their

Various physical systems with the same mathematical model are called similar systems. In the mathematical model of similar systems, variables with the same function are called similar variables. According to the concept of similar systems, the conclusions of a physical system research can be extended to its similar systems. A system that is relatively easy to implement can be used to simulate other systems that are difficult to implement. Therefore, the construction of smart classroom can be fulfilled by the linear system under 5G technology derivatives; convert them into standard forms.

3. 5G Smart Classroom Construction

The application of 5G in the field of education mainly focuses on the smart classroom and smart campus. 5G+smart classroom, with 5G's low delay and high speed characteristics, combined with VR/AR/holographic imaging and other technologies, can realize real-time transmission of image information, provide holographic and interactive teaching services for the two places, and improve the teaching experience; The 5G intelligent terminal can collect the whole scene data in the teaching process through the 5G network. Combining big data and artificial intelligence technology, it can build a picture of students' learning, provide comprehensive and objective data analysis for teaching, and improve the accuracy of education and teaching. 5G+smart campus, security monitoring based on ultra-high definition video can provide the campus with applications such as remote inspection tour, campus personnel management, student work and rest management, access control management, etc., to solve the security problems such as strangers entering the campus, untimely danger detection, and improve the efficiency and level of campus management; Based on AI image analysis, GIS (geographic information system) and other technologies, it can provide comprehensive security services for students' travel, activities, food safety and other links, so that parents can timely understand students' school location and performance, and create a safe learning environment. 5G Smart Classrooms make full use of the inherent technical and business advantages of 5G networks through the 5Gization of each component of the hardware terminal to bring school users a faster, better, and smoother experience.

(A) Unified network bearer, schools no longer need to deploy multiple networks.

(B) The ultra-high bandwidth ensures that the interactive display terminal equipment, signal transmission and processing terminal equipment in the smart classroom cannot only perfectly reproduce the 4K-level picture effect, but also can carry the upcoming 8K interactive terminal equipment.

(C) The speed is faster and the delay is lower. It guarantees the normal recording and broadcasting in the smart classroom. During remote teaching, the remote conference site can experience the "famous teacher excellent class" up to 4K or even clearer classroom pictures without any delay.

(D) New application scenarios in education and teaching, such as gamification courses, VR experimental environment, virtual reality control environment, high-definition stereo display, remote examination monitoring, learning behavior tracking and mining, compared with 4G mobile network, 5G can pass Network slicing and edge computing to meet the application needs of industry users. In the education industry, an education private network can be realized through network slicing. The specific architecture is shown in the figure 4 below:

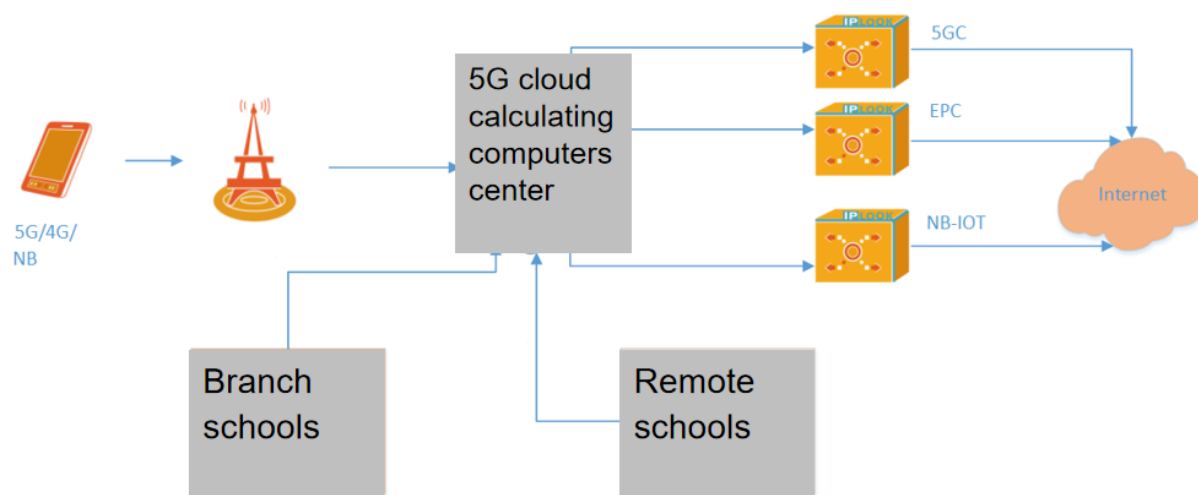


Figure 4. The Architecture of 5G Network.

With the 5G technology, smart classroom is flexible and stable in transformation. The teacher compares and restores the real person, and the camp photos the real classroom environment to make the students feel more engaging. Teachers do not need to adapt to changes in equipment to change their own teaching methods, and truly restore natural teaching interaction. Real-time superposition of virtual reality and reality creates a vivid future classroom, allowing teachers to visually display the obscure content in the past and create unique and high-quality teaching resources. Realize multi-site holographic interactive teaching, and complete dual-teacher and multi-teacher classrooms in a true sense. A good solution to the problem of insufficient teachers (Figure 5)."

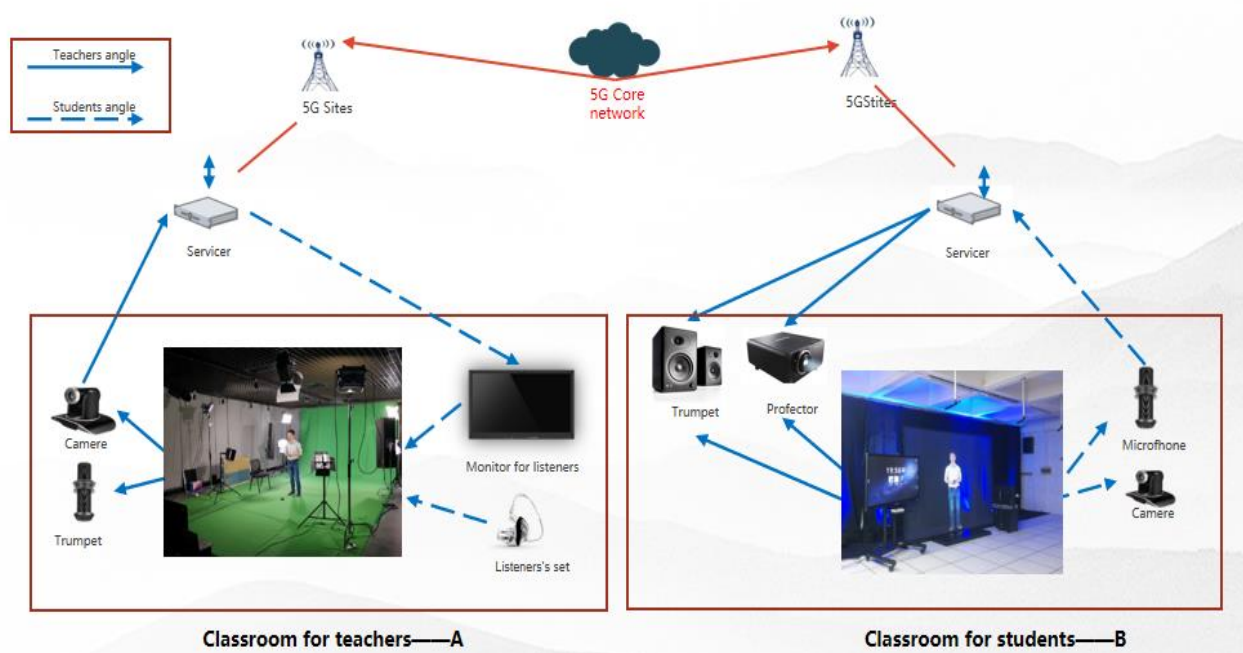


Figure 5. The Framework of 5G Smart Classroom based on Linear System.

4. Application of 5G classroom case

Classroom interactive teaching has become a popular scene of 5G application. The technology of "5G+VR/AR", "5G+holographic projection", "5G+4K/8K remote live broadcast (fast live broadcast, slow live broadcast)" and other technologies can be used to create an immersive smart classroom, interactive online teaching and virtual simulation experiment teaching. At present, this kind of scene has become a reality in many places.

In terms of "5G+intelligent examination", relying on 5G+AI, VR, image processing and other technologies, intelligent online examination, intelligent inspection supervision, remote collection of face data, sensorless intelligent admission recognition, intelligent auxiliary correction and other applications can be realized.

In terms of "5G+Smart Campus", with the help of 5G and other new generation information technologies, it is helpful to build an intelligent teaching environment of "everything is connected", establish centralized and intelligent support services for teachers' research, education governance, education supervision, students' life, consulting and learning, and home school collaboration, and effectively serve the education and teaching process.

In terms of "5G+regional education management", using 5G+AI to upgrade the regional education brain and management platform can realize the timely transmission of the operating status data of the schools under the jurisdiction of the region, carry out dynamic monitoring and analysis of the degree resources, learning data, emergency events and other information of each school, and support the education authorities to make management decisions and respond

5G has broad application prospects in the field of education. It can optimize the smart learning environment, innovate the form of learning and teaching, improve the learning experience and teaching effect, improve the smart education service level and the modernization level of education governance, and promote the high-quality and balanced development of regional, urban and rural and inter school education.



Figure 6. The Development of Electricity Chip.

Campus terminal computers have many points, large coverage, difficult management and other characteristics. In addition, information security personnel are limited, terminal distribution environment is complex, and there are many threat risk events, which makes information security personnel passive to terminal security work. In terms of terminal security, once virus infection, malicious damage propagation, data loss and other events occur, serious losses will be caused and the consequences will be unimaginable. The security of computer information system is seriously affected by the uneven awareness and ability of teachers and students of various schools to use computers in compliance, terminal security and virus prevention. Because of this, we should do a good job in terminal security protection in an all-round way and build a set of terminal security detection and response system to ensure the safe, stable and efficient operation of daily learning.

5. Conclusions

Linear system provides a solution to set up the framework of 5G technology. Researchers should catch the wave of 5G development and take 5G as the entry point to package a certain 5G network, education private network service and holographic remote video solution equipment to form a network service.

References

- [1] Margaret Carr, translated by Zhou Xin and others. Another evaluation: learning stories [M]. Educational Science Publishing Society, 2016.
- [2] Xu Weimin. Deepening the Course Construction of "Linear System Theory" for Postgraduates and Exploration of Teaching Methods [J]. Education Teaching Forum, 2017 (43): 139-140.
- [3] He Shuping. Exploration and Research on the Teaching Reform of "Linear System Theory" [J]. Examination Weekly, 2012 (74): 13-14.
- [4] Chen Li (2004). Teaching interaction model and teaching interaction layer of distance learning the second tower [J]. China Distance Education, (5):24-28, 78.
- [5] Kress, G. R., & Van Leeuwen, T. (2001). Multimodal Discourse: the Modes and Media of Contemporary Communication [M]. London: Arnold.
- [6] ITU-R (2015). IMT Vision-Framework and Overall Objectives of the Future Development of IMT for 2020 and Beyond[R]. Geneva: ITU-R M.2083:5.
- [7] Zhao Xinglong, Xu Lin, Li Yaxuan (2019). 5G Educational Application: Connotation Exploration and Scene Innovation——Also on the New Thinking of Emerging Information Technology to Optimize the Educational Ecology [J]. China Audio-visual Education, (4):5-9.
- [8] Zhong Shaochun, Zhong Zhuo, Zhang Zhuo (2020).How to build a smart classroom [J]. Electricity Educational Research, 41(10): 15-21, 28.
- [9] Zhou Xiaochun (2020). The configuration of a smart English learning classroom from a multi-modal perspective Preliminary Study [J]. Journal of Hubei University of Arts and Science,41(4):72-76,85