# Digital SandClock Research Project

Bohdan Hashchuk*, Taras Lysun †, Sviatoslav Stehnii‡, and Elizabeth Arnauta§
Email: *hashchuk.pn@ucu.edu.ua, †lysun.pn@eucu.edu.ua, ‡stehnii.pn@ucu.edu.ua, §arnauta.pn@eucu.edu.ua

Faculty of Appied Science
Ukrainian Catholic University
Lviv, Ukraine

## I. Introduction

The Digital SandClock research project aimed to develop a software application that simulates the flow of sand particles through an hourglass-shaped container. This section provides an introduction to the project, highlighting the motivation behind creating a digital representation of a traditional sand hourglass.

In the Digital SandClock project, we integrated the I2C (Inter-Integrated Circuit) and SPI (Serial Peripheral Interface) protocols to facilitate communication and ensure the proper functioning of the system.

- For the communication between the accelerometer sensor and the microcontroller STM32F411E-DISCO, we employed the I2C (Inter-Integrated Circuit) protocol. This allowed the microcontroller to receive data from the accelerometer, providing valuable information about the sandclock's position.
- To connect the digital sandclock to the display module ILI9341, we utilized the SPI (Serial Peripheral Interface) protocol. We established a serial communication link between the microcontroller and the display module.

Overall, using of the I2C and SPI protocols in the Digital SandClock project helped us a lot in establishing communication pathways and ensuring the coordinated operation of our main components, contributing to the accurate determination of the sandclock's position and enhancing the whole functionality of the system.

## II. Methodology

**System Architecture Design:** A system architecture was designed to show the whole structure of the project. This included identifying the microcontroller, accelerometer (which is build in STM32F4), display module, and their connections.

**Algorithm Design:** The algorithms for detecting and determining the sandclock's position using the accelerometer data was implemented. Also we used mathematical models and logic to read the data from the accelerometer properly. Also, our SandClock has logic of counting for one minute. It Reads data from the accelereometes in x,y,z axes and let our sand fall in 8 different directions. Microcontroller is powered by small 3.7V battery which is built in the box of SandClock.

The SandClock can change the ducation of sands falling by turning its screen to the sun. There are 3 possible modes:

- Red Pixels – The duration is 60 seconds
- Blue Pixels – The duration is 30 seconds
- Green Pixels – The duration is 40 seconds

It is achieved by using reset function and data taken from accelerometer. **User Interface Design:** The user interface for the digital sandclock was designed very simply and intuitevely. You can see a two triagles which shapes a SandClock on our screen. But defore that, we tried three different methods to show the clock. Firslty we used two 8*8 matrices and put them one to another. After that we decided to make it more beautiful and statred testing with Nokia 5110 Display and ILI9341 Dispay. After several tests it was decided to leave the last Display because it has the 2.8" display which is the biggest among which we used and it was easier to see the behaviour of Sandclock.

Also we added a power button so user can switch off the Clock when it is not needed.

According to design we decided to make a box with help of LEGO constructor because it was very convenient to change the shape as we needed and to be creative during desinging process.

## III. Results and Discussion

Result of our work is working Digital SandClock which takes one minute to fall sands from one side to another. Also it follows the behavoiur of real SandClock which means that all the physics is implemented. The sand changes the direction of falling depending on the position of accelerometer according to x,y,z axes.

## IV. Conclusion

In conclusion, the Digital SandClock project successfully developed a realistic and accurate simulation of a sand hourglass. The project achieved its goal of creating a digital version of traditional hourglasses. Our goals for future is to reduse the size of our box to make it more portable, also we would like to change the microcontroller because STM32F411E-DISCO is very massive and too poverful for ourr task. So we would like to look for something smaller(for example STM32F1).

## Acknowledgment

The authors would like to express their gratitude to their mentor Danylo Sahaidak for his contribution to project and

continuous support throughout the whole process of development this project. Also we are grateful to Applied Science Faculty and Oleg Fareniuk personally for giving us an opportunity to work with such an interesting project.

## REFERENCES

[1] Adafruit ILI9341: https://www.arduinolibraries.info/libraries/adafruit-ili9341

[2] How to set up TouchGFX with SPI Displays (ILI9341): https://youtu.be/suMytEyQTP4?si=Ekd02niOS4-tyu2E