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Designing an IoT-based Biorobotic Complex Board Game <Eurasia Channel>

Song-Lin CHEN*, Ju-Ling SHIH, Shaun-Wen CHEN
Department of Network Learning Technology, National Central University, Taiwan
*ccssll120061203@gmail.com

Abstract: <Eurasia Channel> integrates Internet of Things (IoT) technology to create a captivating and intricate complex board game experience for learners. Set against the backdrop of ancient China's Silk Road, the game offers players a diverse range of tasks while delving into the historical knowledge of the Silk Road. The role of IoT technology is crucial, facilitating the transmission of a wide array of data between objects and servers, enabling the study of learners' historical thinking performance during their engagement with the game. This game also places significant emphasis on interaction and entertainment, skillfully blending elements from large-scale complex board gaming to enhance the learning process. <Eurasia Channel> seamlessly merges education, technology, and entertainment, opening a gateway for learners to explore both ancient history and modern technology in an engaging manner.

Keywords: Internet of Things, Complex Board Game, Silk Road, Biorobotic.

1. Introduction

IoT technology remains underutilized in STEM education and game-based learning (Mavroudi et al., 2012). This study seeks to innovate traditional board games by incorporating IoT, enhancing player experience. In formal education, textbooks dominate, yet technology prompts varied learning tools, including board games (Paris & Yussof, 2012). Board games traditionally lack dynamism, but IoT envisions seamless interconnection, adding dynamism through sensors and microcontrollers (Pai, 2017). This study aims to develop a complex board game called <Eurasia Channel> that merges education, technology, and entertainment, bridging ancient history and modern tech for learners.

2. Related work: Internet of Things in Education

The Internet of Things (IoT) is a technology pioneered by the MIT Auto-ID Center. The core functionality of IoT revolves around communication between devices (Pai, 2017). All objects utilize RFID as their unique identifier (Haller, Karnouskos, & Schroth, 2009). Existing literature predominantly focuses on the technical aspects of IoT (Gong, 2016). However, IoT has profound implications for the education sector, bringing forth numerous benefits (Pai, 2017), such as: (1) enhancing the learning experience, (2) improving operational efficiency, (3) reducing costs, (4) ensuring reliability, and (5) addressing security concerns. Therefore, IoT technology is a crucial and efficient asset in the field of education. In this study, we have designed a board game that leverages IoT technology to enhance engagement and interactivity.

3. Game Design

<Eurasia Channel> is based on the design by Chen, Shih, and Chen (2022), which takes inspiration from the ancient Silk Road map of China. In this board game, players start on a journey using biorobotic horses to complete specific tasks and progress through the game

(as shown in Figure 1). Each team represents distinct ethnicities, and individual players assume unique roles, engaging in trading various items or constructing stations to earn coins and emerge victorious. To enhance the interactive experience, IoT technology is seamlessly integrated into the game, responsible for recording all transaction records among players, tracking object locations and movement paths, and triggering specific tasks and scores through MQTT signals sent to a server. This integrated approach empowers players to easily control the biorobotic horses, while enjoying the game's interactivity, ultimately elevating immersion and underscoring the indispensability of IoT technology in educational gaming.

Figure 1. Map of < Eurasia Channel >

With the integration of Internet of Things (IoT) technology, players can effortlessly maneuver the biorobotic horses by using a terminal. As the biorobotic horse traverses designated areas, sensors transmit specific signals to the server via Message Queuing Telemetry Transport (MQTT) (Hunkeler, Truong, & Stanford-Clark, 2008). Subsequently, players receive targeted missions or scores. Upon successful completion of in-game tasks, the game map engages in interactive exchanges with players (as shown in Figure 1 錯誤! 找不到參照來源。). During gameplay, players have the opportunity to acquire knowledge in mechanics, electronics, geography, and history. <Eurasia Channel> incorporates Internet of Things (IoT) technology through the implementation of the MQTT protocol. Upon network establishment, RFID sensors are utilized to scan embedded RFID tags on the Silk Road map (Figure 1 錯誤! 找不到參照來源。). Each tag's unique ID triggers distinct events displayed on terminals. The server records individual player checkpoints, data, movements, statuses, resources, and paths.

Engaging in < Eurasia Channel> enables players to partake in interdisciplinary learning. The integration of IoT technology allows the server to capture various data types, facilitating communication among different components. This enhances player engagement and interactivity, ultimately fostering the development of historical thinking skills. With all RFID sensors in place on the map, IoT devices can transmit tag IDs to specific channels on the MQTT Broker. The process begins with the biorobotic horses' movement on the map. Upon reaching a designated area, the RFID scanner continuously scans the path beneath the robot. Detection of a tag ID prompts the ESP32 to publish data to the designated Broker channel. Subsequently, the server subscribes to this channel, retrieves the data, and stores it in the database. Ultimately, users can access the database to control the biorobotic horses in accordance with the obtained data. System structure is as shown in Figure 2.

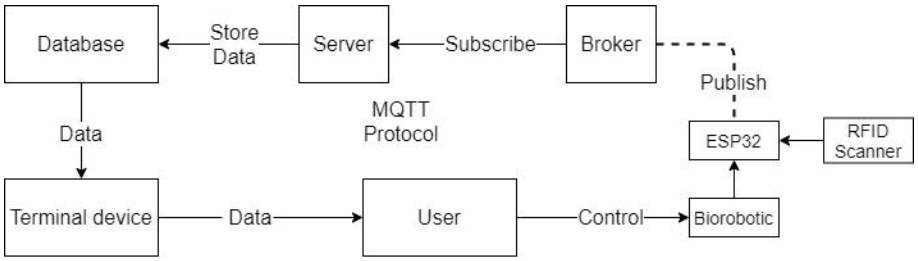

Figure 2. System Structure

4. Excepted Result

By integrating Internet of Things (IoT) technology into the complex board game, players are afforded the opportunity to learn about ancient cultural history and cultivate historical thinking while accomplishing tasks. The inclusion of these in-game tasks serves to enhance players' motivation to learn, facilitating a continuous state of engagement for learners throughout the process of playing and learning. Teachers can effortlessly record all essential information, including task completion, scores, and the paths of each team. Beyond collecting these quantitative data points, we can further delve into various aspects related to players and the game. For instance, we can explore the impact of playing <Eurasia Channel> on players' historical thinking abilities.

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