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Smart Travel Leader - A Study on the Design of an Intelligent Robot Based on Safe Travel for Children's School Tours

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Abstract

With growing attention to children's safety and educational needs in China, study tours have become a popular approach combining travel and learning. This paper proposes the design of a compact, portable intelligent robot-Smart Travel Leader-to enhance safety during children's school trips. The system includes a student-friendly robot, teacher tools, and a supporting mobile app. The design process involves user analysis, journey mapping and service blueprinting. Based on the findings, an innovative concept is developed using conceptual design and 3D modeling. The robot integrates AI, GPS, voice interaction, and environmental sensing to monitor children's location, health, and surroundings in real time. It offers intelligent navigation, emergency alerts, learning assistance, and coordination features. By combining multi-sensor data and real-time analysis, it can identify risks and issue early warnings. The system also enables real-time communication among parents, teachers, and students, aiming to deliver a safer, smarter, and more personalized study tour experience.

Keywords: children's school trips; intelligent robots; travel safety; school trip experience

Abbreviations

IoT: Internet of Things.
AI: Artificial intelligence.
APP: Mobile Application.

Introduction

In recent years, with the development of quality education in China, children's study tours have gained increasing attention as a form of education that integrates learning and traveling. Through group trips organized by schools or institutions, children broaden their horizons, enrich their knowledge and enhance their understanding of nature and culture in practice, while cultivating independence, teamwork and social adaptability [1]. However, children's self-protection ability is weak in the process of school trips, security risks are prominent, the existing positioning tracking and emergency call and other technical means of single function, it is difficult to deal with complex situations. With the advancement of artificial intelligence and Internet of Things (IoT) technology, intelligent robots are widely used in the field of education, but there are still fewer intelligent products for children's safety during school trips [2]. Therefore, it is of great practical significance and broad application prospect to design a children's school trip safety robot with real-time monitoring, intelligent interaction and auxiliary management function.

Purpose and significance

In the context of educational diversification, children's study tours have attracted widespread attention as a way of integrating learning and traveling, which not only expands their horizons but also enhances their comprehensive abilities. However, due to children's weak self-protection awareness and the complex environment, safety issues are prominent. The current means of protection mostly rely on manual management, and it is difficult to realize real-time monitoring and response, and there is a management blind spot. Therefore, the use of technology to improve the safety and management efficiency of school trips has become a design direction that needs urgent attention. Therefore, we expect to research and design an intelligent robot for children's school trip safety. Through the integration of artificial intelligence, environment perception and other technologies, it can realize real-time monitoring of children's location, condition and surrounding environment, and provide intelligent navigation, emergency help, learning assistance and other functions. This robot can help parents and teachers understand the status of children in real time, thus improving the safety and experience of children's school trips.

Intelligent Robots for Children's School Trips Market Research

Expanding School Trips Market Size

In recent years, the study tour market has continued to grow, and in 2019, the number of study tours in China reached 6.25 million trips, a record high, of which 4.8 million trips were domestic tours and 1.45 million trips were international tours. 2020 was affected by the epidemic, and the number of trips dropped to 1.53 million trips. 2021 saw a gradual recovery of study tours, and the total number of trips amounted to 3.51 million trips, with 3.5 million trips accounted for domestically, and only 10,000 trips were international trips. 2022 Continued to rebound, the total number of people reached 4.5 million, of which 4.2 million domestic, up 20%; international study tours 300,000, an increase of 2,900%. The data shows that the demand for study tours is gradually recovering and the market potential is huge [3].

Year	*Total number of study tours (million/trips)*	*Market size (billion RMB)*	*Domestic study tours share*	*International study tours share*
2019	625	715	76.8%	23.2%
2020	153	120	99.3%	0.7%
2021	351	127	99.7%	0.3%
2022	450	310	51.6%	48.4%

Table 1: China Study Tours Market Size (2019-2022).

Children's Intelligent Robot Types Analysis

Intelligent robot products on the market can be divided into 3 major categories according to the form of use, and the main functions of several representative products of each category of intelligent robots are shown in Table 2.

By analyzing the existing intelligent robots in Table 2, the following conclusions are drawn:

Currently on the market children's intelligent robots are mostly cartoon or bionic design, rounded and safe appearance, white color and supplemented by colorful embellishments, highlighting the affinity and sense of technology. Functions mainly cover entertainment, education and communication, such as playing children's songs, storytelling, voice interaction, literacy, etc., also supports remote video and human-machine communication. Scenic robot favors navigation and popularization of science, large size, mainly used to assist staff. Although the existing robots have certain functions in learning assistance, but the overall shape is more similar, most of the products are suitable for indoor environments, not easy to carry and use outdoors, limiting the full play of its functions.

Type	*Brand name*	*Diagram*	*Key features*
Desktop Fixed	Alpha Egg		Black science and technology to help pre-school enlightenment, language, mathematics and English synchronization to improve, bilingual assessment of fun.
Desktop Fixed	LukaMini		Picture book reading robot to help children develop independent reading early, return to paper reading, support multiple languages.
Desktop Removable	EMO Robotics		Intelligent voice accompaniment, expression interaction for multi-scene application.
Desktop Removable	Alpha Mini		Robotic multimodal interaction with 14 actuators for rich motions.
Desktop Removable	Makeblock mBot2		Meet the needs of China's new curriculum for teaching AI, sensors, IoT and robotics.
Scenic Robot	Kokusatsu Scenic Robot		Intelligent explanation and route planning, image interactive presentation of attraction information, to enhance the efficiency of the tour experience.

Table 2: Existing intelligent robots.

Research on users and environments of intelligent robots for children's school trips

User research

Children are at a critical stage of their physical and mental development, and the way they play with products needs to fit their cognitive abilities. Children of different ages will have different ways of playing with the same product. Therefore, when developing children's products, we should have a deep understanding of the characteristics of each stage of growth, so as to enhance the adaptability and developmental value of the products.

6-12 year olds gradually show a strong interest in brain and hands-on activities. 6-12 year olds enjoy games such as checkers and kite flying, and gain new experiences through science experiments, art creations, and sports equipment, as well as improved physical coordination. 9-12 year olds begin to develop stable interests in hands-on activities such as model building, magic props, and puzzles, and show a strong interest in science experiments and They are also interested in science experiments and artistic endeavors such as drawing, painting, and ceramics, and are beginning to enjoy participating in team sports [4, 5].

Through interviews with three main types of users, namely, teachers of educational institutions, students and parents of students, we conducted research on the application of intelligent robots in study tours, and researched the needs of different users from the user background, user pain points, and user expectations, respectively. The final results are shown in Table 3.

Users	*Student 1*	*Student 2*	*Parents*	*Teachers*
User Background	He is more outgoing and full of curiosity and anticipation for outbound study tours. He has a strong interest in the smart companion for school trips.	She is rather introverted and quiet, and is not very likely to play with children very often. She is also not very willing to talk to her teachers about anything.	They value their children's learning, are willing to invest in their children's education, and value their children's safety.	They have been in the education industry for many years. They have their own way of managing children and are committed to improving the quality of teaching and student learning.
User Pain Points	He likes to ask questions and has many doubts in his mind. Parents and teachers sometimes give vague answers and do not get the right answers.	She doesn't like to talk to people.	They work a lot and want their children to be able to see more and travel farther. They worry about the safety of their children traveling without them.	They don't know much about today's AI smart development and are not sure if they are comfortable with the tour smart robot operation during the tour.
User Expectations	Hopefully, the Tour Smart Robot will answer your questions and satisfy your curiosity.	She wants a good friend with similar interests.	They hope that the emergence of intelligent robots for school trips can present the general condition of their children when they are traveling, and the safe guarding of their children.	They want intelligent robots that are simpler and more efficient in operation, with features whose use is easy to learn.

Table 3: Summary of user interviews.

Interview results show that children are interested in the application of intelligent robots in school trips and believe that they can effectively answer questions. Parents are more concerned about their children's safety and learning status when they are away from home, and hope to keep track of their children's dynamics in real time. Teachers expect the robots to assist in the management of school trips, emphasize safety, and hope that they are easy to operate and have practical functions. Based on the needs of children, parents and teachers, the study drew a user requirement map, systematically organizing the functional requirements of children's smart robots for school trips, in order to guide the design of products that are more in line with the actual use scenarios. The target user age group is 6 to 12 years old. The final drawing is shown in Figure 1.

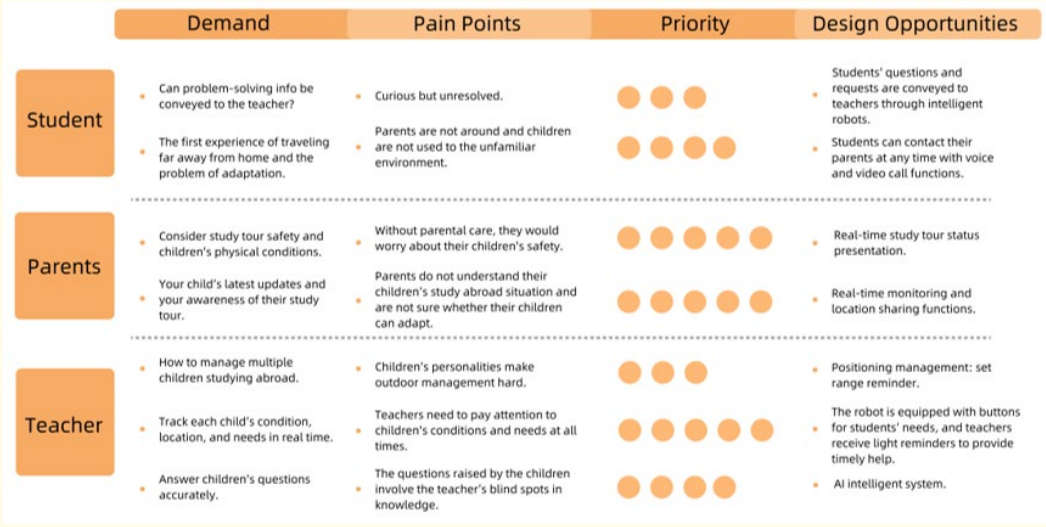

Figure 1: User requirements map.

Environment and routes

School trips are becoming more and more popular among parents and educational institutions because of their "edutainment" advantages. Unlike traditional classrooms, study tours stimulate children's interest in learning through field trips and immersive experiences, combining book knowledge with reality. Children can not only touch the history and feel the regional culture during the journey, but also collaborate with their peers to complete tasks, improve teamwork skills, expand their horizons, and enhance their observation, thinking and aesthetic skills [6].

Study tours are usually customized according to the interests and cognitive characteristics of children of different age groups to help them grow in happiness. The research found that the current study tour process is roughly divided into three stages: pre-preparation, implementation and post-summary, and the study tour programs of the existing organizations are mostly based on visits and experiences, and the forms tend to be the same. In this regard, we can try to provide more innovative multi-functional and intelligent study tours, such as optimizing the communication mechanism between home and school, realizing real-time feedback on children's dynamics, and introducing intelligent robots, designing functions in conjunction with the educational needs to create a more interactive and safe and secure intelligent study tour.

Service Design Framework

User Journey Mapping Analysis

Analyze the four stages of a traditional children's study tour-beginning, process, experience and end-through the user journey map, identifying the contact points, behaviors and emotional fluctuations in each stage. Combined with observation and interviews, the user's real motives and needs are explored, and the emotions and thoughts behind the behaviors are analyzed in depth, so as to identify pain points and find design opportunities, and ultimately drawn into a user journey map (see Figure 2).

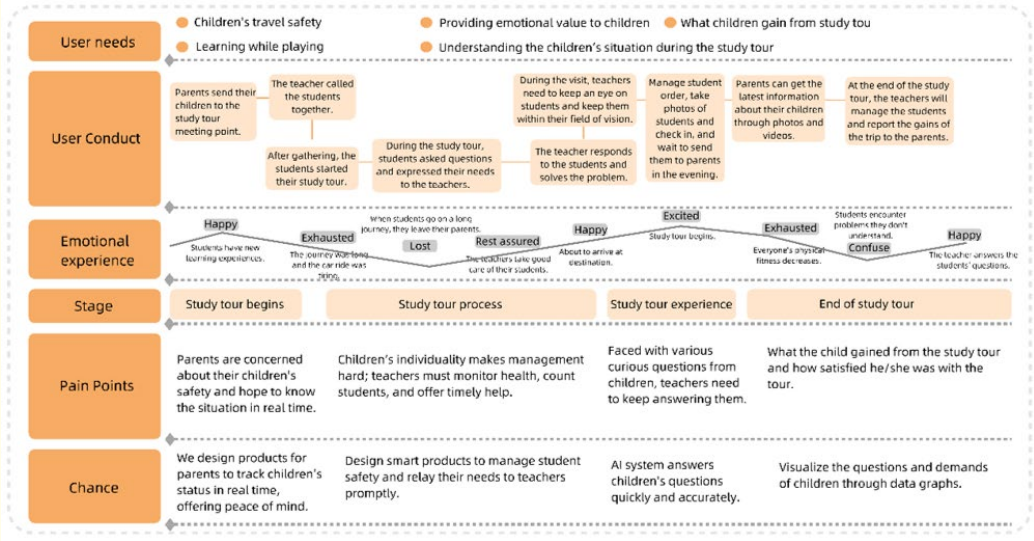

Figure 2: Map of current user journeys.

Service blueprint analysis

By analyzing the interactions between parents, students and teachers at the beginning, during and at the end of the study tour, improvement points for each segment can be identified and presented in a service blueprint. In the current study tour process, parents rely on teachers or social software to communicate with their children, which is inefficient and lags behind information. Students need to solve problems through teachers, and some introverted students find it difficult to express their needs, which affects their experience. Parents can only contact their children through phone watches, which makes it impossible for them to keep track of their children's situation in real time and increases their anxiety about safety. Teachers need to take care of multiple tasks such as leading, managing, taking photos and reporting progress, which is a heavy burden. Existing study tours are traditional and lack intelligent support, making it difficult to meet the demands for efficient communication and safety. To this end, a service blueprint (see Figure 3) was drawn to identify pain points and provide a basis for intelligent study tour design.

Based on the demand points distilled from the service blueprint of the current situation of study tours, an improved service process centered on an intelligent robot is designed. The system includes four-way interactions among the cell phone APP, teacher, student and intelligent robot, constituting a complete service closed loop. The robot adopts the combined design of child and mother, and the child machine records and transmits children's demand data to the mother machine. If the child robot is out of the range set by the mother robot, it will automatically issue an alarm and display its position on the APP. When detecting children expressing sensitive words such as physical discomfort, the child machine will recognize and notify the teacher immediately. Parents can apply for a call or view the real-time screen through the APP to understand the status of the tour from the child's perspective. In addition, the robot is equipped with navigation and other auxiliary functions to provide all-round support for the school trip process. The related service blueprint is detailed in Figure 4.

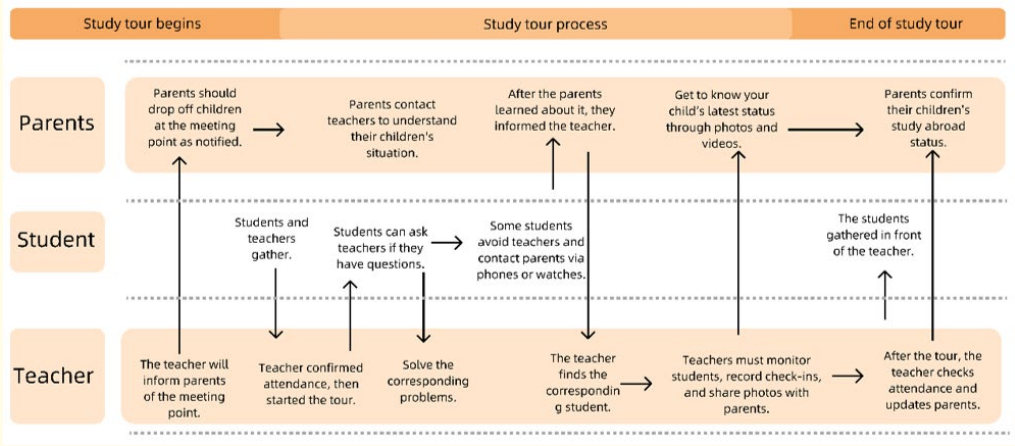

Figure 3: Flowchart of current tour services.

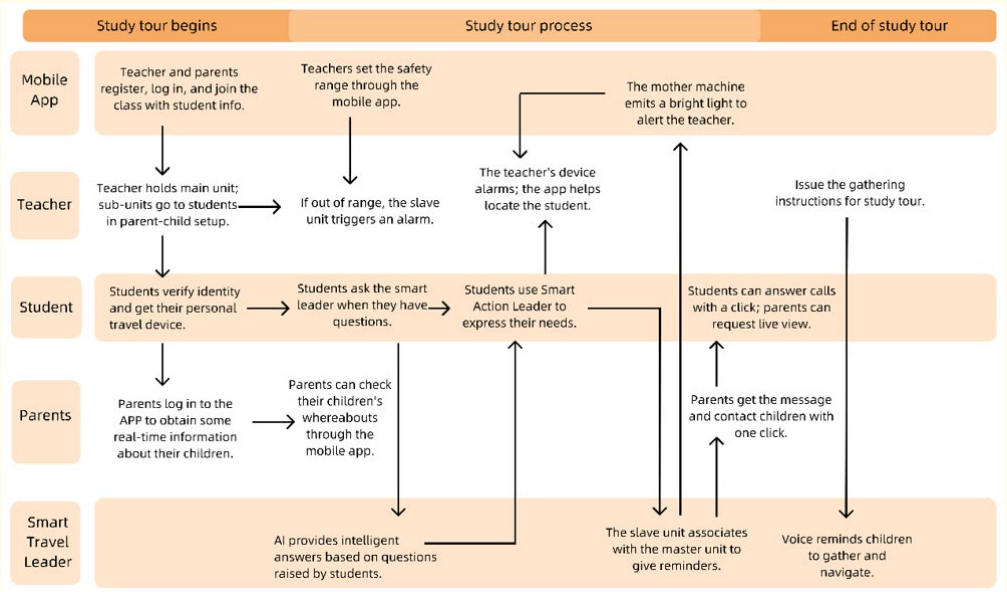

Figure 4: Service blueprint.

Design Positioning of Intelligent Robots for Children's School Trips

Design thinking

Comprehensive analysis to determine the product positioning for children's intelligent robots, the shape of the children's favorite design. Functions are planned according to the needs of children's school trips and teachers' management needs. In terms of ergonomics, the focus is on portability, which is convenient to carry outside. The interface style is simple and lively, and the modules are clear, so it is easy for parents and teachers to operate and use it quickly.

Functional positioning and technology needs

Security monitoring system

The safety monitoring system of the intelligent robot for children's school trips-Smart Walk Leader is mainly composed of real-time localization and environment sensing functions. The real-time tracking of children's location through GPS positioning and the use of cameras and other series of equipment to realize the loading of real-time images.

Learning Assistance Functions

The learning assistance function of the intelligent robot for children's tour designed in this paper mainly includes voice explanation and interactive mutual answer. For children to explain the new knowledge, introduce the traveled learning points, cultural knowledge explanation and so on. It can also carry out human-robot interaction through voice or screen, children ask questions and the intelligent robot answers the questions for them.

Managing Collaboration Functions

The children's school trip intelligent robot is connected with the cell phone APP, data sharing, parents can through the cell phone APP more clearly understand the child's status in the school trip. Also comes with emergency help function can actively press the button to help. After the child leaves the action range set by the teacher for a certain period of time, it automatically sends a signal for help. The signal is transmitted from the child's cell phone to the parent cell phone held by the teacher and the associated cell phone APP message notification.

Mobile APP overall framework

The Kids Tour Robot App includes three frames: Start, Unparticipated and Participated. Unparticipated users can view program recommendations, program introduction and customer service inquiries; Participated users can view weather, real-time positioning and tour status. The itinerary page displays attraction information, itinerary arrangement and sharing content; the communication page contains parent-child, home-school and class communication; the management page is divided into the parent side and the teacher side, and the teacher side provides device management functions.

Intelligent Robot Design Program for Children's Tour

The final study tour intelligent robot is designed as a combination of mother and child, the mother machine is the teacher's machine, the child machine is the student's machine, and the mother machine assists the teacher's management in the process of the student's study tour.

The student machine has buttons to call parents and teachers, and supports demand raising, intelligent recognition and voice wake-up robot functions. The intelligent robot can answer questions and provide knowledge of science. The top is equipped with a camera and an emergency button, which makes it easy for parents and teachers to view the screen and record in real time through the APP. Teacher's machine is equipped with collection call, telephone dialing, range reminder and intelligent recognition function, with record marking button on the side. The bottom of the device is connected to the backpack strap and has a built-in drawstring to prevent loss. Teachers can also manage the robot device through the APP, realizing independent use separate from the base. The whale bionic shape is divided into two parts, with function buttons and pull-string device, and the base is in the shape of a wave, which is easy to fix the school bag strap.

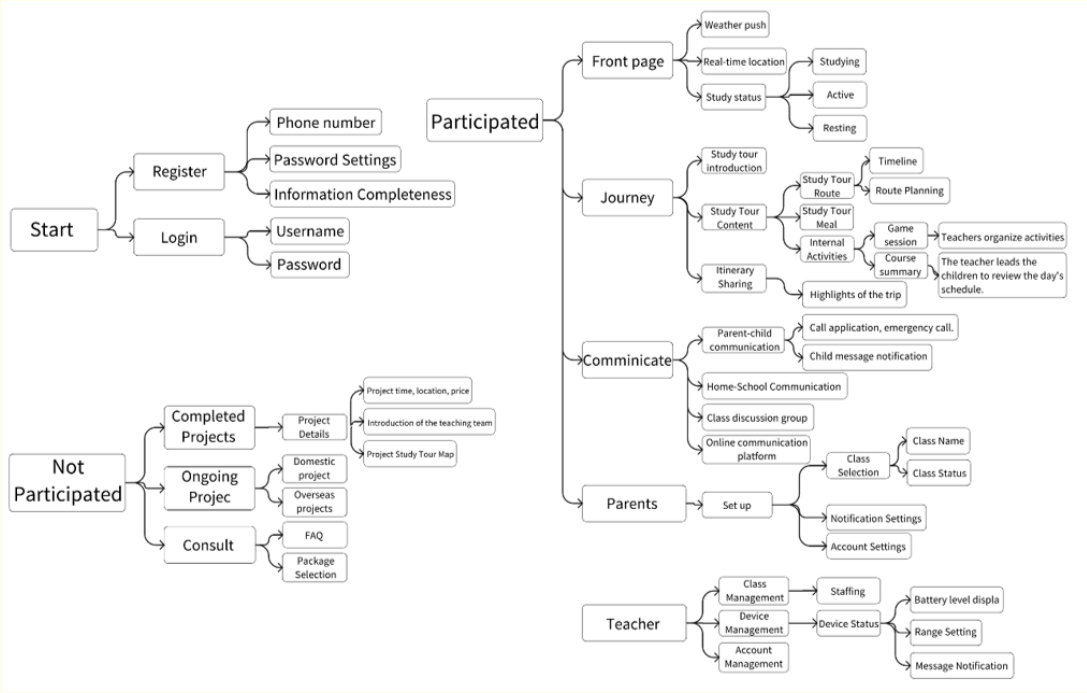

Figure 5: Mobile APP framework.

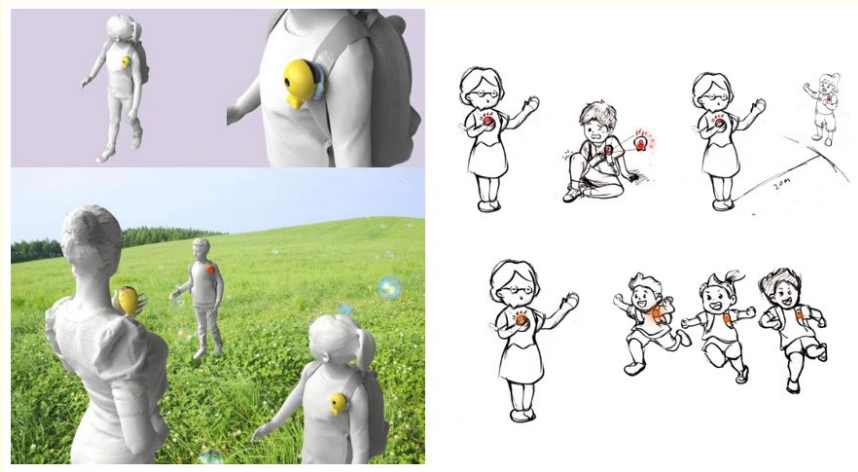

Figure 6: Product usage scenario diagram.

Figure 7: Touring Intelligent Robot Display.

The children's tour robot APP adopts yellow and green color scheme and contains eight pages such as registration, program push, location weather, attraction introduction, itinerary, etc., as shown in Figure 8.

Figure 8: Mobile APP interface design (Chinese version).

Conclusion

With the theme of "Intelligent Robot Design Based on Children's Safe Travel on School Tours", this study proposes the concept of intelligent robot integrating safety monitoring, learning assistance and interaction, taking into account market research and user needs. Through the analysis of user journey mapping and service blueprinting, the robot's multi-scenario application tasks in school trips are clarified. The design covers the functional positioning, technical path and APP architecture, aiming to guarantee children's safety, improve teachers' management efficiency and optimize the study tour experience. Although the study is still in the conceptual stage and has not been tested in the field, the established service model and user framework provide the basis for subsequent prototype development and validation, and further empirical research and cross-disciplinary collaboration can be promoted in the future.

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