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MEMÓRIAJÁTÉKON ALAPULÓ MODULÁRIS RENDSZER FEJLESZTÉSE

DEVELOPMENT OF A MODULAR SYSTEM BASED ON MEMORY GAME

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ABSTRACT

The well-known Simon memory game is used not only for entertainment but also for mental therapy and development purposes, as well as for the development of machine learning and automation tasks. This article deals with building a basic Simon's game from a student budget and then programming it in two uses. First, it provides an opportunity for interested people visiting department of mechatronics to play. Second, it demonstrates the possibility of camera image processing and the operation of a machine opponent. In this project Arduino Nano development platforms are used with LED lights, button, potentiometer, extended USB camera and actuators programmed by language Phyton.

1. INTRODUCTION

Nowadays, many scientific fields are dealing with the development and therapeutic use of games that resemble the well-known game called Simon. This game is also popular among young children and the elderly for mental development purposes [1] – [4]. On the other hand, researchers are dealing with the application of machine learning and other methods in solving this game [5] – [6]. Despite how simple a game may seem, it has many uses and research directions. *Figure 1* shows the original Simon memory game, which consists of colourfully flashing push buttons, and has an audio signal accompanying the different colours. This game flashes LED lights in random order and expects the user to play back in correct order.

Figure 1. The Simon memory game [7]

In this project, first, basic memory game was built on Arduino Nano development platform. Randomly ordered tasks with flashing LED lights have running which able to play back by customer in way of using potentiometer and button of set. In this case opportunity for human players is provided which is shown deeply in Section 2.

Next chapters of article included case of machine opponent with observer and actuator components, it is written about specific script in language Phyton, USB camera and another Arduino Nano development platform as actuator which get tasks from personal computer. Finally, this paper ended conclusions and plans for future developments.

2. PART OF BASIC GAME

At the first period of project was built and programmed a testbench which include 4 LED lights for

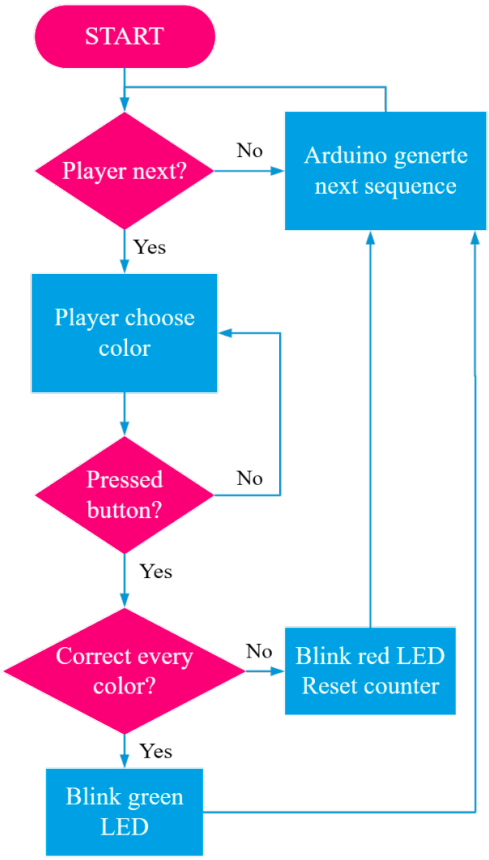

Figure 2. Flowchart of basic game

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visual tasks, 1 potentiometer for selection, 1 customer's button for setting and 2 LED lights to provide feedback on correctness.

Figure 2 present flowchart of part of basic game. In the beginning, random colour is flashed on this platform (yellow, green, blue and red), after colour has chosen by player in correct order by rotation of potentiometer and pression of setting button. In case of right ordered answer green LED lights up, otherwise red one. Next level is given after successfully answer. Task by task the game is expanded by one additional random colour. In case of fault all points are gone (reset of counter) and game started from the beginning. Before every new round 4 LED light up at the same moment for draw attention. This construction can be developed in the future by audio functions increase user satisfaction or help the visually impaired participate. Furthermore, design is needed to create electrical circuit, mechanical components and ergonomics of test bench in relation to safety.

The term "Player" used in *Figure 2* can be understood as human who plays the game, turning potentiometer and pressing button or a machine opponent. Presented program by flowchart is running continuously thanks for programmed ATmega328 microcontroller which is integrated into Arduino Nano development platform and included closed programming loop.

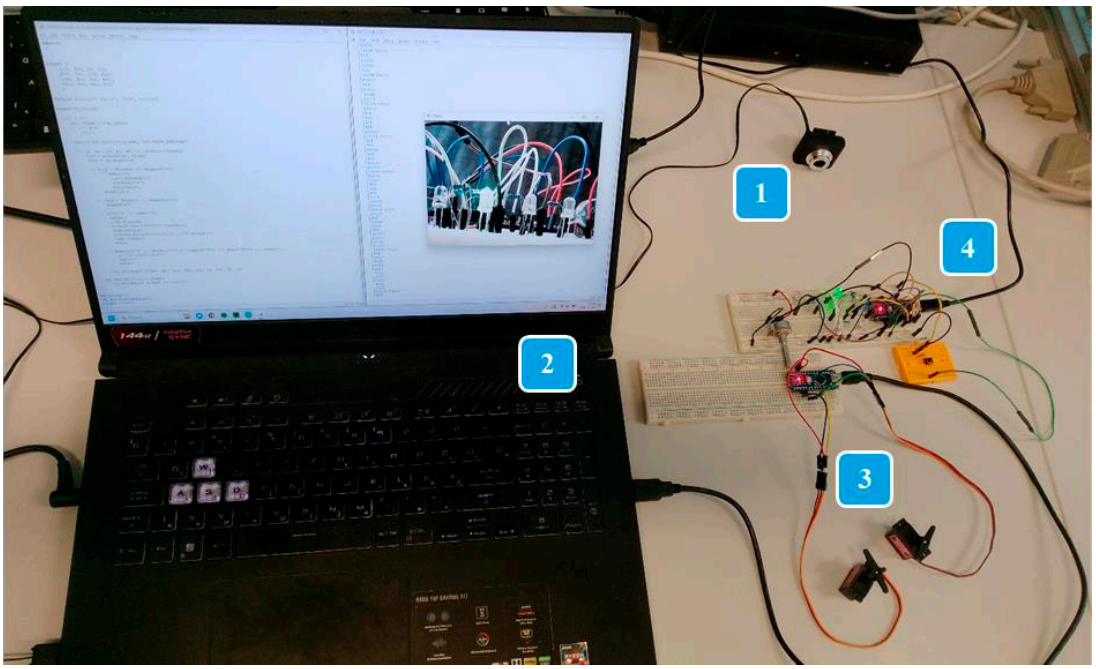

Figure 3. Assembly for testing

3. MACHINE OPPONENT

This chapter discusses the design of a machine opponent, which consists of two main components: an observer for detecting flashing lights and an actuator responsible for controlling the playback process.

3.1. OBSERVER OF MACHINE OPPONENT

In case of machine opponent, first topic was programming of camera. Three ways are known: camera containing lens, sensor and own communication protocol which able to connect Arduino development platform which runs program to display image and processing, e.g., OV7670. Another option to use camera which has integrated microcontroller; therefore, it can be programmed in a task-oriented manner, e.g., OpenMV Cam H7 Plus. In the third case USB camera is connected to personal computer and the selected programming environment can handle the camera image and processing.

In this project, based on the design decision, the third way was selected. *Figure 3* presents the test system where parts are denoted with numbers 1: connected USB camera, 2: personal computer, 3: actuator, 4: part of basic game. Observer of machine opponent is meaning the personal computer with USB camera.

The process of observer can be seen in Figure 4. The personal computer can run such a program code which are developed for this task and was written in language Python. In the beginning camera should be started, the script recolours the saved image in grey and detected areas based on brightness. There can be found after 4 predefined squares which are positioned to 4 LED lights. In this paper will be shown the development of autonomy and automatically search method for detecting position of blinking LED lights. After camera calibration follows the program.

It is known, that start of a new round is signed with 4 LED light up at the same time, first programmed decision belongs to this case: record status of LED lights and reset counter. In each tasks dedication list is rewritten and honour the last one blinked LED. End of the task observer sends data to actuator, as computer sends data to Arduino Nano development platform via serial port.

Program of observer saved each task of level and feedback of correction. This is the reason why only the last LED data is needed to send to actuator part.

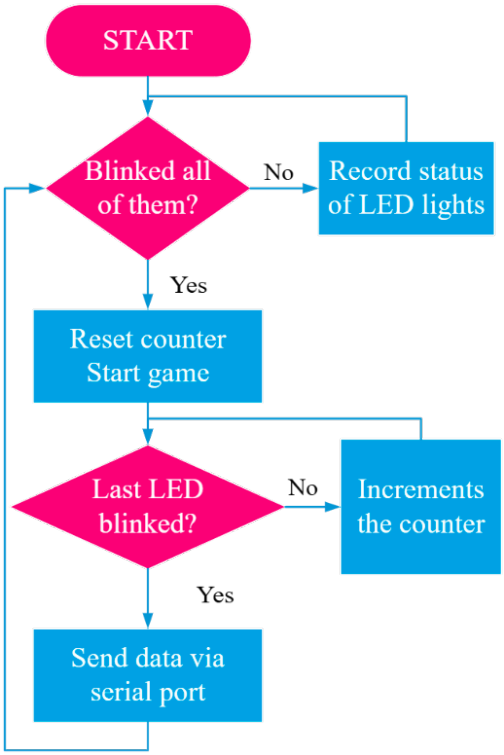

Figure 4. Flowchart of observer

3.2. ACTUATOR OF MACHINE OPPONENT

The last part of modular system is actuator part of machine opponent which consists of an extra Arduino Nano development platform with two controlled servo motors. In case of machine opponent one of servo motors is used to rotate potentiometer, the other one for push button of set. In *Figure 3* can be seen this part marked by number 3. The flowchart of the actuator module, which receives data from the personal computer via serial communication is shown in *Figure 5*.

When transported data is received by the ATmega328 microcontroller, the list of sequence is expended the last one dedicated LED sign. Replay the hole sequence is started after end of serial communication. An improvement has been made: if two identical colours are to be played back consecutively, the button press no longer waits for the potentiometer to turn. Moreover, the servo motor of actuator and potentiometer of basic game have different rotation ranges which requires calibration between them. Two options are available: mechanical solution using a gear mechanism, or a software-based one by modifying the colour-to-angle mapping. The second one is preferred by researchers.

After completing the playback of the entire sequence, the actuator waits for new data to arrive. Designed parts of mechanical connection will be produced in the future.

As of now, this test bench provided to test electrical connection, communication between parts and system capabilities. At the second period of project was developed opponent: human player via personal computer.

4. HUMAN OPPONENT VIA PERSONAL COMPUTER

Towards the end of the project, a small additional development was implemented to allow a human opponent to play as well, with the computer controlling the actuator module.

The image processing algorithm of the camera has been modified to include an automated detection of the four brightest points following grayscale conversion. The system then provides visual feedback by marking these points, in left-to-right order, with coloured squares: yellow, green, blue, and red. The method can be further enhanced through the integration of colour recognition. As shown in *Figure 6*, a display interface has been added adjacent to the camera feedback. In the upper-left row, black squares are displayed corresponding in number to the randomly generated colours available for interaction. Below these, buttons for colour selection, deletion, and configuration are provided.

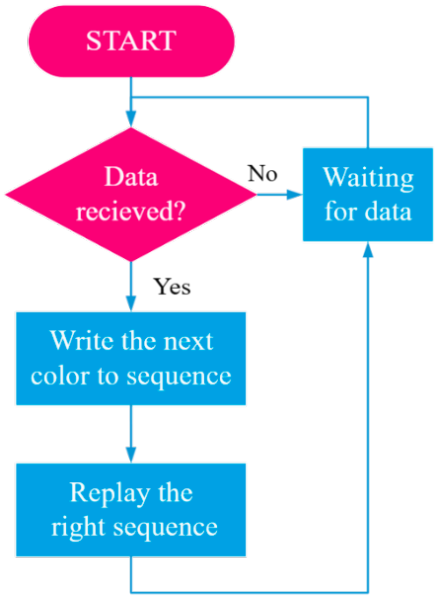

Figure 5. Flowchart of actuator

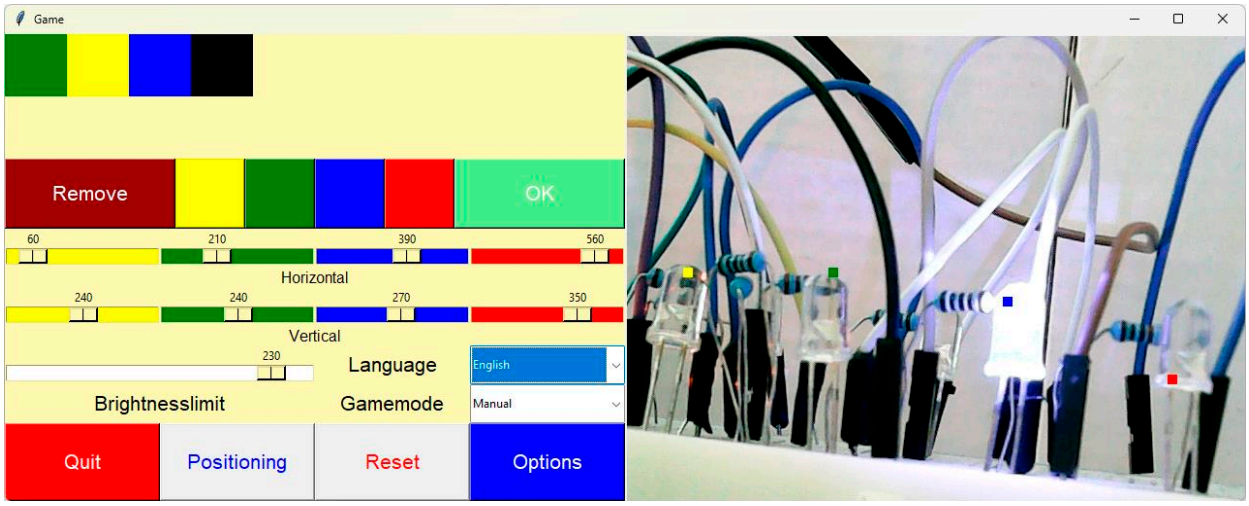

Figure 6. Human opponent option via personal computer and function settings

The interface also includes options for language selection, manual or automatic calibration, and a restart button. The sliders located in the central part of the console allow for manual adjustments; however, these controls are deactivated when the automatic calibration mode is enabled or when a non-human opponent is selected. In the latter case, the row of colour selection buttons is also hidden. The top row, which provides game feedback, and the bottom menu bar - including the dropdown menus - always remain accessible.

5. CONCLUTION

This research presents a modular system developed within a student budget, based on the well-known Simon memory game. During the first period of the project, a basic version of the game was implemented on the Arduino Nano platform, utilizing LED lights, a potentiometer, and a push button. Subsequently, a machine opponent was introduced, incorporating a USB camera and part of actuator, built on the Arduino Nano platform.

In the second period of project, combined gameplay mode between a human and a machine opponent was developed, featuring a graphical user interface and a menu system.

The constructed tests successfully validated the design concepts, providing a solid foundation for future development. Planned future work includes the extension of electrical circuit design, mechanical component development, and enhancements to the camera-based image processing algorithms.

6. ACKNOWLEDGEMENTS

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