Progress Report - Baby Patient Simulator Project

S4 - Baby Patient Simulator Project

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1 Introduction

1.1 Project background

The usage of Baby Patient Simulators for educational purposes goes ahead with some problems. The first problem is the expensive price of baby patient simulators that can provide a realistic feedback functionality. In contrast to that cheap manikins are not able to provide realistic feedback in the context of basic life support. Because of those problems, most of the current manikins on the market are not suitable for large-scale educational purposes. Therefore, the Patient Simulator Research group, the researchers of Utrecht University, and other involved project members are trying to solve this problem by designing a manikin that can give real-time feedback for basic life support at an affordable price. In this context, the S4 project group focuses on designing the ventilation system and the compression functionality of the manikin. A prototype has been worked on in recent years. The current design has several limitations.

1.2 Project goal

The goal of the S4 project group for this year is the implementation of sensors on the compression and ventilation using a Real Time Operating System(ManikinOS based on FreeRTOS) for the ESE students, and the redesign of the head and improvement of the chest area for the IDE students.

1.3 Project Progress

To measure the progress of the Baby Patient Simulator project, some key performance indicators are needed. Therefore, the following table shows the goals, the tasks and the status of the tasks for every week.

FINISHED	
PARTLY FINISHED	
NOT FINISHED	

1.3.3 Task Matrix

Last time updated on 09.05.2022.

WEEK	GOAL(S)	TASKS	
		IDE	ESE
Week 1	Get in touch with CPR, Basic Life Support and Baby Patient Simulators	• Research work about CPR, BLS and BPS • Gather ideas for the implementation of ventilation and compression • Define limitations	
Week 2	Define project goals and solve uncertainties	• Gather most important points of the research work • Try to define project goals • Meet with Johan to clear uncertainties	
Week 3	Analyse the given prototype of the manikin	• Create user requirements list • Problem definition • Main goal definition • Plan of approach	
Week 4	Overview about all involved project members and their tasks	• Improve user requirements list • Health Concept Lab meeting	
Week 5	• Begin with adapting the compression functionality • Understand the previous work	• Make sketches and designes for the compression functionality	• Analyse the given code from the S3 project • Test the ToF sensor
Week 6	• Work further on the compression functionality • Gain knowledge about freeRTOS	• Print a prototype • Work on further designs • Meet with Mathijs	• Adapt code for ToF • Get in touch with freeRTOS • Meet with Johan
Week 7	• Work on the head and the inner body • Work on compression functionality	• Work on the head components • Work on designing the airway system	• Learn how freeRTOS works

Week 8	• Work on the same things like in week 7	• Make measurements together with IPO students	• Implement compression code into freeRTOS • (Now solved)
Week 9	• Prototyping • Solving freeRTOS problem with Gert	• Make prototypes for the inner body • Meeting with S6 student about the airway system	• Solve problem with freeRTOS and compression code
Week 10			
Week 11			
Week 12			

2 Activities and Results

2.1 Summary of the daily work

2.1.1 Week 1 (01.02.2022 - 04.02.2022)

The goal of the first week of work was to get familiar with the project. And about that the project group needed to research topics like the baby patient simulator, basic life support, CPR (cardiopulmonary resuscitation), etc. For this purpose, the project group defined the following fields of research: Compression and ventilation, feedback and integration, characteristics of an infant, CPR on an infant, project limitations, and market analysis. Marc and Antonios handled researching the functionality of the compression and ventilation tasks as well as the feedback and integration methods. Mylo focused his research on the characteristics of a nine-month-old baby in the context of basic life support. Niels defined and gathered some limitation ideas for the project. Youri did the market analysis and Sima gathered some general information about baby patient simulators.

Results of this week:

- Get an overview of the topic and its background
- Get an understanding of compression and ventilation tasks on an infant
- Gathered ideas for affordable sensors for compression and ventilation in the given prototype
- Gathered some possible types of feedback
- Discussed some limitations of the project

2.1.2 Week 2 (07.02.2022 - 11.02.2022)

The second week started the same as the first week with research work. When most of the research work was finished, the group gathered and discussed the most important points in the topics of compression, ventilation, basic life support, and CPR. After ending the research work the group tried to define project goals and to separate tasks for ESE (Embedded System Engineering) and IDE (Industrial Design Engineering). But because the project was very new for everyone this exercise went along with many uncertainties. Therefore, the most important questions were written in a document for the meeting with Johan.

Results of this week :

- A similar level of knowledge
- Separate tasks for ESE and IDE
- Ideas for an approach for the project

2.1.3 Week 3 (14.02.2022 - 18.02.2022)

In the third week, the project group worked on figuring out problems in the technical aspect of the manikin that they can work on. For this purpose, the given prototype was analyzed on one hand from the ESE point of view and on the other hand from the IDE point of view. The result of the analysis was that the given thorax is not realistic for CPR on an infant and needs to be redesigned by the IDE students. From the ESE point of view, it became clear that for the compression task a time-of-flight sensor is the best choice because this sensor had the best performance in the S3 project tests. The given air-ventilation system in the manikin is also not durable and needs to be redesigned and equipped with sensors in several positions in the manikin. Based on the analysis the project group defined user requirements for the manikin and handed them in for feedback. To get a better overview of all the project tasks a plan of approach document was created.

Results of this week:

- Defined a main goal for the project
- Problem definition
- User requirements list
- Uncertainties have been removed

2.1.4 Week 4 (21.02.2022 - 25.02.2022)

The fourth week started with discussing the feedback given by Johan and Matthijs on the user requirements list. After discussion, the most critical points have been revised or removed. In this week, the ESE students tried to get in touch with the written Software of the S3 project group and find some ideas for the implementation of the sensors. The IDE students worked on a sketch for the thorax of the prototype and discussed some possible approaches. Furthermore, a general meeting of all members involved in the project was scheduled as well as a trip to the Nijmegen

nursing school. In the meeting of the Health Concept Lab all parts of the project could mention their problems and things they try to focus on. The meeting was immensely helpful to get a better overview of the project as well as the different tasks of all project members. In conclusion you can say that it became clear that the IDE students have to primarily focus on adjusting the inner body of the manikin and the ESE students on design a sensor who is able to measure the compression distance and the air-volume of the manikin.

Results of this week:

- Overview of all parts of the project
- It is clear what we have to do and what we do not have to do
- Improved user-requirements list

2.1.5 Week 5 (07.03.2022 - 11.03.2022)

After the fourth week the project group tried to focus more on delivering results than on working on documentation. So for the fifth week the agenda was filled with mainly practice work like sketching, designing and testing. The main goal of this week was to begin the adaption of the compression functionality. The IDE students worked primarily on designs for the chest and the head of the manikin. This included gathering information about the measurements of the necessary components like batteries and sensors. The ESE students worked on analyzing and testing the given code from the S3 project for the Time of Flight sensor. Therefore it was necessary to understand the code and its functionality. After that the ESE students began with testing the Time of Flight sensor in order to see if the compression works.

Results of this week:

- Began the adaption of the compression functionality of the manikin
- Created a design prototype for 3D printing
- The code for the Time of Flight sensor works almost well
- Time of Flight sensor is working

2.1.6 Week 6 (14.03.2022 - 18.03.2022)

This week the project group focused on working further on the compression functionality of the manikin. The IDE students worked on further designs of the head and the chest. Therefore all parts of the manikin were scanned to get an overview about the space in the manikin. As well the first design prototype was sent to printing. The ESE students worked on further testing of the Time of Flight sensor. In order to get to know if the time of flight sensor meets all needs of the compression task some small statistics were made. As well for the RTOS- meeting on 22nd March some research work about free RTOS was made.

Results of this week:

- Printed design prototype
- Performance statistics of Time of Flight sensor
- Research documents

2.1.7 Week 7 (21.03.2022 - 25.03.2022)

This week the project group worked on the further implementation of the head and the compression, as well as the integration with RTOS. The ESE students had a meeting with Johan and Gert, a graduation student working on creating a Real-Time operating system called ManikinOS that was based on FreeRTOS. We discussed how the operating system worked and that we should test the operating system ourselves, and try to integrate part of our code for the compression sensor to the operating system, so that we can test if the operating system works as intended.

Results:

- Get in touch with freeRTOS

2.1.8 Week 8 (11.04.2022 - 15.04.2022)

This week the focus of the project group was mainly on the head as well as on ManikinOS. The ESE students started testing ManikinOS to see how it works, and had problems when trying to use the different tasks that were already created. We contacted Gert to help us with the problems we found but little progress was made.

2.1.9 Week 9 (19.04.2022 - 22.04.2022)

This week the projectgroup worked on different parts of the manikin, depending on the study. The inside of the head is being modeled to make redesign and rearranging components in the head easier. Apart from this, there have been made a few prototypes on the inner body and there has been a lot of communication with the S6 students to work on the airway system. The ESE students had a meeting with Gert, and we managed to figure out that the problem we came across was because of not enough memory being provided by the operating system to the tasks. We also found some more problems that we spoke about with Gert but we couldn't conclude the reason behind them.

Results:

- Rearrange components of the head
- Prototypes for the inner body
- Solving memory problem for the freeRTOS tasks

2.1.10 Week 10 (25.04.2022 – 29.04.2022)

2.1.11 Week 11 (09.05.2022 – 13.04.2022)

2.2 Results

During the first period, we laid the backbone of the project. The scope of the project changed many times because there was a lot of overlap between the different groups working on the simulator, so a lot of time was wasted on figuring out what each group was doing, as well as on researching what the previous project groups that preceded us had done. Having done that, we started working on our iterations.

The IDE students made a scan of the head to have a 3D model of it they can work on and are cooperating with the ESE students and the IPS students from S6 to redesign the inside of the head to house the batteries that will power the simulator, as well as the pressure sensors that will be used as part of the ventilation system. Furthermore, a design of the chest was made and printed according to the specifications we had from Johan.

The ESE members started implementing the compression part, using a ToF sensor and have made code based on the previous semester's S3 project group. Halfway through the period, we had a meeting with Gert van Lagen, who is a graduation student working on a real-time operating system called ManikinOS for the Baby patient simulator. We started adapting our current code for the ToF sensor to work with ManikinOS.

2.3 Problems

Because the scope of the project was unclear at the start, we started working on things that other groups working on the project were also doing and had an overlap. This caused a delay during the first 3-4 weeks because we had to scrap some things that we did. We also had dependencies on other groups, such as the S6 IPS students that need to provide the battery dimensions for the design of the head, but they are still testing to see which battery is best. COVID also had a part, as some of the group weren't able to come to the HAN because they were positive, and the chip shortage it caused means that new sensors and parts are almost impossible to find in stock, and shipping times are taking months.

3 Future

3.1 IDE

For the next period, the design of the head needs to be made to have a housing for the battery and the sensors, but first, the battery needs to be chosen by the IPS students. We will also need to speak to the other project groups and see what still needs to be done to the chest.

3.2 ESE

For the next period, the compression part using the ToF sensor with ManikinOS needs to be finalized, and we need to start working on the ventilation as soon as possible. We are still waiting for new PCBs to arrive for the ventilation sensors, but we can already work on PCBs that we have right now to test our code. We also need to get more familiar with ManikinOS and test its functionality so it works as intended with our code.

4 Conclusions and recommendations

Overall, despite the hiccups in the beginning, the project is going well. We are behind our planning, but we are picking up pace now that we have clear goals and know how to approach said goals. Our communication with the other groups needs to be more frequent to ensure that we don’t repeat the mistakes made at the start of the semester.