Politecnico di Milano

AUI Project, group 2

SAM Activities

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Chapter 1

Abstract

SAM Activities project consist of a set of activities that address the study and the therapeutics needs of people affected by Neurodevelopmental Disorders (NDD). The aim is to help the therapeutic process of the patients, by creating entertaining and relaxing activities that can improve the visual-motor coordination and space awareness of the patients. The activities are developed in a multi-sensory environment that includes equipment such as smart lights and kinect and the main controller is represented by the Smart Toy Dolphin Sam.

The project comprises two kinds of activities, Dolphin Run and Dolphin Search. Dolphin Run is a multi-level obstacle game mode set in a marine environment, where the patient, interacting with Dolphin Sam, is moved around the virtual game area with the goal of avoiding all the obstacle that comes along his way, in order to reach the end of the level. Dolphin Search instead is a Search&Find game mode where the patient has to find all the starfish hidden in the virtual game area. Both the activities can be parameterized and personalized by the therapist based on the patient needs. The sessions results, sessions parameters and user profiles are accessible by the therapist through a web application.

Chapter 2

Introduction

Neurodevelopmental disorders (NDD) are a group of disorders in which the development of the central nervous system is disturbed. This can include developmental brain dysfunction, which can manifest as neuropsychiatric problems or impaired motor function, learning, language or non-verbal communication [7]. It should be noted that autism falls under the definition of NDD and it is not a synonym.

Our project *"SAM Activities"* consists in a set of activities targeted to support the study and the treatment process for patients affected by NDD. These activities take place in a controlled multi-sensory environment equipped with a Kinect, SmartPlugs, SmartLights and the Dolphin SAM smart toy. In particular our solution provides support to both the patients and the therapists in multiple ways.

From the patients' needs point of view we developed two different kind of activities in order to stimulate them and to let them explore multiple level of interaction with the smart toy and the Magic Room:

The Run activity Which consists in a obstacle course game mode, during which the patient, interacting with the Dolphin SAM smart toy, is able to move around the virtual enviroment and overcome static and dynamic obstacles that will get in his/her way.

The Search activity Which consists in a search&find game mode, during which the patient, interacting with the Dolphin SAM smart toy and with the room space using the Kinect, is requested to search for seastars hidden within a virtual game area.

From the therapists needs' point of view our solution provides full support in the monitoring of the patients' session. In fact the activities work with the support of a website via which the therapist can register, add his/her patients records with all the relevant information, and associate them the current session data in order to store them for later consulting. Furthermore the therapist can customize, either from the website or directly from the game, the level of difficulty of the activities by setting specific parameters based on a particular patient abilities as he/she finds more suitable and store those settings for future runs.

Chapter 3

Target Groups and User Needs

3.1 Main Target Groups

As explained before in the introduction, our solution was designed and developed in order to be supportive in the treatment process of patients affected by NDD (Neurodevelopmental Disorder). In order to do so we identified different types of stakeholders and target groups with their respective needs that were taken into account:

- Main targets
  - Therapists
  - Patients
- Other entities affected
  - Families of the patients
  - Caregivers
  - Hospitals
  - Other specialized centers

3.2 Context and Needs addressed

3.2.1 Context

Our solution is designed to be used in centers specialized in the treatment of patients affected by NDD. In particular, given the centrality of the system-patient interaction and the key role that immersion plays in this aspect, the solution is designed to exploit the resources available in the Magic Room setup. The presence of a therapist in order to setup the activities, to monitor the patients and to analyze the information about their performances is also needed.

3.2.2 Needs addressed

During the design and development of *SAM Activities* we took into account the following main needs of the main targets for our solution:

Patients:

- Be entertained and relaxed during the activities.
- Being able to carry an activity autonomously.
- Improve visual-motor coordination.
- Acquire a better body awareness (both coarse and fine grained).
- Acquire a better spacial awareness.
- Carry out activities in a physical safe environment.
- Avoid any kind of pressure.

Therapists:

- Monitor patients during activities.
- Customize the activities based on the specific patients' conditions.
- Being able to consult analytics about the different patients sessions.
- To have activities that can be carried out autonomously by patients without the constant support of the therapist.

3.3 Constraints

Regarding the constraints that had to be taken into account during development we divided them in three categories based on the source of the constraints:

- Context related constraints:
  - The limited space available in the Magic Room is a constraint that has to be taken into account specially for activities that require coarse grained movements.
  - The limited air exchange in the room doesn't allow a too frequent or intense usage of the bubble machine as an activities' reward for the patient.

- User related constraints:
  - Patients affected by NDD usually are particularly sensitive to stimuli so it was important not to overstimulate them with frequent light shifts (especially from cold and warm lights).
  - Patients affected by NDD might have limitations in focusing on multiple events at the same time so the activities in our solution have a limited number of interactive objects in order to give a linear experience to the user.
  - For the same reason above we provided our scenes with a limited graphic level of details and clear hints in order to focus the patients' attention as much as possible.
- Technology related constraints:
  - The Magic Room system, as explained in the architecture section, allow the control of multiple smart objects that provide help provide an immersive experience by handling http requests between smart objects. This was taken into account in order to give a fluid experience to the user by rightly calibrating the inter-request interval and the requests distribution to the various smart object and their response time.

3.4 Goals of the project

The main goals of our solution are the following:

1. The system must provide multiple activities with various levels of difficulty for each one.
2. The system must provide an immersive environment to the patient.
3. The system must put the patient in condition to relax.
4. The patient must be able to choose autonomously one or more activities suited for his abilities.
5. The therapist must be able to customize the activities in order to suite at best the current patient.
6. The therapist must be able to instantaneously interrupt the activity.
7. The therapist must be able to monitor patients' activity during one or more sessions.
8. The system must help to improve patient's motor coordination ability.

9. The system must help to improve patient's focus ability.
10. The system must create an empathy between patient and the *Dolphin SAM* smart toy.
11. The system must provide playful activities in an immersive environment.
12. The system must limit the physical risks due to the abuse of devices.

3.5 Requirements

In order to fulfill the goals described above the system has to meet the following functional requirements:

1. The system must provide analytics related to the different sessions of activities carried out by a specific patient.
2. The system must interface with the Magic Room's devices.
3. The system must provide an intuitive and accessible interface to patients within the game.
4. The system must provide an effective and detailed interface for the monitoring of the patients.
5. The system must enable the therapist to create a profile for himself/herself and his/her patients.
6. The system must be able to persist user's performances and associate them to his/her profile.
7. The system must provide a summary dashboard of the patient's game sessions.
8. The system must provide a protection for user's personal data (depending on the domain authority).
9. The patient must not be overstimulated by the activity in order to avoid restlessness and indisposition.
10. The system must be able to track user's position data within the Magic Room via the Kinect.
11. The system must guide the patient during the activity based on the previously chosen difficulty level.
12. The system must support the parametrization of the activities' levels in order to let the therapist set the most suitable level of difficulty for a patient.

13. The system must use *Dolphin SAM* as an input interface (accelerometer, gyroscope, touch sensors, RFID reader).

14. The system must use *Dolphin SAM's* lights as an output interface.

15. The system must use the Magic Room's appliances as an output interface (smart lights, projectors, bubble machine).

Chapter 4

State of the Art

Although multi-sensory environments and smart objects can be integrated in numerous different ways, the number of actual projects that mixes both concepts in a **balanced way** are very limited.

Every related work that we are taking into account is either mainly (or totally) focused on the first aspect [6][9][8], or on the second one [10].

The concept of *multimodality* in particular is seen by Birchfield [1], together with the concepts of *embodiment (physical exploration of concepts and systems by moving within and acting upon an environment) and composition(composition of new interaction scenarios, and extensibility of the base toolset)* as a major theme for building learning environments.

Following these concepts, the Magic Room system [4] and its successor Magika [5], on which we based our work, represents one of the best examples of interactive learning environments. The system is in fact built connecting together multiple sensors, actuators, and output devices. The connection is taken in charge by a multilayered software platform that also orchestrate all the elements behaviors.

Other relevant projects are Sensory Paint [9] and Mediate [8].

Mediate A multi-sensory environment used to interact with autistic children through a continuous generation of real-time stimuli. The interaction is based on action-reaction dialogues with the system, i.e. contingent interactions. The system is then built to **enhance non-repetitive behaviors**, since the repetition of typical attitudes are in general considered undesirable by psychologist, particularly referred to autistic children.

The main idea was to **not give explicit elements of reaction**, but let the environment to react automatically, whatever action is taken by the user, creating *the environment as a sort of living thing.* The problem of typifying the various users is then presented, and solved through an interaction-driven design.

Sensory Paint A multimodal Natural User Interface system, that enable users to paint with textured colored balls, showing a superimposed reflection of the user on a wall, to highlight the actions of the user. It combine sensory integration and body awareness in a multisensory environment, i.e. a multimodal environment.

The activities are presented and carried on in a task-oriented fashion, providing in this way engagement and sense of purpose.

Overall the study also demonstrates that **multimodal systems can improve motor skills and body awareness as well as coordination**. As depicted in the evaluation, **the time of the interaction should not be too long**, since some participants found it not fun otherwise.

Additionally, some other works are really useful to define design principles for the creation of activities that uses certain devices. For example, the ones defined in the M4all project [1], which consists of multiple Kinect-based activities developed for creating natural and playful learning experiences. The activities are, in fact, built following multiple design principles:

- Simple level geometry
- Slow pace
- Simple Level Flow
- Limited simultaneous actions
- Balanced required effort
- Non-precise timing
- Limited consequences for errors

More smart-object-focused works explore the interaction between the user and the object, through sensors and actuators, which basically render the object a controller for the virtual activity. Our work is in fact based on the interaction with Dolphin Sam, a stuffed dolphin-like toy enhanced with complex system made up of several embedded sensors and actuators [2]. Another relevant work on this aspect is Rope Revolution [10].

Rope Revolution A rope-based gaming system for collaborative play. The system is designed as a rope module with a motion sensing handle at the free end, and a force feedback mechanism, attached to a wall, to which the fixed end is mounted to, creating the **illusion that someone, or something, in the virtual world is pulling the rope**. Additionally, a projection of the virtual environment is then projected on the wall. Multiple users are connected through the internet in order to create a collaborative multiplayer environment.

Both the gesture recognition and the force feedback systems are used in different ways, according to the game mode selected. There are a lot of different game modes: kite flying, rope jumping, horse driving, and wood sawing. Each of the activities can be performed either by a single player or multiple players remotely.

The evaluation highlighted how the rope systems is very useful to enhance the integration between the physical and the virtual world, with some subjects highlighting how *"it feels like the body was extended into the screen"*. Some other user pointed out that the rope interface provided visual feedback, not only physical, meaning that observing the movement of the rope help them also realize how to improve their movements.

Finally, the system can assist creative play, and different combination of gestures that represent a variation from the standard behavior, meaning that people are capable of generating new interaction methods based on the knowledge that they have of the system.

Finally, another relevant related work is Lands of Fog [6], that represents also a partial example of how to integrate a smart object in those kind of environment as the main controller for the activity, although, in this case, the multisensory aspect is not exploited in a very deep fashion.

Lands of Fog A full-body-interaction system [6] designed to improve social and cognitive skills.

The physical materialization of the system is designed around a circular projection of six meters of diameter. Additionally, **the systems makes use of handheld physical pointers**, used by the children to interact with the underlining projection. This is due to the analysis of various psychologists that supported the idea that for ASD children interacting with a *physical object can help in the mental mapping between the physical world and the virtual one.*

The virtual world is designed as **a natural environment covered by fog, of which only a small portion can be observed**. This practice is called *"peephole"*, a design strategy which is proven to be good [3] for improving exploration, since it motivates children to discover and explore the underlining world. This technique can also be useful for helping ASD children in focusing on just small samples of the environment, eliminating any other possible distraction.

The world is the populated by fireflies, that can be captured, collected. At a certain point, multiple fireflies can transform into a bigger one, becoming a *companion* for the child, *creating a sense of empathy between the children and the creature.* Also, the creation of a persistent entity that follow the child can be useful to drive the child attention and behavior inside the game.

The consequent evaluation demonstrate how the system can help the children in developing a certain *mental flexibility and capacity of adapting to different game situations*, distancing from their repetitive behaviors. Also the "peephole" technique result to be effective, since most children decrease the distance traveled across consecutive sessions, indicating a tendency of first understanding the world and then use that knowledge for a more efficient behavior.

Chapter 5

UX Design

5.1 General approach

5.1.1 Website client

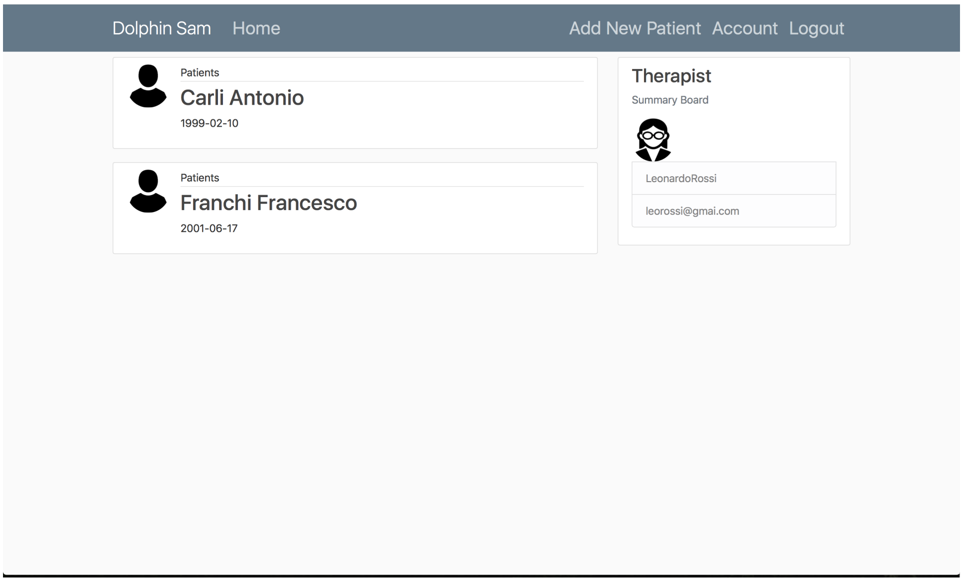


Figure 5.1: Therapist's personal home page

In Figure 5.1 is represented the website's personal page of the therapist that will be shown after a successful login authentication. Here he/she can see all his/her patients' records (notice that a therapist can only manage and access records about his/her own patients), choose to add a new patient by pressing the "Add New Patient" button, edit his/her account by clicking the "Account" button and logout via the "Logout" button.

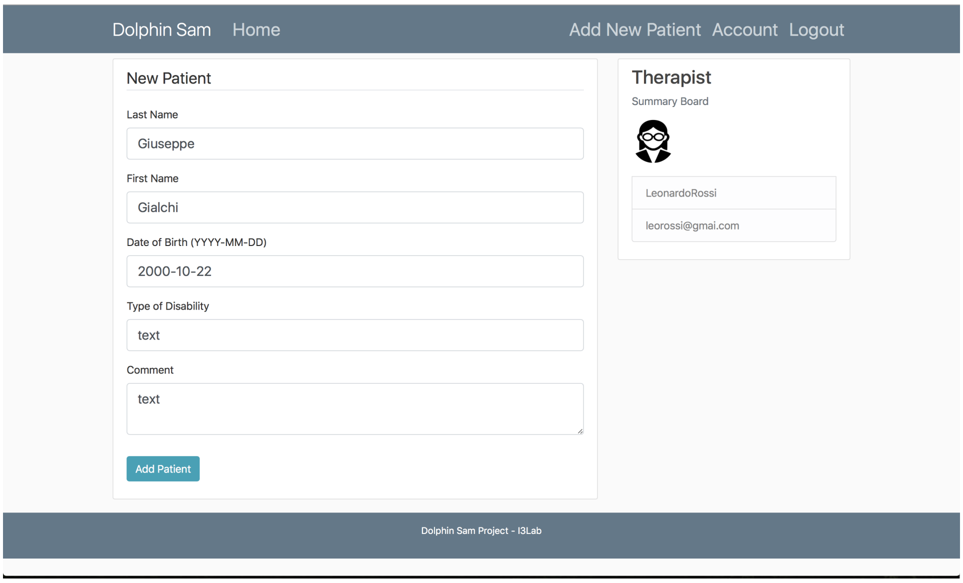


Figure 5.2: Add a new patient form

In Figure 5.2 is represented the form that will be used to collect the patient's information during the registration process brought by the therapist. When completed the new patient's record will be made persistent and added to the therapist's list of patients by clicking on the "Add Patient" button below.

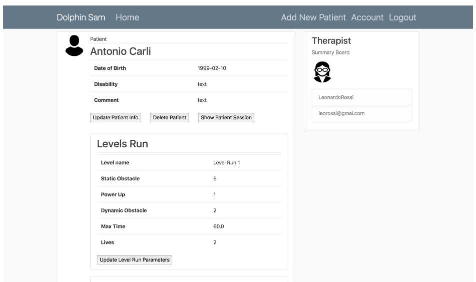


Figure 5.3: Patient's parameters for the Run activity

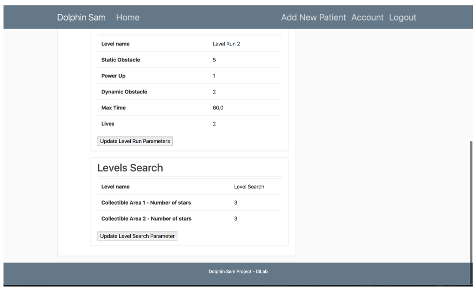


Figure 5.4: Patient's parameters for the Search activity

By selecting a patient from the list (Figure 5.1) the therapist is redirected to the patient's details page (Figure 5.3, 5.4) which contains the patient's information and the parameters that will be used to set the different levels of difficulty for the various activities. Those parameters can be updated by selecting the respective "Update" button below in order to customize the activities for the specific patient starting from the next session.

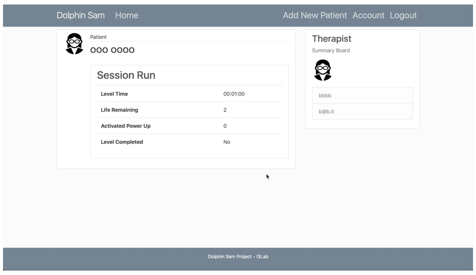


Figure 5.5: Session data for Dolphin Run activity

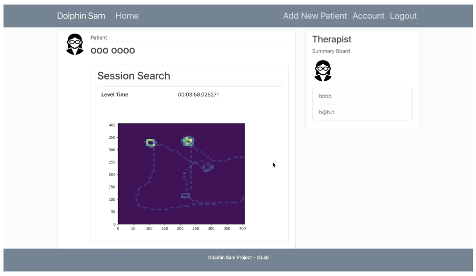


Figure 5.6: Session data for Dolphin Search activity

By clicking on the "Show Patient Session" button in a patient's detail page the therapist is able to see the data regarding all the session performed by the patient during the Dolphin Run activity (Figure 5.5) and the Dolphin Search activity (Figure 5.6).

5.1.2 Unity client

Figure 5.7: Therapist's patient list

Once the game is started and the therapist is logged in, his/her patients' list is shown (Figure 5.7) and the patient that will perform the session has to be selected using the mouse.

Figure 5.8: Session's mode selection

After selecting a patient it will be asked to select which one of the activities (Dolphin Run or Dolphin Search) will be played in the next session, still using the mouse. (Figure 5.8).

Figure 5.9: Parameters settings for Dolphin Run

Figure 5.10: Parameters settings for Dolphin Search

Depending on the selected activity then the user is redirected into the session parameters' page (Figure 5.9, 5.10) where is possible to modify once again the patient's parameters for the next session and to store them permanently.

Dolphin Run

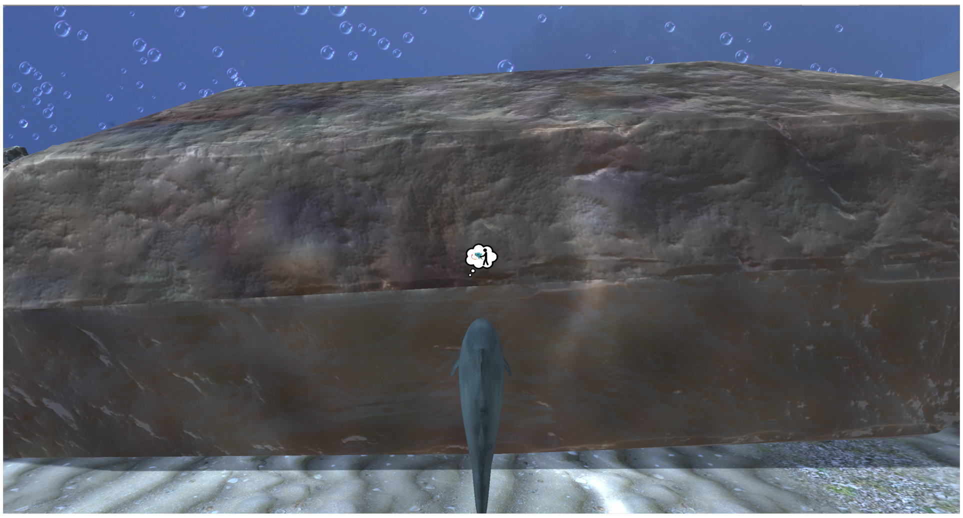


Figure 5.11: Dolphin Run activity

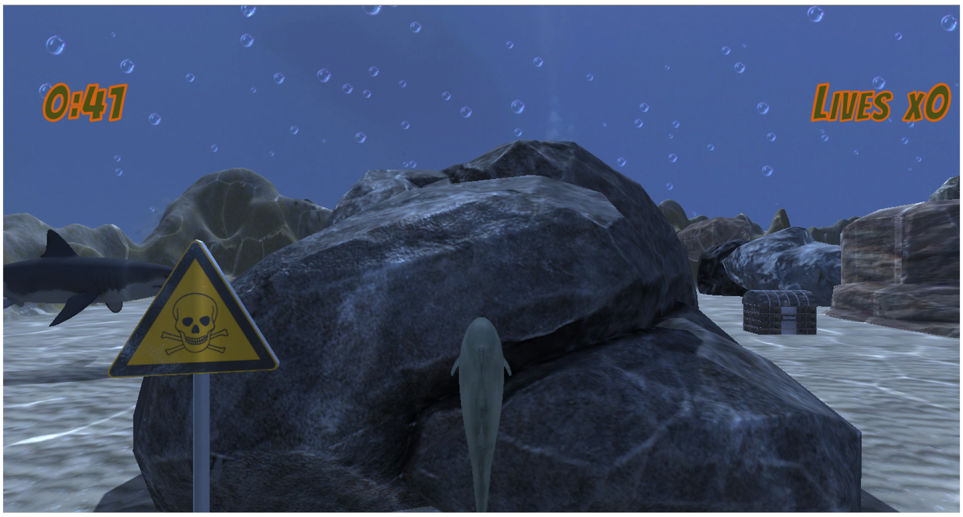


Figure 5.12: Example of crossroad and requested interaction in the Dolphin Run

Once the Dolphin Run activity is selected and one of the two possible levels is chosen the session will start. This activity consists in an obstacle course during which the patient, interacting with the *Dolphin SAM* smart toy has to control the virtual dolphin in the game in order to proceed. The interaction for this activity is both full body and tactile: by rotating the *Dolphin SAM* smart toy upwards (by tilting the head upward like in Figure 5.11), downwards (by tilting the head downwards), clockwise (by tilting the right fin towards the ground) and counterclockwise (by tilting the left fin towards the ground) the patient is able to change the proceeding direction of the virtual dolphin respectively to an up direction, a down direction, a right direction and a left direction.

During the course there are multiple obstacle both static and dynamic which density is defined by the parameters set beforehand via the website (Figure 5.3) or the unity menu (Figure 5.9). Other than obstacles is also possible to set the maximum time available to finish the level, the number of lives available and the number of power ups (like the speed up one). Furthermore there are also crossroads in the levels in which the patient has to use the touch sensors present on the *Dolphin SAM*'s right fin and left fin in order to choose in which direction to proceed (Figure 5.12).

Once completed the level the activity will terminate and forward the user back to the menu (Figure 5.8).

Dolphin Search

After selecting the Dolphin Search game mode and setting the desired parameters of the session (that consists in the number of *Search Zones* to be put into the game and their respective number of starfishes to collect) the Dolphin Search session will start.

In this activity the patient will use multiple interaction schemes that will alternate with the two game phases of the activity:

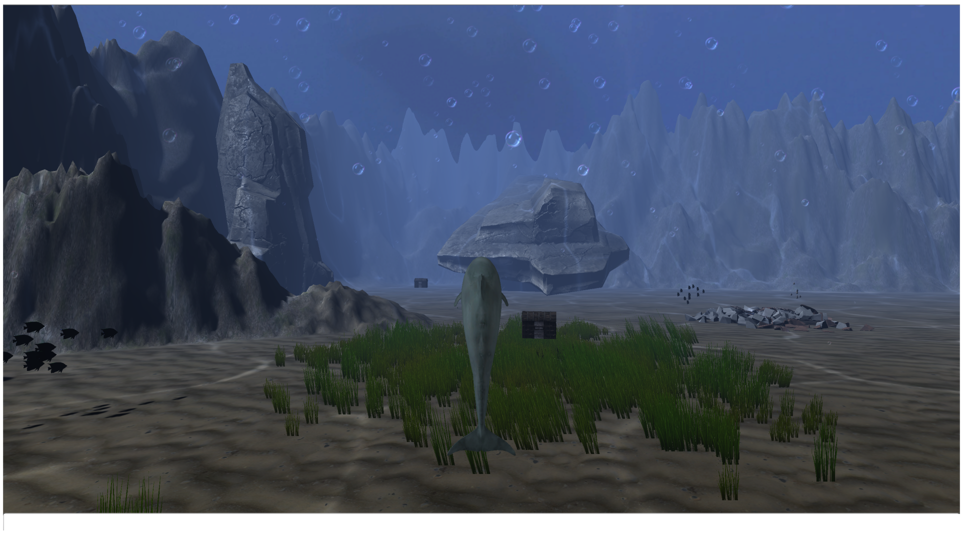


Figure 5.13: Represents a *Search Zone* inside the gaming area.

- **Exploration phase** : in which the patient uses the same controls as in the Dolphin Run activity to move around a virtual area in order to find the *Search Zones* (Figure 5.13) Notice that differently from the other activity here the patient has to give an input to the system in order to move forward that consist in touching both the left and right fin of the *Dolphin SAM* smart toy. When a *Search Zone* is found the user, in order to proceed to the search phase has to insert into the *Dolphin SAM* mouth the magnifier toy equipped with an RFID (Figure 5.14). Once scanned by the RFID reader in *Dolphin SAM's* mouth the search phase will start.

- **Search phase** : during this phase the patient has to find the sea stars, that are hidden below the sand level in the *Search Zone*, by moving around the Magic Room while having the *Search Zone's* seabed projected on the ground. In fact the system tracks the position of the patient inside the magic room using the Kinect and represents it in the virtual environment by using a white disk called the magnifier's focus(Figure 5.15). A sea star is collected when the magnifier's focus passes over it as shown in Figure 5.16. Once all the sea star contained in a *Search Zone* are found, if there are more *Search Zones* in the map the Discovery phase will resume, otherwise the session will terminate and forward the user back to the main menu (Figure 5.8).

Figure 5.14: Once in a *Search Zone* the magnifier is requested to pass into the search phase

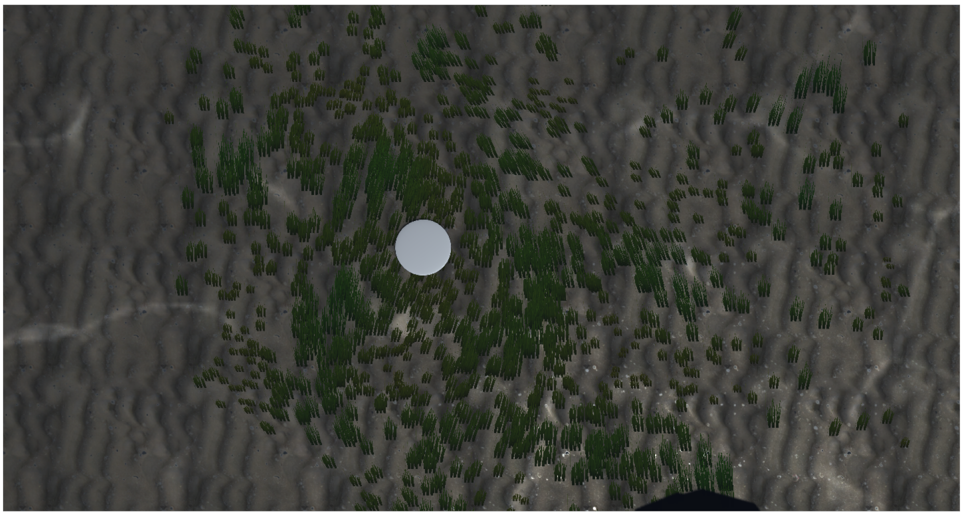


Figure 5.15: The display on the ground shows the magnifier's focus inside the current *Search Zone*

5.2 Scenarios

5.2.1 Dolphin Run Scenario

Carla is a therapist specialized in treating children suffering from various forms of NDD. In particularly Carla is conducting a study on the visual-

Figure 5.16: The display on the ground shows when a sea star is found

motor perception difficulty of certain patients, and she is searching new entertaining activities that can develop this perception.
Carla decides to use the new activities available in the Magic Room that is present in the center where she works. In the email that she received from her collegue Monica, Carla read about "Sam Activities" and she was particulary attracted from Dolphin Run activity, a multi-level obstacle game that can help to improve the visual-motor perception of the patients. She decides to use Dolphin Run activity with Elena, one of her patients. Firstly she accesses the website of SAM Activities from the pc inside the Magic Room. She creates her therapist account and then adds Elena's records by inserting her name, surname, date of birth, type of disability and an optional comment. Once Elena's profile is created, Carla logs in to unity by typing email and password created before on the website, and she selects Elena as patient profile. Then she goes for Dolphin Run Acivities, by selecting the first level in order to allow Elena to gain confidence with the activity. Elena takes dolphin SAM in her hands which is used as main controller, Carla starts the activity and the displayed virtual dolphin start its run through the obstacle. Elena impacts the first obstacle, and Carla suggests her to rotate the smart toys upwards, so she can overcome the obstacle. Once Elena arrives at the first corner, by looking at the displayed hint, she presses the left fin in order turn left and proceed the dolphin run. Then Elena arrives to the cliff obstacle. This time, without Carla suggestion, she rotate the dolphin downwards in order to overcome the obstacle as displayed by the hint. After she has overcome all the obstacles and corners, Elena reaches

the end of the level.
Carla, observing the confidence and the happiness that Elena shows by playing with Dolphin Run, decides to increase the difficulty by selecting the second level. For the second level, she decides to modify the standard parameters that are displayed in the menu for the second activity, and she decreases the life time, in order to challenging Elena abilities.
Elena holds the smart toy again and Carla starts the activity. Carla notices immediately that the second level is more challenging, with an increased speed of the dolphin, the addition of new elements such as power up, and the possibility to runs out life points if the obstacles are collided. Elena loses four times before reaching the first corner. Then she decides to use the power up, by feeding the smart toy with the RFID card displayed in the game scene. Using the RFID, the dolphin gains more speed. After Elena has completed the level, Carla goes on the web sites and presses the show sessions button in the patient profile, in order to see the session's results of Elena. Then, based on the sessions result, she decides to change the parameters of Dolphin Run level two directly from the web sites, in order to use them the next time Elena will play with Dolphin Run activity.

5.2.2 Dolphin Search Scenario

In a center specialized in the treatment of patients affected by NDD a therapist named Erica is looking for some new activities to entertain her patients Carlo and Giulio. Since the patients would like to use the Magic Room and "SAM Activities" is already being installed on the pc of the Magic Room that's in the center where she works, she decides to try it for the first time. Firstly she goes on the website and register, then she adds Carlo's and Giulio's records by inserting name, surname, date of birth, type of disability and a comment. Once the all the profiles are created, since Carlo is more skilled than Giulio in trying new games and is more prone to have longer session than his friend, she decides to modify the session's parameters regarding the Dolphin Search activity from the websites so that Carlo's session will be more challenging while Giulio's will be more brief. In order to do that she selects Carlo's profile from her patients list, and inserts two more zones with five sea stars each in the Dolphin Search parameters. Accordingly she does the same with Carlo's parameters but this time she deletes one Search Zone and sets a low number of stars for the others remaining. Since Giulio is the first one to go Erica selects his profile from the unity menu and starts the game. Giulio explores the seabed looking for *Search zones* by pressing Dolphin SAM's right and left fins and tilting the toy in order to orient the movement. Once he finds a *Search zones*, like the one represented in figure 5.13, he grabs the magnifier as requested (Figure 5.14) and then starts physically exploring the area around him in order to find the hidden sea stars. After he has found all the sea stars inside the zone he can return to the exploring phase by using the Dolphin SAM to look for the remaining zones. When both the patients have finished their sessions Erica can visit the website in order to have a look at the time that they required in order to complete the activity and take a look at the sessions' heat map (Figure 5.6) so that she can adjust the parameters for the next sessions in order to best fit her patients' needs.

Chapter 6

Implementation

The goal of this chapter is to describe how the activities were implemented, regarding the hardware aspects, as well as the software ones.

6.1 Hardware platforms

Dolphin Sam

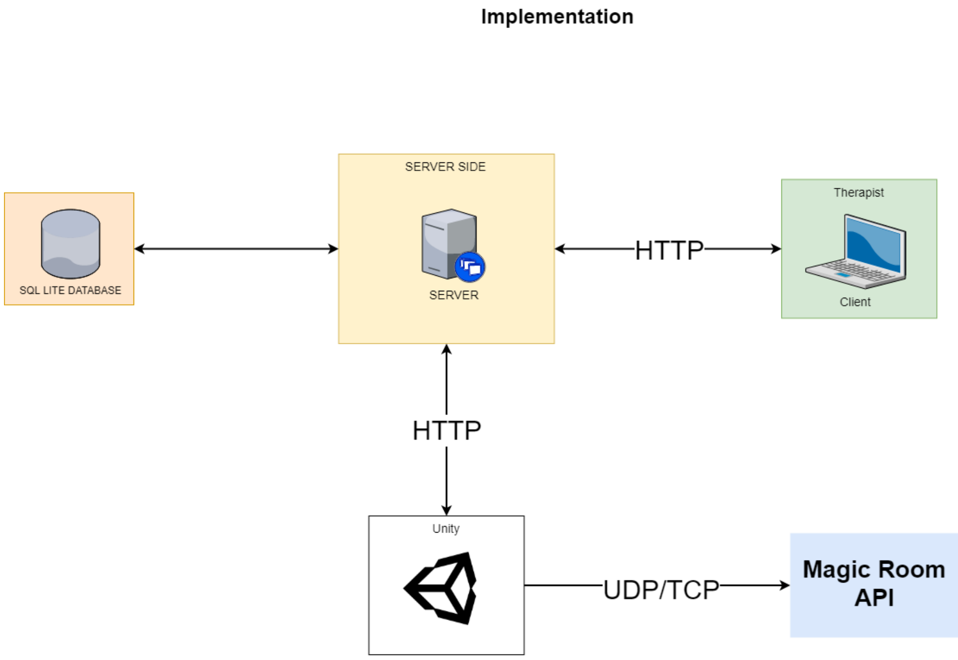
The main device used was Dolphin Sam, a smart object developed by I3Lab.

Dolphin Sam [2] is a stuffed toy enhanced with complex system made up of several embedded sensors, actuators and external components. Four parts of the body, such as head, stomach, right and left fins are integrated with four touch sensors. There are light actuators on the stomach and a speaker and an RFID reader into the mouth. Eyes and mouth movements are controlled by two different motors. In addition a chip is used for Wi-Fi communication.

All embedded components are connected and managed by an Arduino module which manages also the communication between the smart dolphin and the external components, such as smart lights and tagged RFID cards.

6.2 Hardware architectures

The hardware architecture of the system is based on a three tier client-server architecture, where we can distinguish between:



- **Data tier:** consists of a SQL Lite database
- **Application tier:** consists of a python flask web server which is built on REST architecture and contains part of the application logic. SQLAlchemy is used as Object Relational Mapper in order to query and manipulate data from the database, using an object-oriented paradigm.
- **Presentation tier:** represented the fron-end of our architecture, consists of web-based application accessible through a web-browser and three-dimensional games activities, built using Unity Game Engine platform, both communicating through HTTP calls with the server.

Unity game activities were implemented using a fat client approach by placing the whole application logic inside the presentation level.
The interactions between the system and all the smart objects and sensors inside the Magic Room, is managed through http requests to the Magic Room API, which handle the communication between the smart objects and the unity activities.

6.3 Software Architectures

Regarding the server side, the software architecture was based on the **MVC** (Model View Controller) design pattern, where the main components are:

- **Controller:** responsible to dispatch all the requests coming from client side, both web application and unity game engine. The controller is also responsible to loads the views to display in the web application.
- **Model:** responsible for mapping user-defined python classes with database tables
- **View:** responsible for represent data coming from the model as user interface. HTML templates are used.

Regarding the software implementation of the game activities on client side, the software architecure was organized in three main modules:

- **Menu**
- **Run Activity**
- **Search Activity**

that were treated separately.

Referring to Menu module, the main components are:

- Login Manager: responsible for managing the login procedure and the communication with the server.
- Menu Session Manager: responsible for handling information coming from the server and for managing the user session

Referring to Run Activity module, the main components are:

- Player Manager: responsible for managing the player behaviour in the scene.
- Run Session Manager: responsible for gathering information referring to the game session and dispatch those to the Menu Session Manager

Referring to Search Activity module, the main components are:

- Player Manager: responsible for managing the player behaviour in the scene.
- Search Session Manager: responsible for gathering information referring to the game session and dispatch those to the Menu Session Manager

6.4 Programming languages and software used

The programming languages used ti develop the system are:

- C#: Used for the realization of the Unity scripts.
- Python: Used for the server implementation
- HTML & CSS: used for the realization of the web pages' front-end.
- JavaScript: used for the realization of the web pages' back-end.

The software that were used during the development are:

- Unity 2018.1.0f2 for the development of the game activities
- Visual Studio 2017 for the develoment of unity scripts.
- Intellij 2018.3 for the development of the server.
- SublimeText 3 for the development of the web pages.
- Git to synchronize the development between the members of the team.

Chapter 7

Value Proposition

Our solution ends up being really immersive, the integration of the Magic Room with Dolphin SAM provides an interaction equally balanced between the use of the object and the multi-sensory environment. For this reason the work can also be considered innovative and relatively new.

Then, the information gathering through the related server, which is completely automated, helps the educator to maintain clinical records about the patients, and trace eventual improvements across multiple sessions.

Extensibility comes also into place, particularly regarding the level structure of the activities. Also the information gathering mechanism can be easily extended by introducing other types of statistics.

The portability of the application is then strictly related to the portability of the Magic Room. Although a local version of the game can still be played on any laptop, lacking, in that case, the classical immersivity provided by the room.

Chapter 8

Future Work

Session Analytics Improvements

Nowadays data analytics techniques has gained more and more importance, so a future improvement of the system can be done by defining a better and much detailed analytics that could help the therapist in the analysis of the user sessions and user improvements.
Another improvement consist on the creation and collection of new parameters that can analyze in depth the game activities.

Activities Improvements

In future developments of the system, Dolphin Run and Dolphin Search activity can be improved by adding new challenging levels and new features, allowing a deeper personalization of both new and preexistent levels.

Development Improvements

Main improvements that can be done are the deployment of the server in virtual containers such as Heroku or Docker, in order to wrap up the software and its dependencies into a standardized unit for software development, that includes everything it needs to run: code, runtime, system tools and libraries.
The web-application can be improved by using JavaScript for the realization of all the web pages' back end and by adjusting the UX design.

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