Design and Research of Educational Teaching Service System Based on Meta-universe Environment

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Abstract. In this paper, we build a dialogue system for English speaking training. In the meta-universe environment, functions such as reading and writing words, reading sentences aloud, multi-round dialogues and dialogue quality evaluation are implemented, and semantic understanding algorithms are applied to the system, and users can practice speaking through dialogues with virtual characters. In this paper, we use speech recognition, virtual character animation calling, pronunciation quality assessment and utterance template matching to implement a multi-round dialogue based on hotel scenarios. The virtual characters contain realistic character movements and animation effects to provide a good learning experience for learners. By analyzing the feedback on the use of the system through a user research method, the results show that students can practice and measure the effectiveness of spoken English by conversing and interacting with avatars in an immersive metaverse environment, which helps them to learn spoken English.

Keywords: Education Meta Universe · English Speaking Learning · Artificial Intelligence · Semantic Understanding

1 Introduction

The primary implementation method of metaverse is VirtualReality (VR) technology. VR has the advantages of creating realistic scenarios, visualizing abstract contents, creating immersive experiences, and reforming education methods and evaluation methods. By wearing interactive devices such as HTCVIVE, GearVR and OculusRift, rich interaction is used to create an immersive learning experience as if you were in a country where English is the native language [1]. ArtificialIntelligence (AI) techniques include deep learning, natural language processing, etc. By using AI techniques, it is possible to increase the depth of research and to achieve a better experience of use and improve the accuracy and precision of recognition [2]. Natural language understanding in AI technology allows virtual characters to understand the learner's behavior through speech recognition and respond automatically based on the understood language. Voice-driven facial/physical animations make virtual character behavior more realistic. Conversations are divided into task-based and non-task-based conversations, with the former completing fixed tasks and the latter mostly in the form of casual conversations, which are studied in this paper as task-based multi-round conversations in a VR environment [3].

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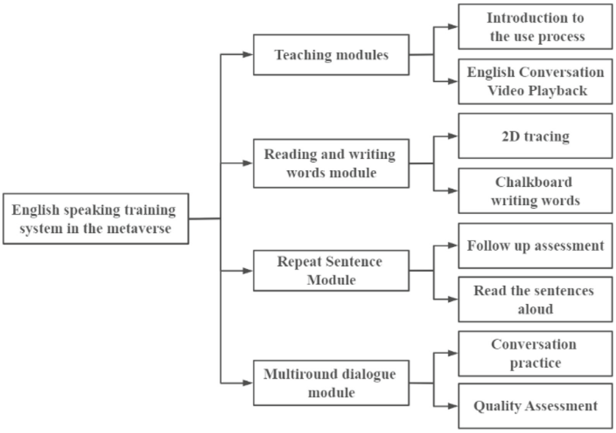

Fig. 1. System functional design diagram

2 Demand Study

2.1 User Needs Analysis

Studying user requirements is the primary prerequisite for developing an educational software, and it is through a reasonable requirements analysis that the developed product can be more applied and marketable. It is necessary to pay timely attention to the current development of the research field and to conduct research to accurately grasp the direction of software development [4].Therefore, according to the design idea of Y model, it is necessary to accurately locate the user's target and complete the design of the product [6].

Functional design.

The functional design of the system in this paper revolves around English speaking training, combined with gamified curriculum elements in a virtual reality scenario. The English-speaking training system based on the meta-universe environment contains four modules: teaching module, reading, and writing words module and following sentences module and multi-round dialogue module [7]. The functional design of the system is shown in Fig. 1.

2.2 System Architecture

The whole system consists of a four-layer structure: data layer, algorithm layer, intermediate logic layer, and external presentation layer. Users interact through HTCVIVE devices, as shown in Fig. 2, to build a complete and highly flexible English speaking training system through a four-layer architecture [8].

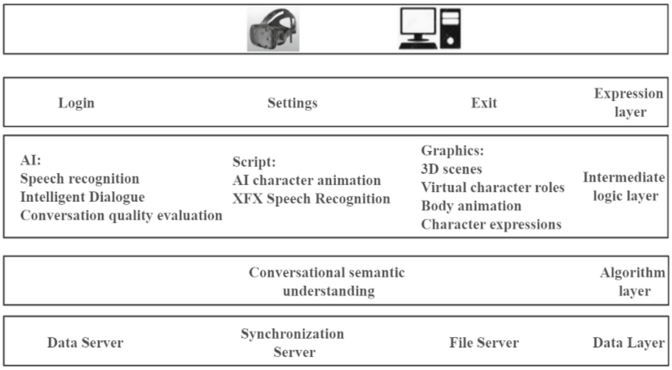

Fig. 2. System architecture diagram

3 Improved Multi-objective Multiverse Algorithm

3.1 Selection of the Initial Universe Population Based on Tent Chaotic Mapping

In the basic multi-objective multiverse algorithm, its initial values are selected using the computer's own pseudo-random function, which is given by:

$$X_i^{(0)} = r \times (ub - lb) + lb \tag{1}$$

where: r is a random number between [0,1], *lb*, and *ub* are the upper and lower bounds of the independent variables.

Chaos represents rich spatial information, and its ergodic nature ensures that individuals can experience all solution space state values and do not have a large number of periodic cycles. So this paper adopts Tent mapping to assign values to the initial universe population, and the Tent mapping formula is:

$$x_{n+1} = f(x_n) \begin{cases} \frac{x_n}{\alpha} x_n \in [0, \alpha) \\ \frac{1-x_n}{1-\alpha} x_n \in [\alpha, 1) \end{cases} \tag{2}$$

where: α is a constant between [0,1].

The unique traversal and uniformly distributed nature of the Tent chaotic sequence can optimize the initial population, ensure the uniformity of the initial population, and inhibit the whale algorithm from falling into the local optimal solution step from the first step of the algorithm. The random number r in the initial values is generated using Eq. This ensures the randomness and ergodicity in the true random numbers and avoids the periodicity of the pseudo-random numbers, which makes the initial universe population wider and the algorithm produces a better set of Pareto solutions [9].

3.2 Wormhole Travel Distance Based on Trigonometric Functions

The wormhole selection probability in MVO, which increases linearly with the number of iterations, and the WEP in MVO denotes the probability of wormhole existence in multiverse space. WEP serves as an important role as a parameter whose can change the search results of the algorithm during the iteration. In response to the sluggish rise of the WEP value leading to the limited update of the universe of individuals, the linear growth form of WEP is modified to the trigonometric growth form (Sine Wormhole Existence Probability, SWEP) with the equation:

$$SWEP = WEP_{min} + (WEP_{max} - WEP_{max}) \times \sin\left(\frac{\pi l}{2L}\right) \tag{3}$$

Figures 3 and 4 show the changes of WEP and SWEP in the iterative process. From the figure, it can be seen that SWEP, compared with WEP, has a relatively faster rising speed at the initial point, which facilitates finding the region where the optimal universe is located in the earlier stage, and a relatively slower rising speed in the middle and later stages, and its convergence accuracy is more accurate when finding the optimal universe location in the later stage.

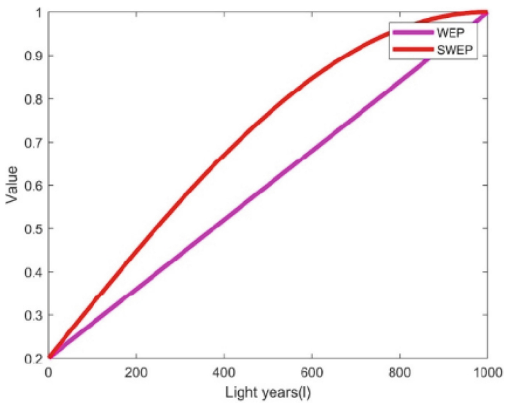

Fig. 3. Comparison between SWEP and WEP.

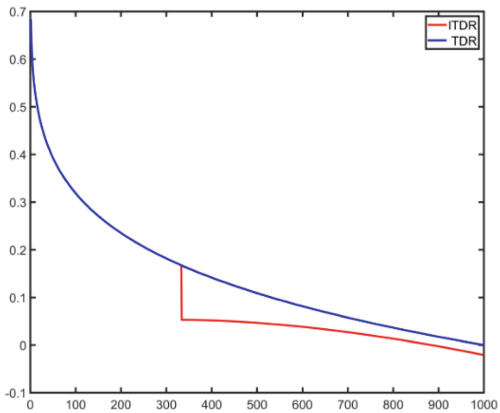

Fig. 4. Comparison between ITDR and TDR

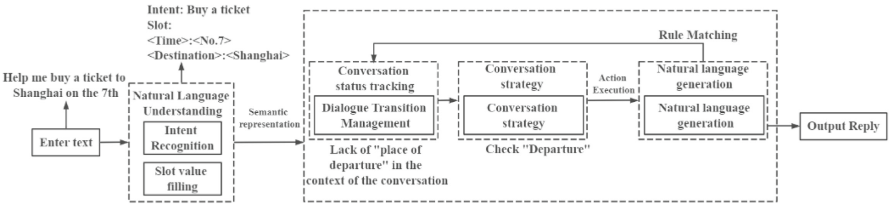

Fig. 5. Intelligent Dialogue Module

4 Intelligent Dialogue Design

4.1 In the System Design Process

The intelligent dialogue structure based on pipeline approach is shown in Fig. 5, which mainly includes four key modules: natural language understanding, dialogue state tracking, dialogue strategy and natural language generation, and the four + key functional modules will be introduced in detail below.

5 Conclusion

This paper firstly analyzes the user requirements, user goals, and product functions of the system mainly based on the Y requirement analysis model, and designs the requirements of the English speaking training system with reference to the Y model; secondly, it introduces the functional design of the system and plans the architecture diagram of the system, including four specific components: presentation layer, intermediate logic layer, algorithm layer, and data layer; after that, it carries out the intelligent dialogue system design, which revolves around four components: natural language understanding, dialogue state tracking, dialogue strategy, and natural language generation; finally, it gives an overview of the main target groups of the system. This paper provides a systematic introduction to the system design, which becomes an important basis for the technical implementation of this paper, and an overview of the technical framework and implementation scheme of the full paper.

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