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Artificial Intelligence-based Intervention Robot for Autistic Children

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ABSTRACT:

Affected by various factors, the incidence of autism is on the rise. Existing studies have confirmed that reasonable intervention can promote the development of autistic children, but it is limited by factors such as lack of teaching resources, low teacher competence and high rehabilitation costs. This paper introduces an experimental study of an artificial intelligence-based intervention robot for autistic children. Using deep learning technology in artificial intelligence combined with Internet of Things sensing technology, a series of feasibility analysis on the application of artificial intelligence in the education of children with autism was conducted from the perspectives of parents and psychologists. The idea of applying intervention therapy robot to the early diagnosis and rehabilitation training of autistic children is proposed to improve the perception and cognitive ability of autistic children's external environment.

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I. INTRODUCTION

Artificial Intelligence (AI) is an interdisciplinary subject involving many fields. Since entering the 21st century, Artificial Intelligence technology has gradually matured and applied in more and more fields, among which education is one of them. In recent years, influenced by various factors, the incidence of autism has been increasing worldwide. According to statistics, there are more than 67 million people with autism worldwide. Estimates of autism prevalence increased by nearly 10 percent, to 1 in 54, according to data released in 2020 by the Centers for Disease Control and Prevention. According to the report on the Development of Autism Education and Rehabilitation Industry in China, there are more than 10 million autism patients in China, including more than 2 million children aged 0-14, with an annual growth rate of nearly 200,000.

At present, existing studies have confirmed that reasonable intervention can promote the development of autistic children, but it is restricted by factors such as lack of teaching resources, low teachers' ability and high rehabilitation costs [1]. With the continuous development of society and technology, this study aims to through deep learning in artificial intelligence technology and combined with the Internet of things technology, perception from children with autism, a psychologist and family and so on a series of feasibility analysis, intelligent tutoring system constructed on the basis of the combination of four components, and considering the influence on the development of the families of children with autism, The idea of applying artificial intelligence to the early diagnosis and rehabilitation training of autistic children is proposed to improve the perception and cognitive ability of autistic children's external environment.

II. REQUIREMENTANALYSIS AND OVERALL DESIGN

This study mainly uses the Internet of things to sense children's state, and cameras to collect children's body movements and facial expressions. Deep learning technology in artificial intelligence is used foranalysis, and voice synthesis technology is used to synthesize children's parents' voices, so as toobserve and analyze children's responses to the voices of their relatives and others.

Corbett[2], Akhras and Self et al. [3] proposed in 1997 and 2002 respectively that the application of this system integrates four components of artificial intelligence technology: autistic child model, domain [4][5] model, psychologist module and parent [6] model. This study draws on this idea and makes corresponding adjustments according to the characteristics of autistic children. The smart partner model is shown in Figure 1.

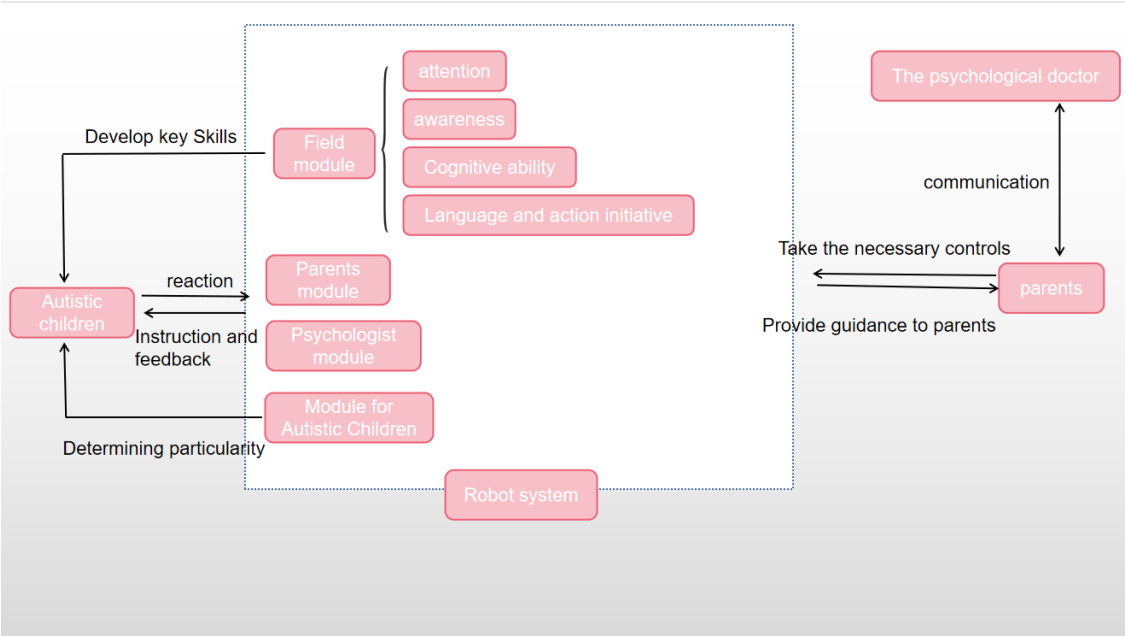

Fig.1Smart partner model

Part of the study shows that effective learning occurs as a result of a combination of robotic systems, children with autism, psychologists and parents. It is mainly composed of four modules: module for autistic children, module for domain, module for psychologist and module for parents. The specific functions of each module are as follows: Autistic children module, on behalf of the profile of children with autism, including special ability, language development level, age, degree of attention to maintain time, easy temper, and the information such as peer relations, in the characteristics of children with autism, should focus on children with autism attention maintain time, this is to set up the foundation of the degree of difficulty learning content. The domain module contains all the knowledge to be taught in the system. The content of this part of knowledge is set according to the expert's problem-solving model, and the difficulty of the problem is adjusted by the ratio of the attention maintenance time of autistic children to the attention maintenance time of normal children. That is, when the ratio is low, the difficulty of learning problems will be reduced according to the actual situation; when the ratio is high, the complexity of problems will be increased. The psychologist module is the child's body movements and facial expressions collected by the psychologist through the camera. Under the coordination with the parents and the system, the system sends certain instructions to the children with autism, and the children with autism make certain responses, so as to realize indirect communication with the children with autism. The parent module is similar to the psychologist module. In coordination with the psychologist, parents can better observe the psychological changes and emotional changes of autistic children, so as to improve the effectiveness of communication with autistic children.

III. HARDWARE DESIGN AND IMPLEMENTATION

SCM CONTROLDESIGN AND REALIZATION

The design of hardware platform includes the design of main control board and peripheral kit. The overall block diagram of the hardware platform is shown in Figure 2. The main control board composed of robot decision system mainly includes minimum system, perception system interface and behavior system interface. It acts as the robot's decision and control center, coordinating the perceptual and behavioral systems. The MCU used in this study is mainly STM32 core board, as shown in Figure 3.

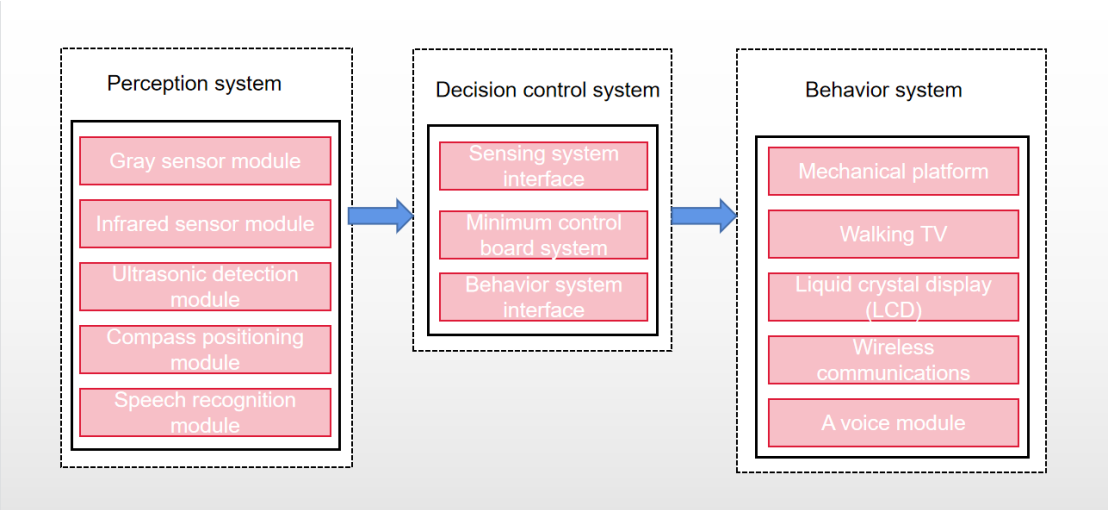

Fig. 2General block diagram of hardware platform

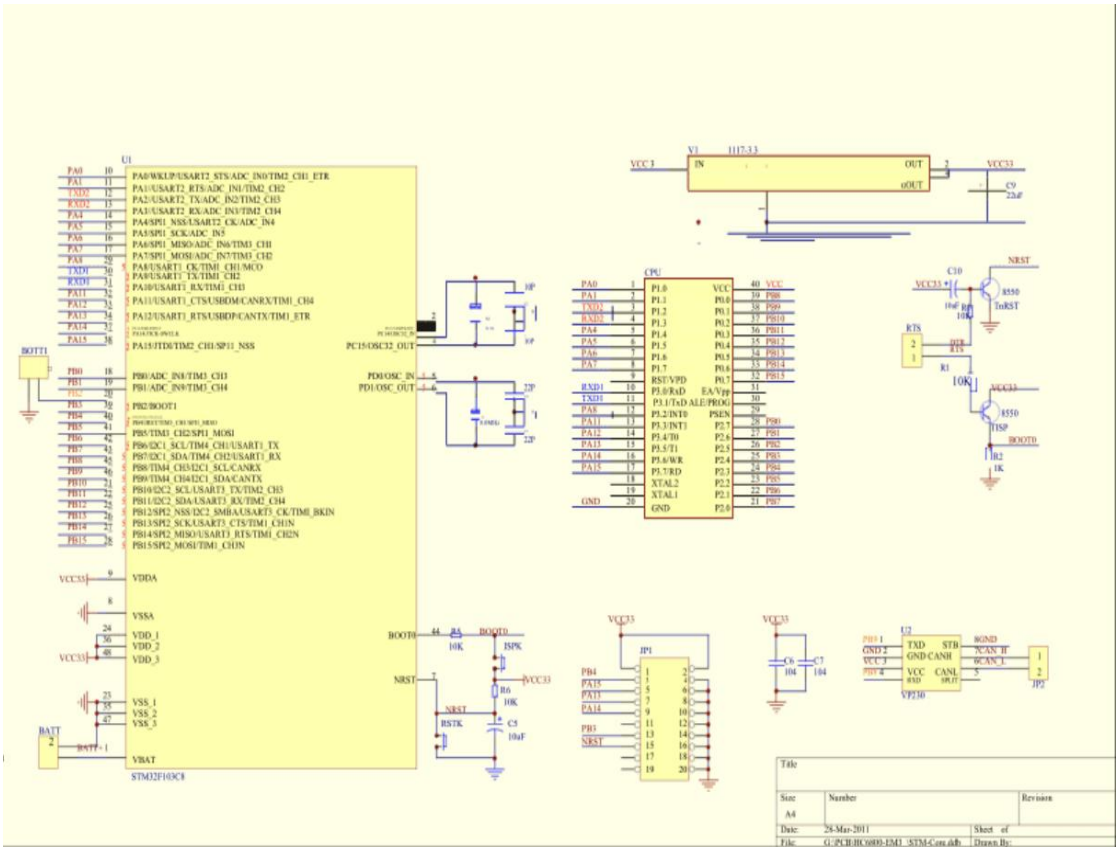

Fig.3Schematic diagram of STM32 core circuit board

SENSORCIRCUITDESIGNANDREALIZATION

Transducer /sensor is a detecting device that can sense the measured information and transform it into electrical signal or other required information output according to certain rules, so as to meet the requirements of information transmission, processing, storage, display, recording and control.

Gray sensor and infrared sensor are used in this study. Gray sensor is a simulation sensor, mainly using different color detection face light reflection degree is different, photosensitive resistance to different detection surface of light resistance is different color detection principle. Used to distinguish black from other colors when ambient light interference is not very serious. It also has a relatively wide operating voltage range, in the power supply voltage fluctuation is relatively large circumstances can still work normally. Its output is continuous analog signal, so it can easily judge the reflectivity of the object through A/D converter or A simple

comparator, which can be used as the patrol sensor of intervention robot. Infrared sensor is a kind of sensor that uses infrared to process data. It has the advantage of high sensitivity. Infrared sensor can control the operation of the driving device. In this study, an infrared sensor was installed on the intervention robot to sense the body temperature of children with autism and monitor the ambient temperature of children with autism, thus playing a certain protective role in the safety of children with autism. See Figure 4 and Figure 5 respectively.

Among them, the perceptual system of this study includes gray sensor module, infrared sensor module, ultrasonic detection module, speech recognition module and compass positioning module. The behavior system includes mechanical platform, walking motor, LIQUID crystal display module, voice module, wireless communication module and other kits. When the robot performs a task, the information of the external environment is obtained through the perception system, and analyzed and processed by the decision control system, and then the control command is issued to the behavior system, so that the robot can make corresponding actions.

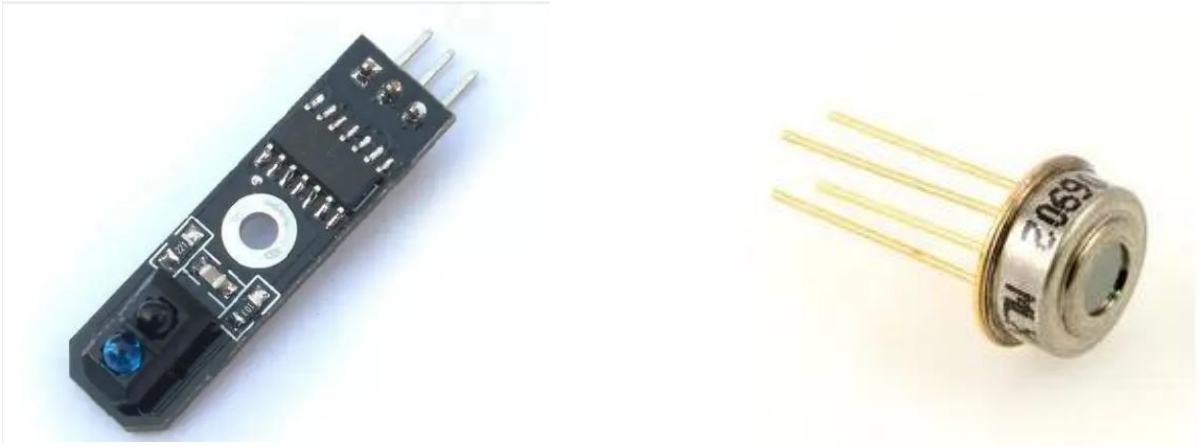

Fig.4 Grayscale sensorFig.5 Infrared sensor

DESIGNAND IMPLEMENTATION OF VOICE PLAYBACK SYSTEM

This study uses speech synthesis technology to synthesize children's parents' voices, which can be divided into waveform editing synthesis, parameter analysis synthesis and rule synthesis.
Waveform editing synthesis, which takes statements, phrases, words or syllables as synthetic units. These units are directly digitally encoded after being recorded separately, and a synthetic language library is formed by appropriate data compression. During the playback, according to the information to be output, the waveform data of the corresponding units are taken out of the corpus, connected or edited together, and the speech is decoded and restored. This synthesis method, also called recording editing synthesis, the larger the synthesis unit, the better the naturalness of synthesis, the system structure is simple, the price is low, but the digital rate of synthesis speech is large, the storage is also large, so the synthesis vocabulary is limited. Parametric analysis synthesis, which takes syllables, semi-syllables or phonemes as synthetic units. Firstly, the speech of all synthetic units is analyzed according to the theory of speech, and the relevant speech parameters are extracted. These parameters are encoded to form a synthetic speech library. When output, according to the information of the speech to be synthesized, the corresponding synthesis parameters are taken out from the speech library, edited and connected, and then sent into the speech synthesizer in sequence. In the synthesizer, the speech waveform can be restored by synthesizing parameters. Regular synthesis, in which phonetic rules are used to produce target sounds. The rule synthesis system stores the acoustic parameters of smaller phonetic units (such as phonemes, diaphonemes, semis syllables or syllables), as well as the rules that form syllables from phonemes and then syllables form words or sentences. As letter symbols are entered, the compositing system automatically converts them into a continuous speech waveform using rules. Due to sound is coordinated in effect, the separate existence of vowels and consonants with continuous different pronunciation of the vowel and consonant, so the synthesized rule is based on the analysis of each unit of coarticulation effects appear in different environment, after summing up the law and rules such as formant frequency, duration, rules, rules

oftone and intonation, etc. Due to the light and heavy sound in the statement, the rules of speech reduction should be concluded.

In order to make the synthesized speech have higher articulation, intelligibility and naturalness, waveform-based speech synthesis technology is usually adopted. The synthesis unit of waveform splicing speech synthesis is segmented from the original natural speech and retains some prosodic characteristics of natural speech. According to the phonetic and prosodic rules of natural language, appropriate phonetic premiant are stored so that these units have the maximum phonetic and prosodic coverage under the determined storage capacity. After acoustic unit selection, waveform splicing, smoothing and other steps, the synthesized speech is output. By carefully designing the corpus and selecting the most suitable acoustic units from the sound library according to the phonetic and prosodic rules, the system can output high-quality speech.

COMMUNICATION SCHEME DESIGN

With the opening and application of 5G wireless communication technology, its characteristics are becoming more and more prominent. This technology has a relatively high utilization rate of spectrum, and the spectrum resources of high frequency band are widely used in 5G wireless communication technology. Compared with traditional communication technology, 5G wireless communication technology has more prominent characteristics of multi-antenna, multi-user, multi-point and multi-cell mutual networking cooperation, and can greatly improve the technical performance of information coding and physical transmission between dots, and reduce energy consumption and cost. This study aims to achieve more efficient indirect communication between autistic children and parents and psychologists through 5G wireless communication technology and robot system.

IV. SYSTEM SOFTWARE DESIGN AND IMPLEMENTATION

Combined with the actual needs, the research system adopts B/S development mode,SSH framework, DWR, JBPM. Development tools MyEclipse8.5, database Mysql5. Server Tomcat6.0, programming language Java, JSP, HTML, JavaScript.

The MAIN PROGRAM

The main program is mainly composed of sub-programs such as camera acquisition, sensor induction and speech recognition. The main function is to collect data and convert it into language that can be recognized by the robot, so as to realize the robot and autistic children and parents. The process flow chart of indirect communication among psychologists is shown in Figure 6.

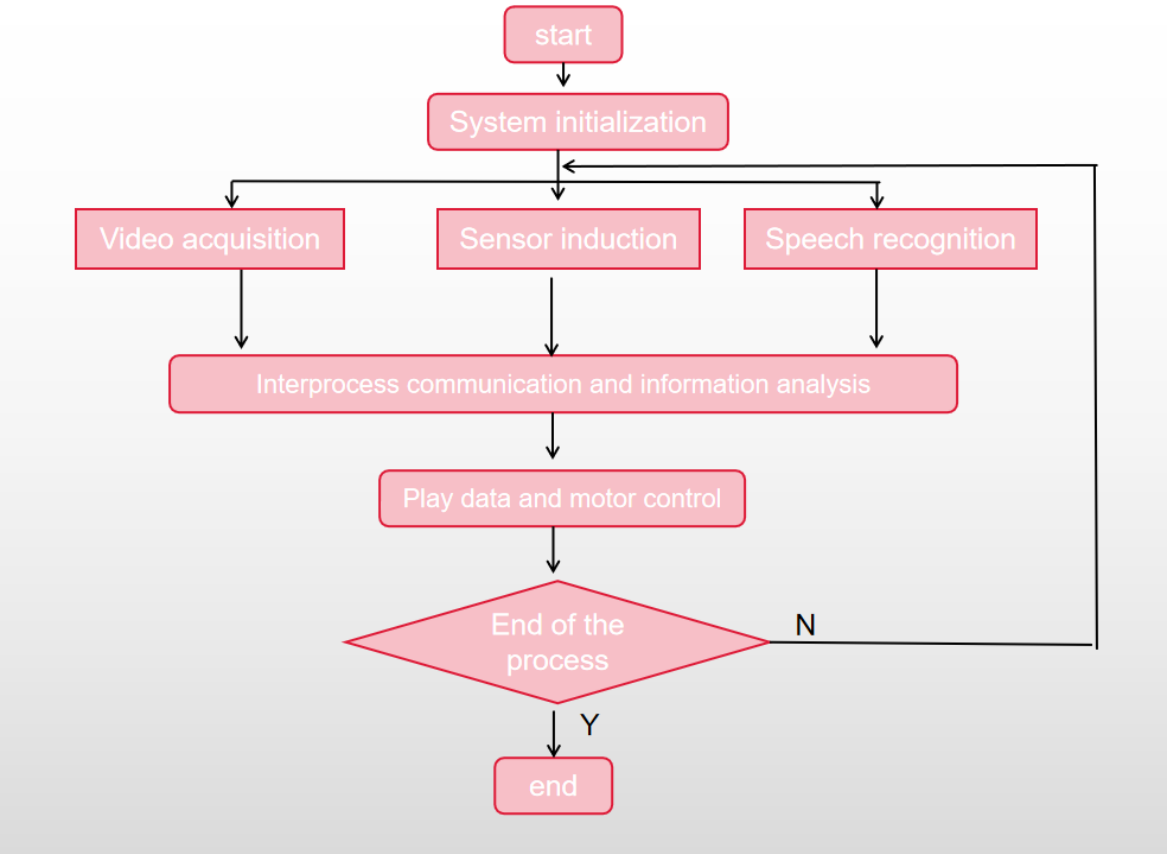

Fig.6 Main program flow chart

SUBROUTINE

The main subroutines in this study are camera acquisition subroutine, sensor subroutine and speech recognition subroutine. The main function of the camera acquisition subroutine is to help psychologists and parents monitor the behavior state of autistic children, so as to better understand the psychological response of autistic children, and then make corresponding guidance and education; The sensor subsystem mainly monitors the temperature of autistic children and the safety of the surrounding environment. Speech recognition subsystem is mainly the psychologist and parents of the voice into the intelligent robot can execute the command, synthesis of children's parents voice, easy to observe and analyze children's response to the voice of relatives and other people. Each subsystem flow chart is shown in Figure 7, Figure 8 and Figure 9 respectively.

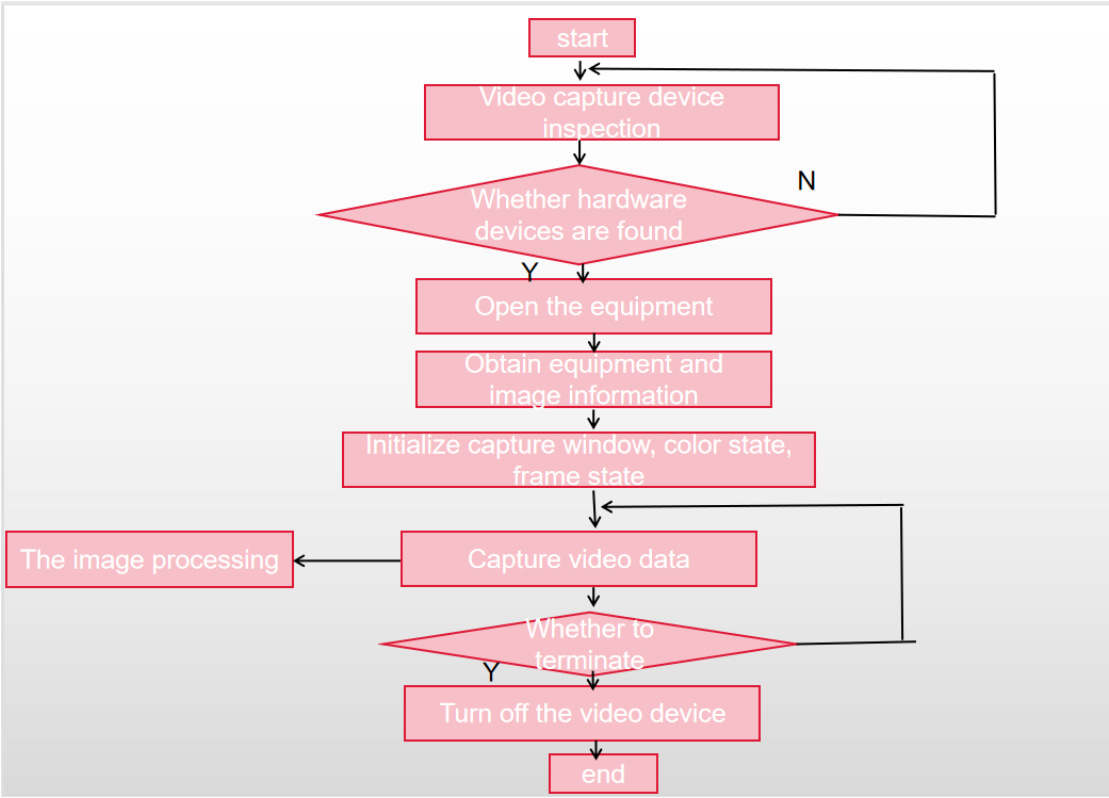

Fig.7 Flow chart of camera acquisition

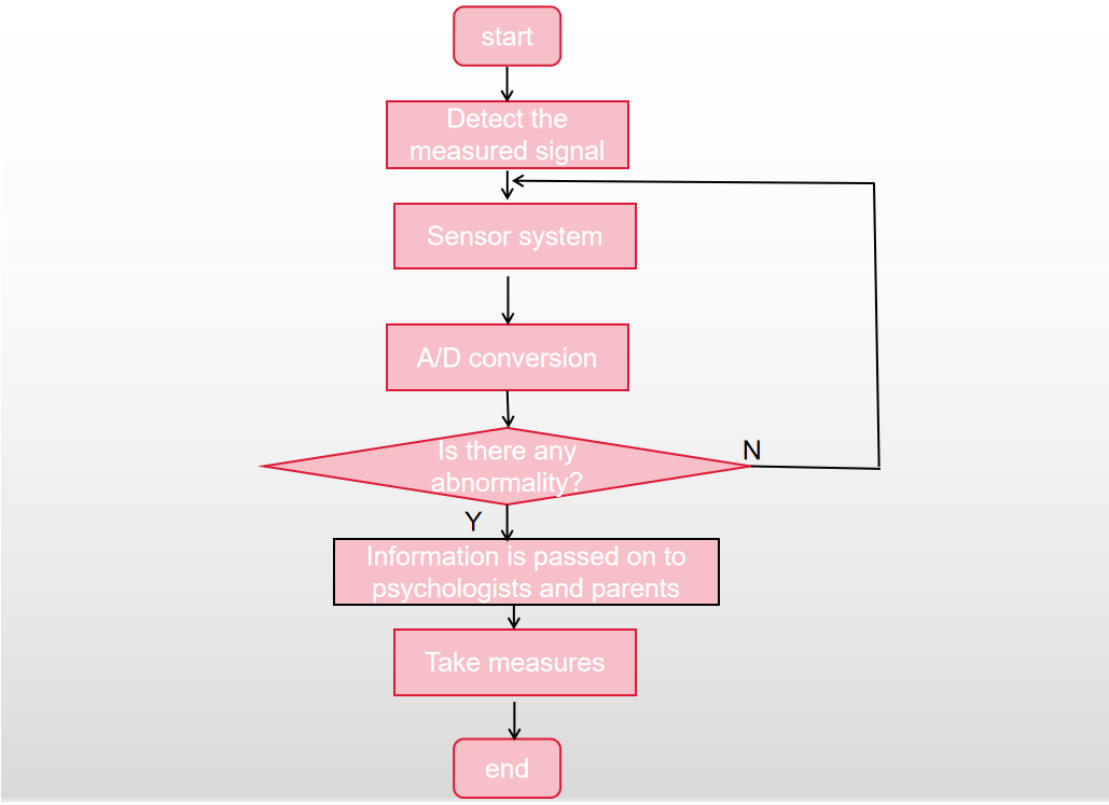

Fig.8 Flow chart of Sensor Subsystem

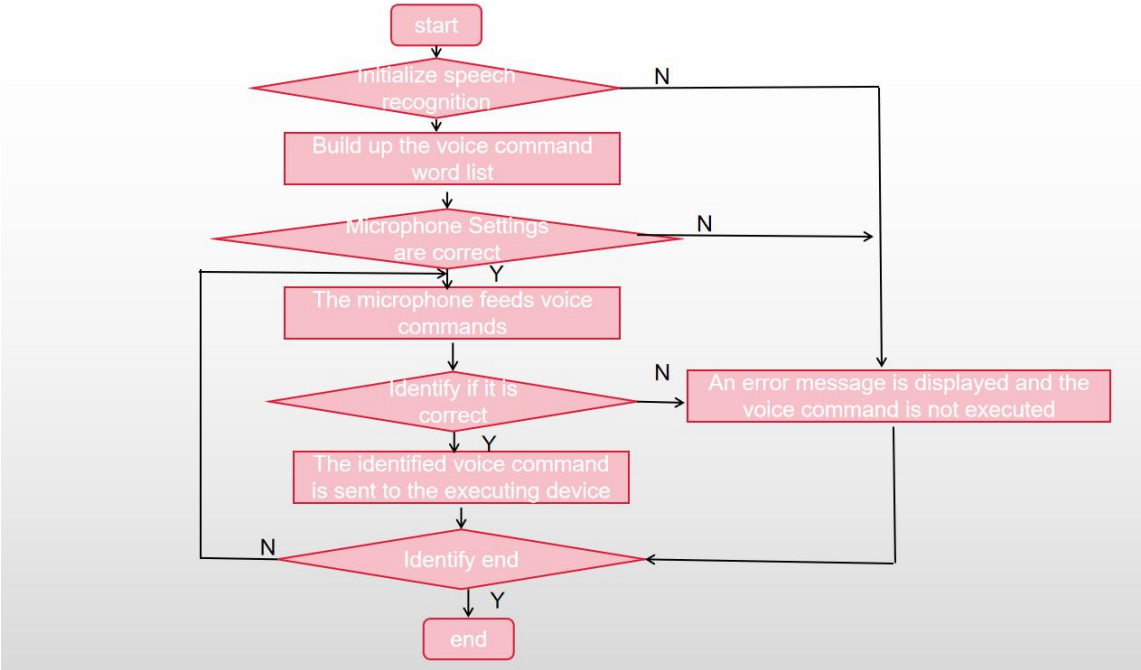

Fig.9 Flow chart of speech recognition subsystem

V. SYSTEM TESTING AND RESULTS

This study on the hard and software of the system environment, network topology, the video acquisition autistic children information, voice synthesis parent child voice, sensors' information, and so on a series of test system can capture the picture clearly, right to monitor success of children with autism behavior, realize video collection function, realizes the intelligent voice synthesis the voice of the child's parents, With the help of the sensors to achieve perception information in the Internet of things at the same time, to a certain extent have played an important role in autistic children's safety, system also implements the permissions to control the function of the elaboration to the menu button, to some extent improve the controllability of the system, also greatly enhance the convenience of the system, the user is more convenient to use.

VI. CONCLUSION

Retrieve this study of artificial intelligence (ai) for the treatment of autistic children education both at home and abroad related research literature, combined with deep learning in artificial intelligence technology and Internet technology, perception from children with autism, a psychologist and family and so on a series of feasibility analysis, through the autistic children, domain module, psychological doctors and parents module four components such as preliminary research, Further enrich the idea of applying artificial intelligence to the early diagnosis and rehabilitation training of autistic children, and improve the perception and cognitive ability of autistic children's external environment. Artificial intelligence technology helps to provide intelligent and personalized intervention methods and more intelligent and accurate support services for the intervention and evaluation of autistic children. The application of ARTIFICIAL intelligence in the education of children with autism is challenging and has great potential. Artificial intelligence is of great significance to the education of special children. At the same time, through the practice of artificial intelligence in the field of special children's education, it may deepen the understanding of artificial intelligence and take a step forward to "develop technology that can simulate human intelligence".

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