

## Research Article

# English Listening Teaching Device and Method Based on Virtual Reality Technology under Wireless Sensor Network Environment

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This paper presents an in-depth study and analysis of the design and implementation of English listening instruction using wireless sensing microprocessors combined with the technology of virtual environments. Inaccurate speech hinders smooth communication and restricts the development of various skills in foreign language learning. To learn English well, mastering phonetics is a crucial first step. Especially for learners in junior and senior high schools, phonics teaching is considered an essential part. In the face of the new standards which put higher demands on phonetic intonation, the traditional methods of teaching phonetics have little effect on improving phonetics and are even somewhat overwhelming. Therefore, increased researchers are trying to find effective phonics teaching methods to improve the current problems in high school phonics teaching. Important definitions of virtual reality, augmented reality, and teaching resources are collected and organized, typical applications of augmented reality in education at the present stage are summarized, important events in the development of augmented reality are reviewed, key technologies of augmented reality are briefly described, hardware and software resources required to realize the effect of augmented reality are introduced, and pedagogical theories underlying the study of augmented reality in English teaching resources are discussed. The results of the student walk-through quizzes are analyzed using SPSS with independent sample *t*-tests, and the distribution of the number of scores is statistically analyzed in the form of graphs, and interviews with students and teachers are used to gain a deeper understanding of the effectiveness of the resource in teaching practice. The value of the application of the augmented reality primary school English teaching resource is explored.

## 1. Introduction

With the informatization of social life and the globalization of the economy, English, as one of the most important carriers of information, has become the most widely used language in all areas of human life. Because of its important role in the international arena and the role of the baton in the Chinese and college entrance exams, English has long been widely valued by the nation and has become the main foreign language studied by school students at present, and English proficiency has become an important criterion for highly qualified personnel [1]. For the cultivation of students' English ability, countless experts, scholars, and frontline educators have made a lot of researches and studies to find the best teaching methods to adapt to students' learning

English, such as the traditional grammar-translation method, listening method, and task-based teaching method, but in the teaching process, they all show some shortcomings and some incompatibilities with the English teaching system. In the long exploration of English teaching, many education experts and frontline English teachers mostly think that the situational teaching method is more effective in secondary school English teaching [2]. The situational approach is constantly being researched and developed in teaching, and it focuses on creating effective situations in the classroom to make learning easier and more interesting. Concerning creating situations, the rapidly developing modern educational technology, especially multimedia network technology, provides teachers with new ways to do so [3]. Using the multimedia network to assist in teaching English

situations in junior high school has improved the teaching and learning of junior high school English classrooms to a certain extent and further improved the teaching efficiency of the classroom, which is not a kind of effective teaching method [4].

The systemic reform of education and the deep involvement of new types of technology have become more closely integrated through multiple rounds, from the initial old slide show presentations and accompanying CD instruction to PPT courseware and online course instruction to teaching forms such as catechism and microlearning. The emergence of educational games, VR teaching, and other teaching tools has brought real changes to fun and situational teaching. Abdul Ameer analyzed the types of interaction in the use of technology in educational teaching and divided the hierarchy of interaction into four tiers [5]. The first tier is content-based interaction, where technology only contributes to the presentation of teaching content, such as multimedia devices; the second tier is mediated interaction, such as computer-assisted instruction; the third level is cognitive interaction, where learning arises from the cognitive interaction between the person and the technology, where the technology releases the cognitive space and allows people to focus on higher-level skills. The highest level is convergent interaction, which uses technology as the interaction mechanism between content and experience, and educational games and VR technology are under this level [6]. Therefore, for VR educational games to have practical implications for education, they must not stop at showing the content and media interaction, but rather explore the potential of technology and use the interactive experience to blend technology with the content. Virtual reality education has been developing relatively fast in China thanks to the support of national policies. The world today is in a period of great development and change, showing the development trend of world multipolarity and economic globalization and informationization. English, as one of the most widely used languages in the world, has become an important tool for international communication and scientific and cultural exchange. Students learning English at the compulsory education level is not only conducive to their better understanding of the world, learning advanced scientific and cultural knowledge, spreading Chinese culture, and improving their mutual communication and understanding with young people from various countries but also provides them with more opportunities for education and career development, laying the foundation for them to better adapt to the world in the future. We will put the CALL related to listening teaching in the follow-up research, because we cannot take so much into consideration now.

After studying the hypothesis of language input and output and related educational theories and having a relatively systematic understanding of the history of foreign language teaching, we hope to verify the teaching effectiveness of the situational teaching method by combining my actual teaching experience, and at the same time, in the process of teaching, combining modern educational tools such as multimedia networks, to gain an in-depth understanding of the impact of multimedia network-assisted situational

teaching of junior high school English on students' English ability. In the process of teaching, we combine the multimedia network and other modern educational tools to understand the impact of multimedia network-assisted junior high school English teaching on students' English ability and learning attitude, and gradually explore how to apply it to junior high school English teaching in a more reasonable and effective way, so as to optimize classroom teaching, improve teaching efficiency and students' learning efficiency, and provide the basis for subsequent teaching examples. Because of the need to realize the "connection of things", the Internet of Things system needs to be able to sense the physical information in nature and send the acquired physical information to other networks through communication technology. After decades of rapid development of science and technology, the new definition concept of the Internet of Things is more precise. A complete Internet of Things network is a complex intelligent network, which includes the perception of physical information, the acquisition of object location, the path of data transmission, and the mutual communication between things and objects. It is the management of things and objects by connecting various physical devices in the actual environment to a network with the help of some communication method.

## 2. Current Status of Research

Developed from virtual reality, augmented reality is an offshoot of virtual reality, a technology that seamlessly integrates virtual images into the real environment, projecting a mix of real and virtual images and information in the user's line of sight, perceived by the user. Augmented reality allows us to access information easily and in real time so that we can access and absorb it faster, and this augmentation is creative, imaginative, and fascinating. With augmented reality, information becomes visible, which allows it to shine in the field of education [7]. Zhou and others see five major potentials for augmented reality in education: to engage, stimulate, and motivate students to explore course material from different perspectives; to help teaching and learning and students to gain first-hand experience of subjects (e.g., astronomy and geography); to enhance student-student and collaboration between teachers and students; to foster creativity and imagination; and to help students take control of their own pace and direction of learning and to create an authentic learning environment style appropriate for a variety of learning [8]. The design and development of augmented reality teaching resources not only helps to create and control teaching and learning situations but also engages the multiple senses of students, allowing learners to escape the dull monotony of written language and receive stimuli efficiently [9]. It has wide application prospects in scenario creation, learning mode innovation, interactive design, expanding learning space, and conducting classroom activities [10]. At this stage, there are fewer studies on augmented reality teaching resources for primary school English in China. The authors consider that the use of augmented reality technology to develop primary school English teaching resources is more accurate to vividly display the content

of primary school English textbooks, making abstract objects figurative and flat information three-dimensional [11]. Compared with traditional teaching, the special feature of augmented reality primary school English teaching resources is that the information presentation channels increased and the teaching contents are presented in more diverse forms, which is conducive to the recognition and memory of language-based information [12]. At the same time, in the context of augmented reality teaching resources, students are more likely to become constructors of knowledge and more likely to be immersed in the English learning environment.

At the practical level, augmented reality technology, as a unique and novel emerging technology, belongs to applied research, and the new human-computer interaction technology represented by augmented reality technology has a broad prospect in educational applications [13]. Primary school English textbooks and texts are mostly narratives, a description of certain situations, scenes, and episodes, and the vocabulary used in the text is mostly specific vocabulary, and the classroom is often boring when it comes to simple language learning [14]. Given that augmented reality can effectively present location-related information, augmented reality can also work well with cultural and language teaching; therefore, this study is aimed at investigating augmented reality-based primary school English teaching resources that overlay models, videos, text, and audio into students' textbooks in real time, using augmented reality technology teaching resources to help students visualize teaching content, supplement the standard curriculum, and interact with the emergent virtual models to provide students with contextualized learning experiences that foster their interest and sense of accomplishment in English and are used to guide educational teaching practices and improve educational performance.

This study fully recognizes the role of teachers in teaching phonetics, but it is debatable whether teachers should be the main imitators of students. Some English teachers have not received rigorous phonetic training, and their phonetics may not be standardized. The author believes that especially in the basic stage of foreign language learning, phonetic accuracy is very important and can be cultivated, if a scientific approach is adopted. This study tries to verify, through empirical evidence, that the introduction of a new phonetic teaching tool, Intelligent Reading Along, is one of the effective ways to improve English phonetics teaching.

### **3. Wireless Sensing Microprocessors and Virtual Environments for Teaching English Listening Analysis**

*3.1. Wireless Sensing Microprocessor Combined with Virtual Environment Design.* The role of a sensor is to acquire information about the real world and communicate that information to the AR system so that the system can determine the location and orientation of different objects in the real environment. For example, a specific sensor commonly used in augmented reality applications for optical tracking, a cam-

era, collects light through a lens and provides an image signal that is then analyzed to determine the desired tracking information [15]. As the efficiency of the current English listening teaching design is very low, it cannot meet our needs. The processor plays the role of the "brain" in an AR system and must have enough computational power to perform the tasks that need to be done in real time, consisting primarily of one or more CPUs or GPUs (dedicated graphics processing units) whose core role is to receive signals from the sensors, execute instructions from the application based on the sensor information, and create the signals that drive the system display. Some of the most common AR system processor configurations are handheld systems such as smartphones; handheld systems connected to a remote server, desktop, or laptop computers; and desktop or laptop computer connected to a remote server, cloud clients, or other combinations.

Cooperative learning plays an active role in teaching and learning by fostering positive interpersonal attitudes such as respect, tolerance, and cooperation, enhancing students' courage and ability to express or communicate ideas, helping students develop creative and critical thinking, and increasing self-esteem and self-concept. At the same time, cooperative learning can increase student classroom participation and student academic achievement, help students develop positive attitudes toward learning content, and promote interaction and friendship to occur. In the process, collaborative individuals increase higher-level reasoning, increase the generation of new ideas and solutions, and transfer learning better between contexts are all benefits of cooperative learning [16]. Thanks for the suggestions, we analyze and explain the research results in the fourth part. Cooperative learning is a positive pedagogy that promotes higher academic achievement; however, when designing the structure of cooperative learning tasks, to ensure the quality of learning of cooperative individuals, it is important to determine the responsibility of cooperative group goals and individual group responsibilities, knowing exactly what their respective responsibilities are to achieve their overall goals.

Discovery learning is both a method of learning and a method of teaching through which students use their own experience and prior knowledge to interact with their environment by exploring and manipulating objects, practicing, and giving feedback to build foundational knowledge, and discovering, thinking, exploring, and experimenting with problems in contexts where they are solving-knowledge content problems. Discovery learning promotes student exploration and collaboration that leads to problem solving. Students can also direct their inquiry and actively participate in the learning process in discovery learning, which contributes to student motivation. It is believed that discovery-based learning results in the development of an inquiring mind and the potential for lifelong learning, as shown in Figure 1.

Augmented reality technology can better provide students with a discovery learning environment and create examples of knowledge content, and its novel way of presenting information is more likely to attract primary school students' attention and generate curiosity about knowledge.

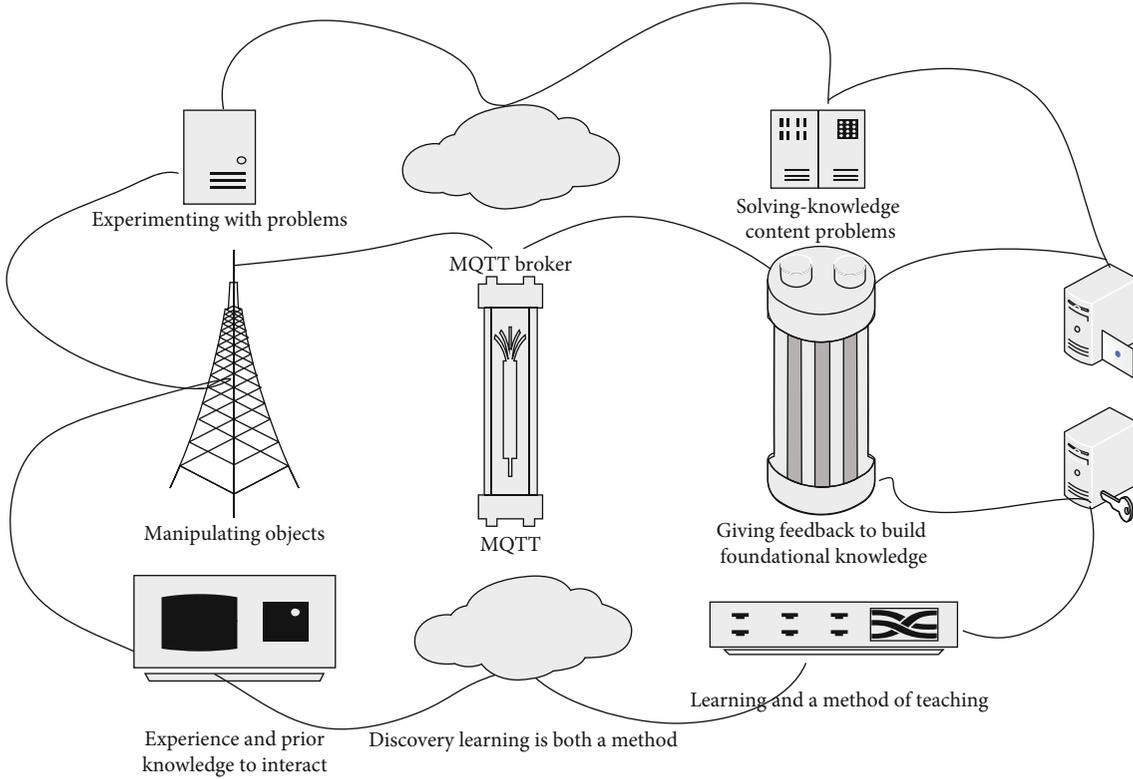


FIGURE 1: Wireless sensing microprocessor combined with the virtual environment framework.

Augmented reality primary school English teaching resources fit the thinking characteristics of primary school students; help teachers visualize content; guide students to discover, reason, investigate, and summarize; and communicate their findings and results; in the process, it is easier to drive students to achieve independent thinking and form inquisitive thinking while promoting teacher-student cooperation.

LoRa is based on linear spread spectrum modulation technology; it is only defined on the physical layer. It is usually deployed in the form of LoRa gateways combined with nodes; LoRa gateways are defined to relay data from the LoRa network to a network with IP. According to the definition of the gateway, the gateway can be a Lora WAN gateway or a self-designed gateway. High-frequency amplification technology is used at the LoRa RF transmitter, which can reach up to 2W or more, thus greatly enhancing long-distance and obstacle-penetrating transmission [17]. When the highest spreading factor and the lowest transmission rate are selected, the longest transmission distance is achieved, which can reach more than 20km in the ideal case. The spreading factor is increased to obtain longer transmission distances. Given that LoRa has a strong autocorrelation at the time of RF modulation, it reduces the difficulty of RF reception at the receiver at the time of reception. The LoRa RF data transmission process uses CRC (cyclic redundancy check), which generates a redundancy check code from the data to be sent, adds the redundancy check code after the data to be sent, and then sends it, and reduces the BER by redundancy check code at the time of reception. Finally,

the LoRa signal is based on a linear spread spectrum, the modulation frequency of the modulated signal is linearly varied to achieve the spectrum expansion, and a timing signal can be obtained by shifting the frequency in the modulated signal can be obtained.

$$|m_x + m_y| \geq dx - dy. \quad (1)$$

When two transmissions overlap in time but have different carrier frequencies, they do not interfere with each other and can both be decoded, assuming a receiver is listening to both carrier frequencies. The overlap in CF is defined as the absolute difference between these frequencies and an acceptable frequency offset depending on the bandwidth used. Thus, when two transmission collisions satisfy Equation (2), it is defined as a collision occurring at the carrier frequency condition.

$$|f_x + f_y| \geq f_i \text{ hreshold}. \quad (2)$$

The spreading factor used in LoRa is orthogonal. When the carrier frequency and coding rate are the same but the two packets have different spreading factors, the data can also be decoded successfully. Therefore, when two transmission collisions satisfy Equation (3), defined as a collision occurring under the spreading factor condition.

$$SF_x + SF_y = 1. \quad (3)$$

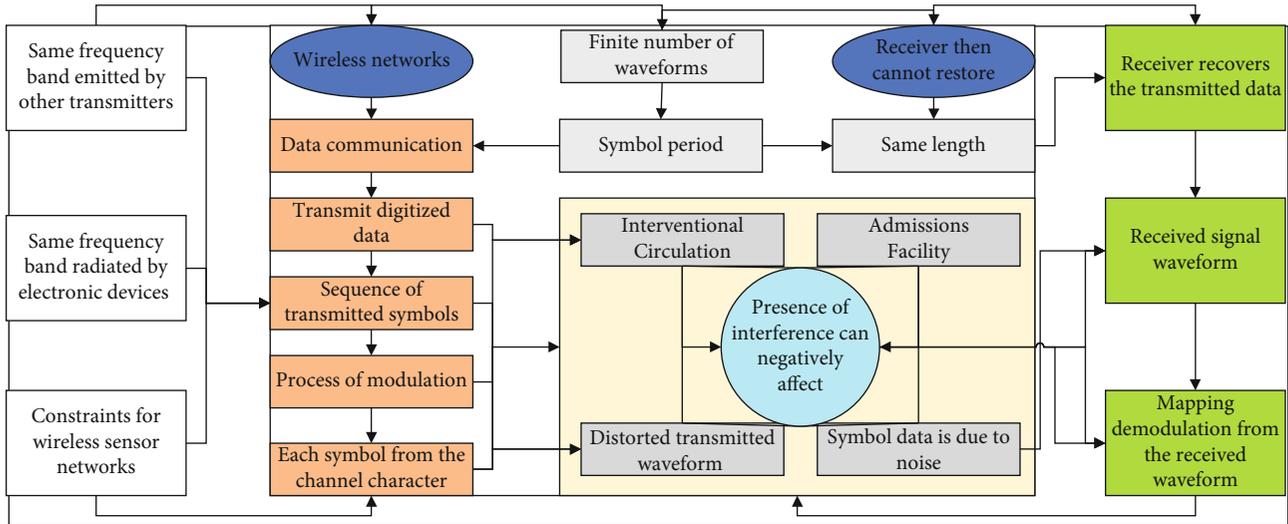


FIGURE 2: Physical layer reference model.

Because LoRa uses a form of linear FM spread spectrum, it has a capture effect. The capture effect occurs when two signals are present at the receiver, and the transmission with the stronger signal overwhelms the transmission with the weaker signal. When the difference in received signal strength is very small, however, the receiver can still maintain switching between the two signals but will result in an inability to decode. Thus, when two transmissions collide satisfying Equation (4), it is defined as a collision that occurs under power conditions.

$$(P_x + P_y) \geq P_i \text{ hreshold.} \quad (4)$$

When wireless networks are used for data communication, it is necessary to transmit digitized data, i.e., a sequence of transmitted symbols. In the process of modulation, each symbol from the channel character set is mapped into one or a finite number of waveforms that have the same length, called symbol period. The process of modulation is carried out in the transmitter while the receiver recovers the transmitted data based on the received signal waveform. The mapping demodulation from the received waveform to the symbol data is due to noise, fading, and interference, the received signal waveform is a distorted transmitted waveform, and the receiver then cannot restore the transmitted symbol data with complete certainty. Interference represents any portion of the signal that comes from an external source, and the presence of interference can negatively affect the reception of the signal. Interference may come from signals in the same frequency band emitted by other transmitters at the same moment, or it may be like signals in the same frequency band radiated by electronic devices such as microwave ovens. In addition, thermal noise (or noise) is another important issue to be concerned about, which is caused by the thermal movement of electrons inside conductors, such as amplifiers of transmitters and receivers. One of the design constraints for wireless sensor networks

is the smaller transmission power (i.e., smaller radiated power), which has a sample value of about 1 dBm. The purpose of limiting the transmission power is to save energy. However, the choice of a smaller transmission power has some implications for the channel, and a smaller transmission power means that only a shorter distance can be transmitted, reducing the range over which it can propagate, etc., as shown in Figure 2.

The processor module is the computational core of the wireless sensor network node, all the device control, task scheduling, energy calculation, functional coordination, communication protocols, data integration, and data dumping procedures will be done with the support of this module; therefore, the choice of processor is crucial in the sensor node design. In the system designed in this paper, the design principles we need to follow include the smallest possible form factor. Miniaturization is the trend of sensor nodes, and the size of the processor often determines the size of the whole node; integration is as high as possible. System on chip (SOC) is generally chosen as the processor of the sensor node. Various sensor nodes are usually selected with processors that integrate program memory, static memory, ADC converters, timers, and counters, and other multifunctional features. Choosing such a processor will make the processor peripheral circuitry of this system simple and neat, essentially eliminating the need to expand any external devices; power consumption is low, and sleep mode is supported [18]. Our research mainly comes from our usual results. The percentage of time that the sensor nodes are working is very small, and the battery has limited energy; for such a system to work for more than a year, the processor needs to support an ultralow-power sleep state mode; it should run as fast as possible. This system can complete the work that must be done in the shortest possible time so that it can quickly enter the sleep state, saving system resources and real-time is also better; but fast processor power consumption is also large, so a careful trade-off is required. Thus, the system in this paper uses the

TABLE 1: Main features of the central expert microprocessor.

Type	Illustrate
Advanced RISC simplified instruction set structure	Most of the 133 instructions can be completed in one clock cycle 32 * 8 general working register + peripheral control register Fully static work
Nonvolatile program and data memory	Up to 16 MIPS performance when working at 16 MHz Hardware multiplier with only two clock cycles Support up to 64 kb optional external memory space Programmable program encryption bit

ATmega128L low-power microprocessor chip. Its detailed technical characteristics are shown in Table 1.

The main purpose of the analysis of learner characteristics is to understand the learning target so that the best way of presenting augmented reality information can be chosen to provide appropriate sensory stimulation; the analysis of learning objectives is aimed at matching the result of the teaching resources to the pedagogical requirements, the curriculum requirements, and the requirements of students and teachers; the analysis of implementation resources determines whether the conditions for development and application are feasible and easy to implement and popularize. The second stage carries out the structural design. The structural design provides specifications and guidelines for the design and production of detailed text units. This phase requires the determination of design principles, design architecture, use case diagrams, flowcharts, and user manual design for augmented reality primary school English teaching resources, with design content that is deterministic, effective, and exhaustive, and a design style that is simple, consistent, and graphical.

*3.2. Designing English Listening Instruction for Virtual Environments.* Cultivating students' English listening and speaking skills is one of the main purposes of the subject of English, and the learning effect is above 50%, mainly cooperative, active, and participatory learning; therefore, the design and development of primary school English teaching resources need to fully carry out cooperative interaction. Based on augmented reality technology to create a team participatory dialogue situation with simple interactive functions and create a good environment for foreign language communication and acquisition, it can not only improve the learning atmosphere but also realize the development of English conversation and communication skills [19]. The traditional grammar translation method, listening and speaking method, task-based teaching method, etc., have shown some shortcomings and some incompatibility with the English teaching system in the teaching process. However, the interaction function does not need to be too complex; if the pursuit of high-level interaction effect is a formality, the classroom needs to be equipped with more complex and expensive equipment, which is not only impractical and impractical but also the intellectual development of primary school students is not sound, and the complex interaction will make them unaware of the acquisition

process, and the attention of primary school students is easily distracted by the complex interaction, thus reducing the teaching efficiency.

The overall architecture design of the augmented reality-based primary school English teaching resources is shown in Figure 3. The augmented reality teaching resources of a text unit are designed based on the architecture design, the design of the functional module script of the text is completed, and resources such as recognition maps, audio, and video, text, and augmented information are prepared according to the functional module script. In the production stage, the collected recognition maps are uploaded to the official Vuforia server and the library of recognition maps generated by Vuforia is downloaded. The recognition map library is called with other prepared augmented information resources for the development of augmented reality teaching resources for that text unit. After successful installation, open the software and scan the recognition map with the camera. If the recognition matches successfully, the real environment image captured by the camera and the corresponding virtual information will be displayed on the screen according to the recognition result, and the user can view the augmented information by changing the position of the camera or the book.

The user manual is used to guide the user to use this teaching resource, which is a physical material in the form of text, pictures, and tables to asynchronously achieve communication with the user and help improve the efficiency of the operation. The manual consists of two main sections: operational requirements and operating instructions. The operation instructions explain in detail how to use the teaching resource, including operation steps, operation table, and operation guide. The operation guide section lists the identification diagrams required to use the teaching resource, which function modules each identification diagram corresponds to, and the page number of each identification diagram in the textbook [20]. By viewing the operation guide, users can quickly find the corresponding identification diagrams in the handheld textbook, so that they can use the corresponding modules of the teaching resource more efficiently. The second level is intermediary interaction, such as computer-assisted teaching; the third level is cognitive interaction, where learning originates from the cognitive interaction between humans and technology, and the cognitive space is released through technology to allow people to focus on higher-level skills.

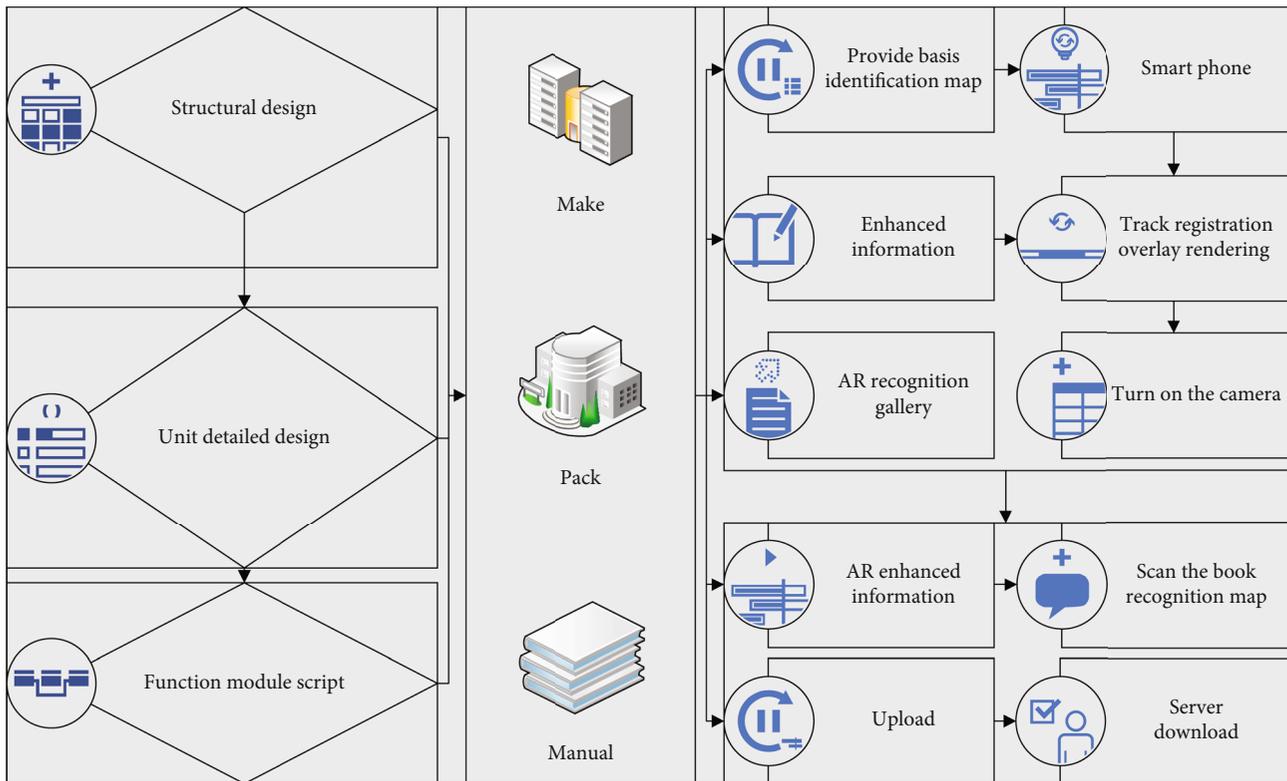


FIGURE 3: General architecture of teaching English in augmented reality.

Therefore, the design and development of the teaching resources of this unit should match the realistic learning scenarios provided by the teaching materials and combine the cognitive development characteristics and the maturity of students' thinking at this stage, to visualize the knowledge content and simplify the interactive methods. We use vivid videos and models to present textual knowledge points and choose intuitive and easy interactive content and methods to let them learn through observation, experience, and thinking. Augmented reality primary school English teaching resources also need to be basic and interesting, to cultivate their interest and positive attitude towards English language learning, as well as their ability to cooperate and innovate, to help them build their self-confidence in learning English, to improve their independent learning ability, and to lay a good foundation for their comprehensive English language skills in the future. And in practice, gradually explore how to apply it more rationally and effectively in junior high school English situational teaching, to optimize classroom teaching, improve teaching efficiency and student learning efficiency, and provide a basis for follow-up teaching. At the same time, we make use of students' plasticity to build good emotional attitudes and cultural awareness and promote comprehensive development.

First, the camera is activated and waits for the user to scan the recognition map, captures the image in the environment in real-time, and compares the feature points of the image with the registered feature points. If the match is successful then the registration is tracked, the markers are located, the enhancement information is loaded from the

server, the enhancement information is overlaid onto the real scene by rendering, and the fused image is delivered to the display. If the match is unsuccessful then the scan recognition map state is maintained. The above process is cycled until the user exits. The flow chart of usage is shown in Figure 4.

Daily communicative phrases include greetings, introductions, thanking and responding, congratulating, and praising and responding, apologizing, and forgiving, offering help, and responding, agreeing, and disagreeing, advising, and responding, suggesting, and responding, expressing feelings, asking for time and date, and responding, opinions, plans, and intentions, and encouragement. This knowledge is mostly presented in the form of dialogues, and the type of questions in the multiple-choice questions of the supplementary dialogue type [21]. Candidates can use every day communicative language to communicate. In this process, cooperative individuals increase higher-level reasoning, increase the generation of new ideas and solutions, and better transfer learning between situations, which are all advantages of cooperative learning. This type of question tests students' ability to use language communicatively, requiring them to answer questions with appropriate language, authentic expressions, a combination of language practice and thinking, and the most relevant language expressions based on the language environment. The main test is the students' ability to understand and grasp the main idea of the text and the general idea and central idea of the passage, and to deepen their understanding of the text by using the relevant information they have obtained, linking it to the

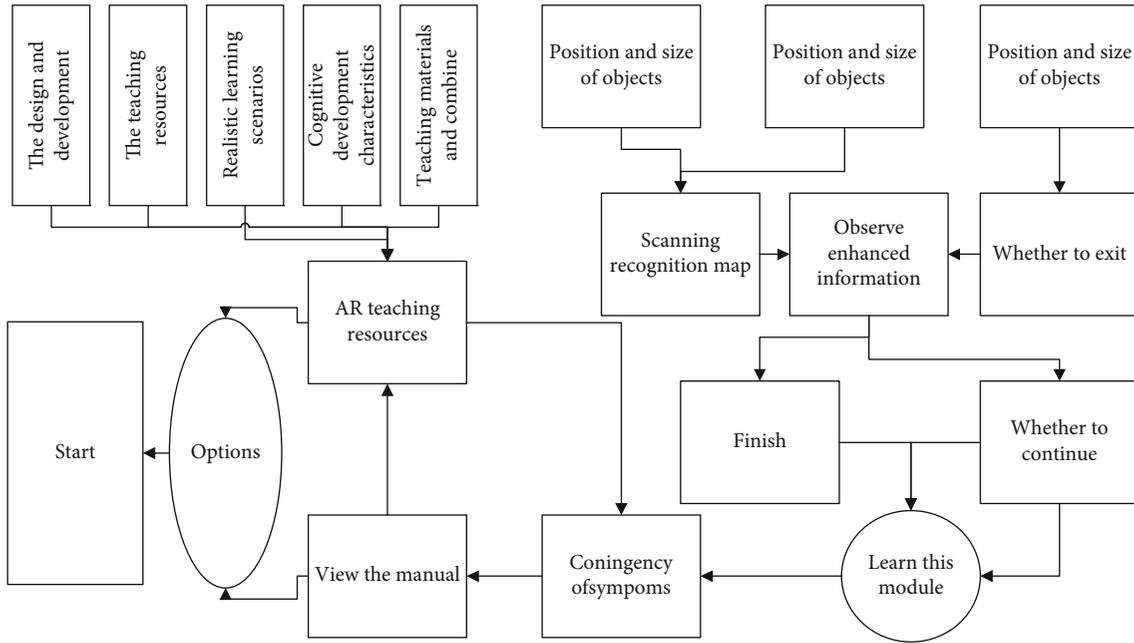


FIGURE 4: Flow chart of usage.

context, and then making inferences about the meaning of the vocabulary, to finally achieve the purpose of understanding the whole text and answering the questions accurately. The LoRa radiofrequency data transmission process uses CRC (cyclic redundancy check). The redundancy check code is generated from the data to be sent, and the redundancy check code is added to the data to be sent, and then send, and then receive. Redundant check codes are used to reduce the bit error rate.

Everyday communication is a good starting point for learning spoken English. Through the practice of daily communication, students gradually develop their English habits and English-speaking skills, reflecting the value of English as a language for daily communication. Through pre-designed VR conversation scenarios with audio files of everyday communicative phrases, students can personally experience and immerse themselves in the VR scenarios to get a more realistic feel of everyday spoken expression situations and gain a deeper understanding and more proficient use of every day spoken conversation content. The spoken dialogues are designed not only to improve spoken English but also to develop students' understanding and integration of foreign cultures. The VR technology provides learners with rich speaking learning resources, so that learners can experience different teaching styles more and can experience a foreign culture in a real and intuitive way, expand their horizons and international connection, and achieve understanding and practical application of speaking learning.

## 4. Analysis of Results

*4.1. Wireless Sensing Microprocessor Combined with Virtual Environment Performance Test Results.* To evaluate the experimental results of the test, all messages sent in a valid LoRa deployment environment should be received by all

receivers. This means that each sent message should be correctly received by at least one LoRa receiver. Define the data reception rate DRR as the ratio of the number of packets sent over a while to the number of packets successfully received by the receiver. One of the design constraints of wireless sensor networks is smaller transmission power (i.e., smaller radiated power); the sample value of this power is about 1 dBm. DRR is a value between 0 and 1. Here, a DRR value greater than 0.8 is defined as a node where data is successfully received. In an ideal deployment environment, the DRR value is 1. This metric is evaluated for individual LoRa nodes, only for the entire LoRa network.

Table 2 shows two different sets of transmission parameters for HTC\_0 and HTC\_1; for both sets of parameters, each node is specified to send a packet containing 20 bytes of payload to the receiver every 10 min. For HTC\_0, the settings with the largest spreading factor, narrowest bandwidth, and lowest coding rate are chosen, and for HTC\_1, to contrast with the HTC\_0 parameter settings, they remain the same as HTC\_0 except for the difference in carrier frequency settings. HTC\_1 uses three channels with the central frequency point as shown in Table 2, and different nodes can select three different channels by randomly transmitting data to the LoRa receiver.

For the compressed data, by the principle of Huffman compression coding, it can be divided into two categories: the first category is data that fluctuates within a certain range, such as temperature and humidity sensor output data, or unsigned 8-bit image data, which is defined as correlated data; the second category is data that changes randomly, without certain regularity, which is defined as uncorrelated data. The compression ratio can be expressed as the ratio of the length of the compressed data to the length of the original data, and the smaller the compression ratio, the more data are compressed and the better the compression

TABLE 2: HTC values.

Parameter	HTC_0	HTC_1
TP (dBm)	11.61	6.34
CF (MHz)	11.59	14.53
SF	2.46	13.47
BW	4.98	10.83
CR	6.83	5.99
Enter	7.83	6.74
P	3.32	9.25

effect. Figure 5 shows the given correlated data, uncorrelated data, and compression ratio; the experimental data are eight-bit unsigned data. For the correlated data, the compression rate decreases gradually as the amount of compressed data rises, because the probability of data repetition is greater as the data increases. The compression rate of correlated data is compared with that of uncorrelated data, and it can be found that the former has better compression effect than the latter in general, which is consistent with Huffman compression coding theory.

First, each node should complete the initialization of all their respective functional modules, because this paper uses an ATmega128L microcontroller to control the 2.4 GHz point-to-point wireless communication technology implemented by CC2420, so it needs to be configured and initialized when using CC2420 for data transmission and reception. The initialization process includes CC2420 initialization and setting of transmitting and receives modes. CC2420 initialization includes initialization of ATmega128L microcontroller SPI, turning on the voltage regulator, restarting the chip, turning on crystal, initializing register values, and setting register values. The setting of transmitting and receive modes is done by accessing the `cc2420_sendcmd` function, respectively; the setting of the transmit and receive modes is done by accessing the two command registers STXON and SRXON of the CC2420, respectively. The real working time of the sensor node is very small, and the battery energy is limited. For such a system to work for more than one year, the processor needs to support an ultralow-power sleep mode; the running speed should be as fast as possible. After completing the initialization work, it starts to listen to the wireless channel and various details sent from other nodes and processes the different information accordingly. To complete an image acquisition process, first, the computer terminal should issue an image acquisition command and transmit the command to the receiving node through the serial port; then, the receiving node sends it to the relay node through the ZigBee wireless network, and the relay node forwards it to the sending node. The sending node receives the command and then transmits the command to the acquisition terminal through the serial port again.

*4.2. Results of Teaching English Listening in a Virtual Environment.* The results of both the pretest and the phonological status questionnaire showed that the students' pho-

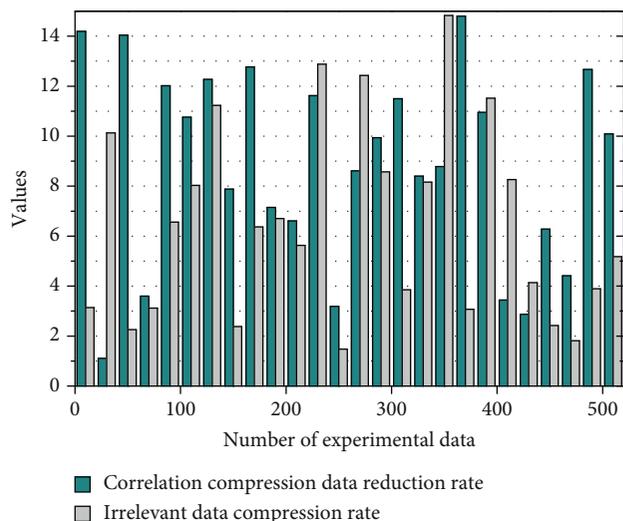


FIGURE 5: Number of experimental data, correlation, and compression rate of uncorrelated data.

nological ability was weak, and they knew little about phonological concepts. The author believes that it is very necessary to provide a period of phonetic training for the students of both groups. As more mature-minded high school students, explaining clearly some basic concepts of phonetics, formal training is more conducive to improving their phonetic ability than subjective summaries of rules that ensure phonetic accuracy. Constrained by the school schedule and space, the author designed a 4-week phonological training course covering both phonemic and suprasegmental phonological segments. Two groups of students participated in the 4-week English phonetic training course. Group B received only 4 weeks of phonetic training, while Group A received the same training in addition to independent phonetic learning using the Speaking 100 software. Group A used Speaking 100 for three months of phonetic training with intelligent follow-along practice. The frequency of the follow-up reading: Once a day for the follow-up reading training. In order not to take up too much of students' time, and because speech training is a highly concentrated training, students are easily fatigued, so half an hour to one hour is appropriate. Students are also instructed to choose other reading materials outside the classroom that are comparable to their level according to their phonetic level and reading performance.

A second phonetic test was administered to all students tested after the four weeks of phonetic training and three months of follow-through training. This phonetic test was conducted to examine whether Group A had improved in their phonetic level relative to Group B after nearly three months of intelligent follow-through training, as shown in Figure 6.

First, let us see if there is any significant change between the Group B pretest and Group B posttest. From the Figure 6, we can see that the mean scores of the pretest and posttest of Group B are very close to each other, and the differences in the standard deviations of the phonemes (12.85 and 12.9) words (13.4 and 13.5) single sentences

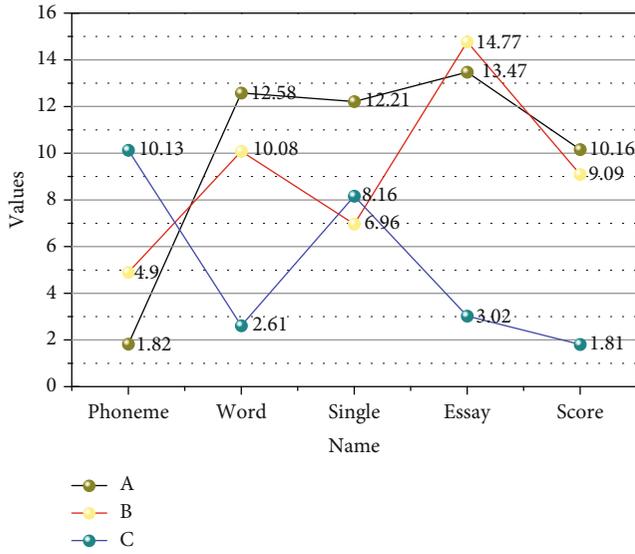


FIGURE 6: Test results.

(29.9 and 29.95) short sentences (13.82 and 13.96) and the mean scores of the total scores are (69.98 and 70.33) are also not significant. The results of the mean significance test P show indicate that there is no significant difference between the Group B pretest and Group B posttest speech test scores ( $p = 0.84$ ,  $p = 0.72$ ,  $p = 0.89$ ,  $p = 0.58$ , and  $p = 0.66$ ; both  $>0.5$ , respectively). Therefore, we can determine that there was no significant change in the Group B pretest and Group B posttest speech. Group A uses Spoken Language 100 to perform intelligent follow-up exercises for three months of voice training. The follow-up frequency is follow-up training once a day. In order not to take up too much time for the students and the voice training being a highly concentrated training, in which students are also prone to fatigue, generally, the training time is half an hour to one hour.

Although there was no significant change in the performance of Group B students, the total score of the pre- and posttests (69.98 and 70.33) showed a slight increase in the overall performance. The increase in performance may be due to the 4 periods of phonics training, or it may be because some of the phonetic symbols in the pre- and posttests were the same, and some students went home to consolidate and review them after the experiment. But unfortunately, there was no significant change in Group B's performance, which indicates that a few weeks of phonics training did little to help Group B students' phonics ability. From the results of the achievement test, we can conclude that the total score of the experimental class is 292 points higher than the control class, and the average score of the experimental class is 7.3 points higher than the control class. The distribution of the number of scores in the experimental and control classes tabulated, and the results are shown in Figure 7 below.

The number of students in the experimental class is 8, with an excellent rate of 20%, and 5 in the control class, with an excellent rate of 12.5%. From Figure 7, the pass rate of the experimental class is about 85% and the fail rate is about 15%, and the pass rate of the control class is 75% and the fail

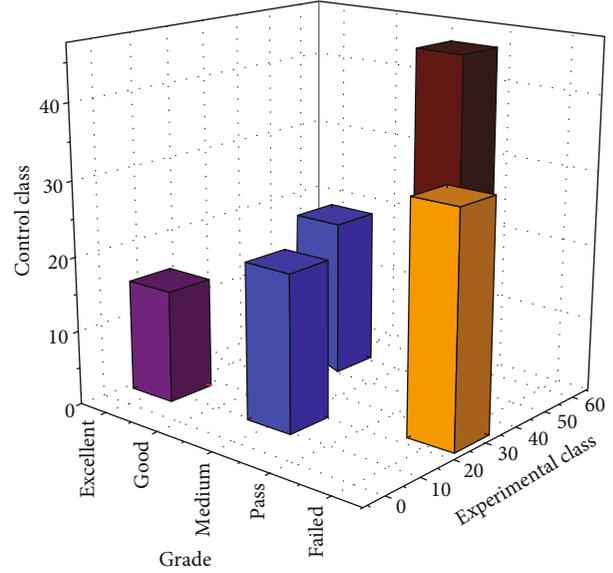


FIGURE 7: Statistical chart of the distribution of the number of students in the experimental and control classes.

rate is 25%. From the above data analysis graphs, it can be seen that the use of augmented reality teaching resources in classroom teaching has increased the pass rate by ten percent compared with the use of ordinary teaching resources, and the overall performance of students has shown a significant upward trend, especially for the intermediate and lower intermediate level students' performance is more obvious, indicating that the use of this teaching resource by teachers has a greater role in promoting the English learning performance of primary school students.

### 5. Conclusion

As an extension of virtual reality technology, augmented reality technology, with its unique advantages of combining reality and reality, flexibility, simplicity, and interactivity, brings students a sensory experience of seamless integration of physical space and virtual space, breaking the limitations of teaching because of time, place, space, and money. We also independently developed a wireless sensor network relay node and transceiver hardware platform for both scalar and vector information transmission, and based on this, we tested and verified the stability, robustness, and real-time performance of the scalar and vector data transmission of the dual terminal communication system for different network environments. The experimental results show that the communication quality of the system constructed in this paper is good and can be applied to multiple types of ubiquitous communication needs. It helps to solve the problems that children's minds can only perform simple abstraction at the concrete computing stage, need the support of concrete matters, have a short attention span, and are easily bored in the face of detachment from the actual environment, provides teachers with new teaching aids, assists teachers to improve teaching efficiency, promotes the achievement of teaching objectives, and enhances teacher-student

communication, and also promotes the development of educational media. The task-driven model is used to organize English teaching activities in the virtual environment, creating a positive atmosphere for English communication and learning, so that students participating in the experiment are enthralled with curiosity and joy in the activities of the virtual scenario, thinking and expressing themselves independently, and striving to complete the tasks, so that the knowledge learned in class can be implicitly applied to practice, consolidation, and improvement.

## Data Availability

The data used to support the findings of this study are available from the corresponding author upon request.

## Conflicts of Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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