Design of individual soldier situation generation software based on AR

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Abstract. According to the requirements of the individual combat command system for real-time emergency command and battlefield situation, the software design based on the AREngine platform for the individual battlefield collaborative situation generation is studied. Using the domestic smart phone to carry out the augmented reality situation of the traditional sandbox, and make full use of the powerful AR function of the smart phone with the core processing equipment of the individual soldier system equipped by the infantry commander and the combat personnel, providing the infantry with infantry command, combat deduction. The realistic deployment of power deployment and battlefield situation can be used for wartime preparation of troops and strategic deployment during simulation training, which has practical significance.

1. Introduction

Future warfare is information-based warfare. As the end node in the battlefield system, the dismounted infantry needs to continuously perform tactical maneuvers according to the commander's instructions and combat mission planning to seize/fix positions and complete combat missions. With the diversification of combat missions, the miniaturization and modularization of combat formations, and the expansion of tactical communication methods, their command requirements have been further increased.

Domestic Tian Wei and others have theoretically optimized and controlled the task-oriented battlefield situation generation research. Chen Hong of the National University of Defense Technology has studied the key situation generation technology, and domestic scholars have developed the virtual situation display system Were studied. These studies have more or less shortcomings. First, most researches focus on purely theoretical aspects, which are difficult to apply to practical engineering. Second, most situation display systems are based on desktop systems, which are unusable for dismounted infantry in complex battlefield environments.

In order to ensure that the commander can conduct battle planning in the battle plan, when the command and control is implemented, the scene is conveniently changed, the operations such as rotation are performed according to the field of vision, and the information formed by sending instructions, deployment and combat operations, etc. [1]. Here, by using the powerful AR function of the single-arm system core processing equipment-smartphone provided by the infantry commander and fighters, the situation is created for the combatants. During the exercise, the command center can
display the macro situation in the software according to the data returned, choose offensive routes and adjust the distribution and deployment of forces at any time, in order to achieve the ideal situation.

2. Technical implementation ideas
The purpose of the individual soldier situation generation software is to facilitate and efficiently scan and detect the specific battlefield environment and display the preset combat situation, automatically superimpose virtual soldiers and set the team number to generate special effects to enhance the display of the situation, and superimpose and display 3D through the interactive mode of the fingers. Guide marks and route deployment, etc., form observation from all angles, and user functions to facilitate the command of the commander. Commanders can easily change the scene, rotate according to the field of vision, etc. when formulating battle plans and implement command and control, gain insight into the entire battlefield situation, conduct war situation deduction, and visualize the two sides in combat strength comparison, combat deployment, and combat operations. The information formed helps the participating personnel make correct decisions and assists the pilots in controlling the participating soldiers to grasp the course of the war [2].

![Diagram of Individual Soldier Situation Generation Software](image)

**Figure 1.** Individual soldier battlefield situation generation design plan.

2.1. Design of individual soldier situation generation software
The software can deploy and control the entire command and combat process, and can run through the entire command and combat process. In order to achieve close coordination of battlefield situational command, combat soldiers can receive instructions and complete combat tasks in real time from the pre-war planning to real-time intervention in the battle. The software information feedback method and the relationship between the user and the system are shown in the following figure 2.
2.2. **Construction of software modules**

According to the content form of the battlefield situation display and the requirements of military interaction methods, the software is programmed through Android Studio, the programming language is Java, and a single soldier situation generation software module is researched and designed.

When implementing AR special effects, in order to reduce the amount of engineering, this article relies on the newer AR SDK: HUAWEI AR Engine. HUAWEI AR Engine is a platform for building augmented reality applications on Android. The basic AR capabilities can be provided through the vertical integration of the AR core algorithm and Hisilicon chip (this article uses Hisilicon 980), and currently provides motion tracking, plane detection, illumination estimation and hit detection [3]. HUAWEI AR Engine can track the position of a mobile phone as it moves, and build an understanding of the real world [3].

The situation generation software uses three-dimensional virtual soldiers to realistically present the infantry squad. The model construction is divided into the construction of human skeletons and the construction of action units. This paper uses Poser modeling software to construct a virtual human model. The feature points of the human model are used to determine the joint position and set DEF node, the action unit establishes the node to realize the forward or reverse physical motion simulation of the human body. VrmlPad is an excellent real-time simulation modeling tool [4]. Because it cannot directly read data, it needs to be converted to a file format and imported into the Android studio programming driver.

3. **3D situation generation and implementation**

The software's AR special effect display uses virtual triangles as identification marks. With the help of AR Engine's edge detection and feature point extraction, its coordinates relative to the real world can be obtained. The brief technical principle is shown below.
3.1. Transformation relationship between three-dimensional coordinates in space

By calculating the transformation relationship between the identified 6 image coordinates and their spatial 3D coordinates, the camera parameters and the rotation matrix and translation matrix of the camera relative to the marker point can be obtained.

\[
\begin{bmatrix}
    x_c \\
    y_c \\
    z_c
\end{bmatrix} =
\begin{bmatrix}
    R & T
\end{bmatrix}
\begin{bmatrix}
    x_m \\
    y_m \\
    z_m
\end{bmatrix} =
\begin{bmatrix}
    r_1 & r_2 & r_3 & t_1 \\
    r_4 & r_5 & r_6 & t_2 \\
    r_7 & r_8 & r_9 & t_3 \\
    0 & 0 & 0 & 1
\end{bmatrix}
\begin{bmatrix}
    x_m \\
    y_m \\
    z_m
\end{bmatrix}
\]

\( (R\ T) \): Parameters outside the camera; R: rotation matrix; T: translation vector [5].

3.2. Software module logic flow

The main basic data classes of the software's AR implementation are as follows: The ARAnchor anchor point is a fixed position and direction in the real world. ARCamera provides camera information for taking pictures, and the camera properties are updated each time the ARSession.update() method is called. ARPlane saves the real-world plane information identified by AR Engine and is
derived from ARTrackableBase. ARPointCloud records all feature points in the scene, including the set of three-dimensional points and their corresponding confidence levels. The function class mainly uses ARHitResult to define the collision intersection point of the ray and the real world.

The software situation display module function class is encapsulated and implemented by 6 function classes. The class MainActivity is the main system framework. It is used to implement functions such as interface switching, message passing, and parameter setting. BackgroundRenderer implements the function of rendering a virtual object window. PlaneRenderer implements the function of rendering virtual objects. For 2D rendering tiling, VirtualObjectRenderer establishes settings for virtual objects, including receiving coordinate parameters and filling graphics settings. CameralPermissionHelper: Get access to the local camera; DisplayRotationHelper: Start and stop settings for plane detection.

The cooperation relationship between the functional modules of the software module is shown in figure 5.

![Figure 5. Software module logic flow chart.](image)

4. Software system test and results

The mobile phone is a convenient and portable mobile device in the complex battlefield environment, and it is the best real-time communication tool for the individual soldier system. This article uses Huawei P20 to design software based on the AR Engine SDK to achieve individual soldier situation generation, force deployment, route planning and other pre-planning. Set function. The combatant can carry a plane detection by holding a smartphone to face the sandbox turning left and right. After the software detects the feature points and displays the returned situation information with a tiled dense triangle marking plane, the force deployment and simple three-dimensional markers can be performed through simple finger interaction Offensive route set [6].

![Figure 6. Software basic interaction example diagram.](image)

When the shooting range of the camera is beyond the deployed area, the flyback data is retained, and the distance between the smartphone and the sandbox can be adjusted by yourself to achieve near-far observation. Click the virtual team to edit and issue the command.
Figure 7. Example of situation special effect display.

The following is the software test chart.

Figure 8. Software test effect chart.

5. Conclusion
Based on a large number of investigations and analysis, this article establishes a single-arms situation generation system that is helpful to the control of individual soldiers' combat control. JAVA programming is used in Android Studio to design and implement AR-based single-arms situation generation software design. Using the finger-based human-computer interaction mode, the Huawei p20 phone is loaded to debug the test results. The software test results prove that it can realize three-dimensional display of battlefield situation, force deployment, and demonstration of combat tasks. At the same time, some shortcomings of the software to be improved were found in the test: when presetting virtual teams, more than 50 can not be placed; the detection rate of the plane is slow and not sufficiently accurate; the generation response is lagging. The next research task is still arduous.

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