International Journal of New Developments in Engineering and Society
ISSN 2522-3488 Vol. 8, Issue 5: 98-104, DOI: 10.25236/IJNDES.2024.080515

Design and application of intelligent companion system based on Unity Sentis technology

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Abstract: *With the development of society and the improvement of medical standards, the problem of population aging is becoming increasingly serious. More and more elderly people are facing the difficulties of loneliness, solitude and lack of companionship. Especially for the elderly who live alone, their companionship problem is even more prominent. Paying attention to the companionship problem of the elderly who live alone is not only related to the quality of life and happiness of the elderly, but also related to the harmony and stability of society. In order to solve the companionship problem of the elderly who live alone, an intelligent companionship system based on Unity Sentis technology is proposed. It can make corresponding reactions according to users' behaviors and emotional states, grow together with users, make them feel care and warmth, help relieve stress and anxiety, and at the same time avoid users from having feelings of loneliness and depression, and improve users' quality of life.*

Keywords: *Unity Sentis, companion, Module*

1. Introduction

With the development of society and the improvement of medical standards, the problem of population aging is becoming increasingly serious. More and more elderly people are facing the difficulties of loneliness, solitude and lack of companionship. Especially for the elderly who live alone, their companionship problem is even more prominent. Paying attention to the companionship problem of the elderly who live alone is not only related to the quality of life and happiness of the elderly, but also related to the harmony and stability of society. By solving the companionship problem of the elderly who live alone, they can feel the care and warmth of society, improve their quality of life, and at the same time reduce the burden on society.

The impact of the lack of companionship for the elderly who live alone mainly lies in two aspects. Firstly, in terms of mental health. The lack of companionship easily makes the elderly who live alone feel lonely and depressed, affecting their mental health. Long-term lack of communication and stimulation may lead to a decline in the cognitive abilities of the elderly who live alone and increase the risk of suffering from diseases such as Alzheimer's disease. Secondly, in terms of physical health. Without companionship, the elderly who live alone often lack the motivation for exercise and social activities, which may lead to a decline in physical functions and increase the risk of getting sick. The lonely living state may make the elderly who live alone have irregular diets, affecting their physical health.

In order to solve the above problems, an intelligent companionship system based on Unity Sentis technology is proposed. It can make corresponding reactions according to users' behaviors and emotional states, grow together with users, make them feel care and warmth, help relieve stress and anxiety, and at the same time avoid users from having feelings of loneliness and depression, and improve users' quality of life.

2. Technical Features and Examples of Unity Sentis

2.1. Technical Features of Unity Sentis

Unity Sentis is an innovative AI solution that connects neural networks with the Unity runtime. It has many remarkable features. Firstly, cross-platform compatibility is a major advantage of Unity Sentis[1].

ISSN 2522-3488 Vol. 8, Issue 5: 98-104, DOI: 10.25236/IJNDES.2024.080515

It can achieve efficient and stable operation whether on PC, mobile devices or console platforms, providing great convenience for developers. It enables the AI intelligent companionship system developed based on this technology to easily cover multiple platforms and meet the needs of different user groups. Secondly, Unity Sentis allows developers to embed various AI models. This means that developers can choose appropriate AI models for integration according to specific application scenarios and requirements, thus realizing more personalized intelligent companionship functions. For example, an emotion recognition model can be embedded in the system, enabling the companion characters to make corresponding reactions according to the players' emotional states. In addition, Unity Sentis reduces the need for cloud hosting, cuts down development costs and network dependence, enabling the AI intelligent companionship system to operate normally even in an offline environment and improving the stability and reliability of the system.

2.2. Examples of Unity Sentis

2.2.1. A Simple AI Example in Game Development

In the development of Unity3D games, the writing of AI scripts often demonstrates the flexibility and importance of tool-like scripts in game development[2]. For example, in some strategy games, AI scripts can be written to control the behaviors of enemy characters, making them make reasonable decisions according to different game scenes and players' actions. Such AI scripts can be customized and developed according to the specific requirements of the game to implement various complex behavioral logics. In game development, AI scripts can be flexibly switched and adjusted according to different conditions and states. For instance, when players are in different positions or take different actions, AI characters can make corresponding reactions, increasing the fun and challenge of the game. Meanwhile, the reusability of tool-like scripts also greatly improves the development efficiency. Developers can reuse these scripts in different projects, reducing the workload of repetitive development.

Applying similar concepts to the design of the AI intelligent companionship system based on Unity Sentis can fully leverage the advantages of Unity Sentis. For example, by embedding different AI models, the companion characters can make more intelligent and personalized reactions according to players' behaviors, emotional states and changes in the game scene[3]. Just as AI characters in games adjust strategies according to players' actions, companion characters can give appropriate comfort and advice according to players' emotional changes.

Moreover, the cross-platform compatibility of Unity Sentis also makes it possible for the intelligent companionship system to be widely applied. No matter which platform players are playing on, they can enjoy high-quality intelligent companionship services. Meanwhile, developers can optimize and adjust the intelligent companionship system according to the characteristics of different platforms and user needs to improve the user experience[4]. The Examples of sentence similarity is shown in Fig. 1.

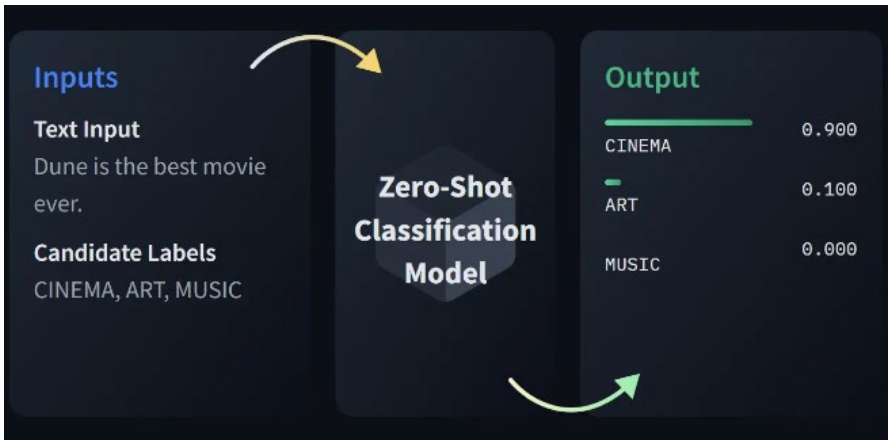

Figure 1: Examples of sentence similarity.

2.2.2. AI System: A Magic Tool for Entertaining Children

In today's digital age, the application of AI technology in various fields is constantly expanding. Among them, "One of the AI Systems Trained with Big Data: A Magic Tool for Entertaining Children" shows unique charm. This magic tool for entertaining children based on AI technology has remarkable features in terms of popular science knowledge and industry applications[5].

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In terms of popular science knowledge, the magic tool for entertaining children can convey various kinds of knowledge to children in a vivid and interesting way. For example, by using the voice interaction function, it can answer children's questions about nature, science, history, etc., stimulating their curiosity and thirst for knowledge. Meanwhile, the magic tool for entertaining children can also let children learn knowledge in a relaxed and pleasant atmosphere through forms such as story-telling and children's song playing.

In terms of industry applications, the magic tool for entertaining children is mainly applied in the fields of children's education and entertainment[6]. In the education field, it can be used as an auxiliary teaching tool to help children better understand and master knowledge. For example, when learning English, the magic tool for entertaining children can help children improve their oral English level through the functions of speech recognition and pronunciation correction. In the entertainment field, the magic tool for entertaining children can provide children with various games and interactive experiences, allowing them to have a happy time while playing.

For the application of the intelligent companionship system based on Unity Sentis in different fields, the magic tool for entertaining children provides the following inspirations[7]. Firstly, in terms of function design, the way of popular science knowledge dissemination of the magic tool for entertaining children can be borrowed to provide personalized knowledge services for users in different fields. For example, in the medical field, the intelligent companionship system can popularize knowledge about disease prevention and treatment to patients; in the education field, it can provide tutoring and expansion of subject knowledge for students. Secondly, in terms of user experience, the interesting and interactive design of the magic tool for entertaining children can be learned to make the intelligent companionship system closer to user needs. For example, through gamification, the participation and enthusiasm of users can be improved. Finally, in terms of industry application expansion, the successful experience of the magic tool for entertaining children in the fields of children's education and entertainment can be referred to, and the intelligent companionship system can be promoted to more fields, such as enterprise training and elderly care.

3. Working Principle of Unity Sentis

Unity Sentis realizes its powerful functions by importing AI models in the ONNX file format[8]. During the Unity runtime, this process mainly includes several key steps such as input, inference, running and optimizing the models.

Firstly, in the input stage. Developers import the trained AI models in the ONNX format into Unity Sentis. These models can be various types of neural network models, such as deep learning models, convolutional neural networks, etc. They are usually trained in other specialized machine learning frameworks.

Next comes the inference stage. When the game is running, Unity Sentis will receive various input data from the game environment and players, such as players' operations, events in the game scene, etc. These input data will be passed to the imported AI models for inference. The AI models will conduct calculations and analyses based on the input data and obtain corresponding output results.

Then, in the running stage. The output results of the AI models will be applied by Unity Sentis to the game to realize various intelligent companionship functions. For example, if it is an emotion recognition model, it may judge the players' emotional states according to the players' behaviors and expressions, and then make the companion characters make corresponding reactions, such as offering comfort and providing suggestions[9].

Finally, in the optimizing model stage. Unity Sentis can also optimize the imported AI models to improve their performance and efficiency. This can be achieved by adjusting the model parameters, optimizing algorithms and so on. Meanwhile, developers can also continuously adjust and improve the AI models according to the actual running situation of the game to ensure that they can better adapt to the game environment and players' needs.

In conclusion, Unity Sentis provides developers with a powerful tool by importing AI models in the ONNX file format and realizing the processes of input, inference, running and optimizing the models during the Unity runtime, enabling them to easily develop AI intelligent companionship systems with high intelligence and personalization.

ISSN 2522-3488 Vol. 8, Issue 5: 98-104, DOI: 10.25236/IJNDES.2024.080515

4. Architecture Design of the Intelligent Companionship System

The overall architecture of the AI intelligent companionship system based on Unity Sentis includes several key modules to achieve efficient and intelligent companionship functions.

4.1. Selection and Import of AI Models

When selecting AI models, the specific requirements and application scenarios of the system need to be considered. You can choose from the existing models on the market, such as browsing interesting models on platforms like Hugging Face, Keras or PyTorch. For developers with a machine learning background, they can also train their own models or use Unity ML-Agents to meet the requirements of reinforcement learning[10]. The key requirement is that the models must be converted into the ONNX file format, and ONNX converters like TF2ONNX can be used. To import the models into Unity Sentis, the process is similar to loading any resource. You just need to drag and drop them into the resource folder in the project window of the editor. Sentis will automatically optimize the imported models and then create a runtime model object.

4.2. Input and Inference Modules

When creating inputs, you need to check the shape and size of the required model inputs in the ONNX model import settings. Then, tensors can be created from the data sources. If multiple inputs are needed, they can all be stored in a dictionary. When the game is running, Unity Sentis will receive various input data from the game environment and players, such as players' operations, events in the game scene, etc. These input data will be passed to the imported AI models for inference. The AI models will conduct calculations and analyses based on the input data and obtain corresponding output results.

4.3. Running and Optimization Modules

When it's time to run the models, a worker thread needs to be created to break the models down into tasks that can be run on the user's device (CPU or GPU). Once the worker thread is set up, the artificial intelligence models can be run. Here, connect the inputs and outputs of the models to the game code, and then use a profiler to check whether it is within the budget. If too much budget is consumed, the models can be "sliced" across multiple frames or other performance tuning options in Sentis can be explored.

4.4. Testing and Deployment Modules

The final step is to test and deploy the game. This can be done in the same way as usually performed on any Unity runtime platform. There are multiple ways to transfer the models in the game binary files: they can be embedded in the build or run as streaming assets so that they are only downloaded when needed. For security reasons, encrypting the models can also be considered.

5. Design of Functional Modules for the Intelligent Companionship System

5.1. Design of the Natural Language Interaction Module

The natural language interaction function is one of the key modules of the intelligent companionship system, enabling the system to understand users' natural language instructions and make corresponding responses. With the help of Unity Sentis, by leveraging its powerful neural network connection capabilities combined with tools like Hugging Face Sharp Transformers, the understanding and processing of natural language can be achieved. For example, through a sentence similarity model, the text input by players can be converted into vectors and then compared with the action list of the robot to find the most similar action and execute it. This approach avoids hard-coding for each interaction, making the intelligent companionship system more flexible and intelligent.

5.2. Construction of the Behavior State Machine Module

Build the behavior state machine of the intelligent companionship system to achieve behavioral manifestations under different states, such as following, interacting, and performing tasks. The method of building the Unity state machine behavior class framework can be referred to. By inheriting the

ISSN 2522-3488 Vol. 8, Issue 5: 98-104, DOI: 10.25236/IJNDES.2024.080515

StateMachineBehaviour class, components can be added to the states in the state machine. Each state machine node has fixed entry points, such as functions like OnEnter, OnUpdate, OnFixedUpdate, OnExit, and OnHandleMessage, which execute specific logic at different stages. For example, at the start of the game, the initialization state node is executed first to complete the initialization of the game, and then different state nodes are switched according to conditions to achieve various behavioral manifestations of the intelligent companionship system.

5.3. Image/Asset Enhancement Module

Utilize enhancement models such as the super-resolution model of TensorFlow to improve the quality of low-resolution images or textures in the game and optimize assets. The relevant content of TensorFlow super-resolution model training can be referred to. Models like TransGAN can be used to reduce the amount of computation by gradually increasing the resolution, improve the resolution by using the upsampling module and the Pixelshuffle module, and capture texture information and structural information by using multi-scale discriminators at the same time. These models are imported into Unity Sentis, converted through the ONNX file format, and then the super-resolution processing of images is realized during the Unity runtime to enhance the visual effects of the game.

5.4. Introduction of the Speech Recognition Module

Introduce speech-to-text models such as OpenAI's Whisper to convert real-time speech into text in the game and promote the interaction between players and the intelligent companionship system. The Whisper.unity project can be referred to to introduce OpenAI's Whisper ASR model into the Unity environment to achieve high-performance local inference capabilities. It supports multiple operating systems and devices, has cross-platform compatibility, and can choose different model weights according to requirements to improve accuracy, covering about 60 languages and enabling free conversion between languages. In the intelligent companionship system, through the speech recognition module, players can use natural language to interact with companion characters, increasing the fun and immersion of the game.

5.5. Adoption of the Graphics Optimization Module

Adopt AI models to improve ray tracing on mobile devices and enhance game performance. The upgraded GAN AI model can be used to transform the pre-rendered frames of the game scene, realizing path-tracking functions such as light refraction and caustic area lights in smaller projects without affecting the performance of user devices. Through the hardware optimization function of Unity Sentis, inferences are deployed to the best available hardware (CPU or GPU), and the existing Unity computing and job systems are utilized to improve the efficiency and effectiveness of graphics optimization.

5.6. Combination of AR and VR Object Recognition Modules

Combine the Ultralytics YOLO model to achieve object recognition in AR and VR, providing users with a unique visual experience. The Ultralytics YOLO model can be used in VR to detect objects in the game scene or in AR to detect real-world objects from the device camera source. Through the object recognition use cases of Unity Sentis, objects are detected, classified, and segmented using the in-game or on-device cameras, adding more interactivity and fun to the intelligent companionship system.

6. Implementation Process of the Intelligent Companionship System

6.1. Installing Unity Sentis

Users can download Unity Sentis through the Package Manager and obtain its documentation via relevant links. After installing the package in the project, they can start integrating AI models.

6.2. Loading AI Models

6.2.1. Selecting Models

Which models to use in the project entirely depends on the users and the tasks that need to be accomplished. Users can first browse some models on the market, such as those on Hugging Face, Keras or PyTorch. For developers with a machine learning background, they can also train their own models or

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use Unity ML-Agents to meet the requirements of reinforcement learning. The key requirement is that the models must be converted into the ONNX file format, and ONNX converters like TF2ONNX can be used.

6.2.2. Loading Process

The process of loading models into Unity is the same as the steps for importing other assets. Just drag and drop them into the Assets folder in the Project window of the editor. Sentis will automatically optimize the imported models and then create a runtime model object.

6.3. Building Inputs and Inference

6.3.1. Creating Inputs

Creating inputs is quite simple. Just check the shape and size of the required model inputs in the ONNX model import settings, and then create tensors from the data sources. If multiple inputs are needed, they can all be stored in a dictionary.

6.3.2. Inference Process

When the game is running, Unity Sentis will receive various input data from the game environment and players, such as players' operations, events in the game scene, etc. These input data will be passed to the imported AI models for inference. The AI models will conduct calculations and analyses based on the input data and obtain corresponding output results.

6.4. Running and Optimizing the Models

6.4.1. Creating a Worker Thread

When it's time to run the models, a worker thread needs to be created to break the models down into tasks that can be run on the user's device (CPU or GPU).

6.4.2. Connecting to the Game Code

After setting up the worker thread, connect the inputs and outputs of the models to the game code, and then use a profiler to check whether the models are running within the given budget of computing resources. If too many resources are consumed, users can "slice" the models across multiple frames or explore other performance tuning methods in Sentis.

7. Testing and Deployment

Through comprehensive testing of the system, we found that the AI intelligent companionship system based on Unity Sentis technology has demonstrated good performance in all aspects. The natural language interaction module can accurately understand users' instructions and make corresponding responses. The behavior state machine module enables companion characters to exhibit diverse behaviors according to different situations. The image/asset enhancement module significantly improves the visual effects of the system. The combination of the speech recognition module, the graphics optimization module, and the AR and VR object recognition modules brings users a richer and more immersive intelligent experience.

8. Conclusion

This research on the design of the AI intelligent companionship system based on Unity Sentis technology has achieved fruitful results. It has realized efficient intelligent companionship functions and emotional care functions, completely solved the difficulties of loneliness, solitude and lack of companionship faced by the elderly who live alone, made this group feel care and warmth, helped relieve their stress and anxiety, and improved their quality of life.

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