INTEGRATING REAL AND VIRTUAL: ENHANCING COMPUTATIONAL THINKING THROUGH GENAI-DRIVEN EDUCATIONAL ROBOTICS

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ABSTRACT

This paper outlines an innovative educational environment that utilizes Generative Artificial Intelligence (GenAI) to cultivate computational thinking (CT) skills among students. Through a technological setup that integrates an animated robot and a real humanoid robot, students tackle CT challenges using Visual Computer Language (VCL). In this environment, students must address challenges formulated by GenAI and propose VCL sequences to solve them. Feedback on their proposed solutions is provided in both virtual and tangible forms, thereby enhancing the learning experience. We highlight the architecture supporting these features and describe the roles of its components in fostering an optimized, efficient, and appealing educational experience focused on CT.

Introduction

Computational Thinking (CT) is a critical skill required for problem-solving through a systematic and multiphase process that enables one to tackle everyday challenges. This skill involves breaking down challenges into manageable parts, identifying similarities or patterns, abstracting away specific details, and designing step-by-step solutions (Wing, 2006). Recognized as essential for students preparing for adulthood in the 21st century, this paper presents our intent to scaffold students' acquisition of such skills within a technological environment supported by Generative Artificial Intelligence (GenAI) (Kurtz et al., 2024). This environment presents tailored CT challenges that students must address by developing solutions using a Visual Computer Language (VCL). These solutions, organized into sequences of blocks, are executable and can be observed in action through an animated robot equipped with interactive features that allow it to respond to spoken words and react to buttons pressed on its body. Alternatively, the solutions can be implemented on a real Humanoid Robot (NAO version 6.00), enabling students to interact with a tangible representation of the robot. In the next section, we will describe the architecture of the environment that supports these features.

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Overview of research and development efforts

In this section, we present our deployed architecture including a description of its components and their roles during the educational experience conducted as part of a student's educational experience. Figure 1 provides an overview of the architecture we developed.

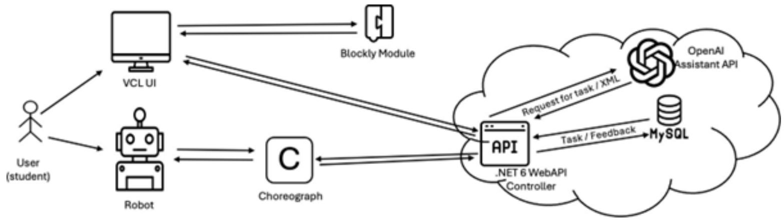

Figure 1:Overview of Architecture

The interaction sequence is triggered by a student (user) who initiates the activity and requests a challenge related to Computational Thinking (CT), which can be solved using the VCL (Visual Computer Language) blocks available in the environment. To facilitate this, the OpenAI service is accessed through a dedicated controller, with a prompt formulated by the VCL User Interface (UI). In response, OpenAI presents a challenge to the student. The student must then address the challenge by proposing a VCL solution in the form of a sequence of blocks. As illustrated, the VCL capabilities in the UI are supported by a Blockly module, which enables VCL notations. These notations are stored in a dedicated MySQL database, accessible through the controller, for research and refinement purposes aimed at enhancing this educational experience. Following the formulation, the student may display the result of the sequence as a series of animations that reflect the programmed sequence. Alternatively, the solutions can be implemented on a real Humanoid Robot (NAO version 6.00), which is accessible through the UI via the same controller that acts as middleware to Choregraphe, facilitating the enactment of the NAO robot according to the formulated VCL solution.

Conclusion

We present an environment designed for students who are required to learn CT-related skills, enhanced by CT capabilities. Furthermore, it offers multiple forms of feedback on their efforts. Our research and development efforts, illustrated in this paper, lay the groundwork for debating the role and the extent to which GenAI is implemented in complex educational contexts and settings. Hence, its perceived position by educational stakeholders in technological settings consists of virtual and tangible aspects necessary for equipping students with the knowledge and skills required in their current and future realistic settings.

Keywords: Computational Thinking (CT), Generative Artificial Intelligence (GenAI), Visual Computer Language (VCL), Humanoid Robot, NAO, Educational Technology

REFEFENCE

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