JKinect: A new Java Software for Designing and Assessing Gross Motor Activities in children with autism based on JFML

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***Abstract*—Motor therapies can be considered as one of the social challenges that have a great impact in children with autism. Traditionally, exercises and activities as therapies have been used to mitigate and to rehabilitate problems related to gross motor skills. Nevertheless, from the perspective of children, these therapies are often repetitive, boring and they need an extra motivation aspect due to the target: children with autism. From the point of interaction with the target population, the use of technology is a key issue in these therapies. In this scenario, a new software named JKinect which is based on RGB-D sensors and computer based games. JKinect helps children with gross motor problems and presents great flexibility in the therapy design and game sharing among specialists. Additionally, a new module for linking JKinect with both fuzzy systems based on the IEEE std 1855-2016 and the JFML library to support experts' decision making in therapies on the basis of fuzzy rules is also included.**

***Index Terms*—Motor therapies, Kinect, JFML, FRBS, ADHD**

I. INTRODUCTION

The sensory-motor area provides an exploratory capacity that promotes learning and stimulates intellectual development. This area allows people to interact properly with their environment [1]. The motor skills, which are related to execution and coordination of movements, can be classified into two groups depending on the type of movement: fine and gross. Fine motor refers to small, precision movements, mainly in the hand and the wrist, while gross motor refers to movements that use large muscles, such as the arms, legs or the upper body. The development of the ability to move the muscles of the body harmoniously [2], [3] is a fundamental key for the discovery of the environment, self-esteem and self-confidence among other skills.

In this context, one of the main challenges to be addressed is these kind of therapies where children are involved. In this field, the advances in neuroscientific research, accompanied by technology, are one of the current objectives in the treatment of children with motor disorders. There are a growing number of studies [4]–[7] that show the effectiveness of training programs focused on gross motor skills in the improvement of different disorders. The current challenge consists of creating activities, in a comfortable way for the therapists, which motivate children to become playfully involved in them.

On the one hand, technology brings important benefits to the realization of such programs. In particular, a technological area of special interest for its application and results in the performance of therapies with children is the multimodal interaction using RGB-D sensors, such as the Kinect devide [8]. These types of sensors combine RGB images with depth information providing the distance to the sensor for each pixel. This technology offers new alternatives to the traditional keyboard and mouse for interaction with a computer system.

On the other hand, Fuzzy Logic Systems (FLS) have been successfully used in a wide range of real-world problems. They can include a priori expert knowledge and represent systems for which it is not possible to obtain a mathematical model. Recently, the IEEE Computational Intelligence Society (IEEE-CIS) has sponsored the publication of the new standard for FLS (IEEE Std 1855-2016). This standard was established with the main objective to provide the fuzzy community with a unique and well-defined tool allowing a system design completely independent from the specific hardware/software. The new standard defines a new W3C eXtensible Markup Language (XML)-based language, named Fuzzy Markup Language (FML) [9] aimed at providing a unified and well-defined representation of interoperable FLS. For example, distributing fuzzy reasoning through fuzzy markup language: An application to ambient intelligence [10]. Additionally, in order to make the IEEE standard operative and useful for the fuzzy community, the library JFML [11] that offers a complete implementation of the new IEEE standard has been developed. Some hardware/sensor developments based on JFML have also

978-1-7281-6932-3/20/$31.00

been successfully done [12].

Therefore, this paper presents an interaction software system specifically designed to help gross motor disorders, based on the Kinect sensor. The software allows designing, sharing and assessing activities to help gross motor problems through games. In these games, target objects are positioned in different areas of the screen. Then, children interact with these objects through their bodies using natural movements and gestures. The system is composed by three modules. The first module carries out the execution of the game using the Kinect device. The second module is focused on the configuration and design of specialized activities through a graphic interface. This interface can store therapies in XML files to be easily exported and imported. The last module provides communications with a Fuzzy Rule Base System (FRBS) using the FML and the JFML library.

This paper is organized as follows: Section II provides a summary of works related to gross motor activities, the main features of the Kinect device and an introduction to *JFML* library. Section III describes the modules that compose the application for designing and assessing gross motor activities. Section IV presents a FRBS that is carried out as an example of the evaluation of several activities. Finally, the main conclusions are highlighted in Section V.

II. PRELIMINARIES

In this section, a brief introduction to gross motor skills is presented. Later, the main features of The Kinect device which are related to the software developed, are detailed. Finally, a summarize of JFML library is exposed.

A. Gross motor skills

In recent studies [13], approximately 15% of the population, children included, has a physical or mental disability. In fact, there are works [14] that show that the most widespread is the problem of gross motor skills, among the delays in the development of motor skills. However, children with these disabilities can mitigate their effect at older ages with activity-based therapies [13].

In this context, hop, jump, pull, push, down and around, among others, are considered essential activities to develop motor skills in childhood [15]. The authors develop different therapies that incorporate traditional activities with music to help children participate in the therapies, in an immersive way.

Colombo–Dougovito et al [16] present a study which reviews current methods for accommodating gross motor assessments of children with autism spectrum. The authors highlight that children with the autism spectrum have slower development of motor skills than those who have no autism. The slow development of these motor activities leads to slower development of communication skills. Also, the authors show studies in which stimulating activities through letters, pictures, and visual programs increase the performance in the therapies. Another aspect that the authors emphasize is that although the number of proposals has been increased in the last years, there are limitations to replicate and use them into practice.

Case et al [17] report that children with autism spectrum who have gross mobility problems are more motivated to engage in activities if they have a choice. For example, choosing which activities to do, or even choosing the color of the ball with which to do the activities. Also, children are more motivated if they are aware that there is a reward after completing the activities. In this sense, children are motivated to make their own decisions while performing the necessary exercises to improve their motor skills.

Azzam [18] has carried out studies in which the integration of sensory therapies provides promising results in gross motor rehabilitation therapies for children with Down syndrome. These therapies cover a wide range of activities: from making the child develop their activities with objects of different textures, to exercises based on visual-spatial perception and postural stability training.

Similar to the gross motor analysis, there are different proposals based on activities lists with scores which are recovered manually [19] to evaluate the progress of the therapy. Also, there are proposals more focused on the analysis of an activity such as walking [20]. In this sense, the advance of technology and communications has made it possible to develop more effective methods of collecting and analyzing gross motor problems. For example, Boonzaaijer et al [21] propose a tool to help assess children's gross motor development from the perspective of parents. In their study, parents can record the exercises practiced at home, upload the videos to a web portal, and get feedback on the diagnosis from an expert within two weeks. However, it is a slow process that requires the therapist to analyze the video completely, without any decision support and having only the information provided by the video images.

Hence, a software, for generating activities, sharing them, and assessing the activity after its completion immediately, is needed.

B. Kinect

The Kinect [8] is a device that, although was created for entertainment, has been used for researching [22]. This device incorporates an RGB (Red-Blue-Green) sensor and the combination of an infrared projector and infrared camera that allows obtaining the distance from the camera to the objects for each pixel of the image. The latest version of this device is accompanied by a library [23] which allows accessing image data, depth data, as well as, to track bodies. The library can track characteristic joints of six people. The joints detected for each body are shown in Fig. 1.

This device will enable the body of the patient to be used as the controller of the game during the gross motor activities.

C. JFML

The IEEE Std 1855-2016 [24] was published in 2016 by the IEEE Computational Intelligence Society (IEEE-CIS [25]). This new standard presents the Fuzzy Markup Language (FML) based on the syntax of the well-defined XML language. FML is used to represent fuzzy logic systems (FLSs) with the aim to solve problems of classification or regression among

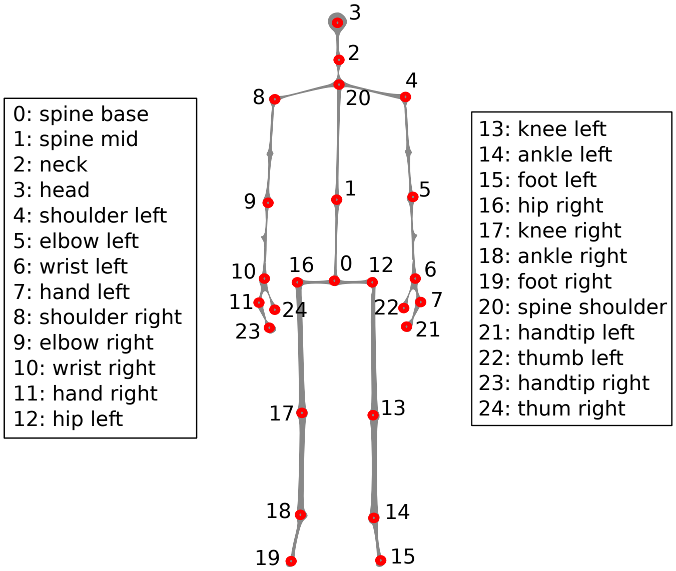


Fig. 1. Joints map tracked by kinect SDK

others, exploiting the features of XML [9]. The FLS are organized into two groups [26]: type-1, and type-2. Type-1 FLS are cases where an expert can exactly determine the values of an attribute of specific problems, while in type-2 ones an expert cannot determine the exact value of an attribute generating intuitionistic fuzzy systems.

In this context, there is a recent library to design FLSs named JFML [11]. JFML is an open-source library [27] encoded in Java ready to solve type-1 and type-2 FLSs. This library can be used with all the fuzzy inference systems (Mamdani [28], Takagi-Sugeno-Kang (TSK) [29], Tsukamoto [30] and AnYa [31]) enclosed in the XML Schema Definition (XSD) of the standard IEEE Std 1855-2016. The modular-based design of JFML using the same labelled tree structure as the IEEE Std 1855-2016 allows to include future changes modifying only the corresponding part of the library without the necessity of changing the usage of this library in older versions. Additionally, the JFML library includes some modules for the importation and exportation of FLSs allowing the interoperability of the library with other software or widely used formats for FLSs, such as FCL [32], PMML [33], and Matlab FIS [34] among others. In addition, JFML can be accessible in Python 3.x through Py4JFML [35].

Hence, JFML is a powerful and scalable library that can be used for designing and sharing fuzzy systems in the field of assessing gross motor skills in children with autism.

III. JKINECT

Jkinect [36] is the name of the proposed application for the design and the use of activities focused on therapies for children with autism and gross motor problems. Jkinect is available as an open-source in which secondary forks can be made by any user. This application is composed by three modules as is shown in Fig. 2:

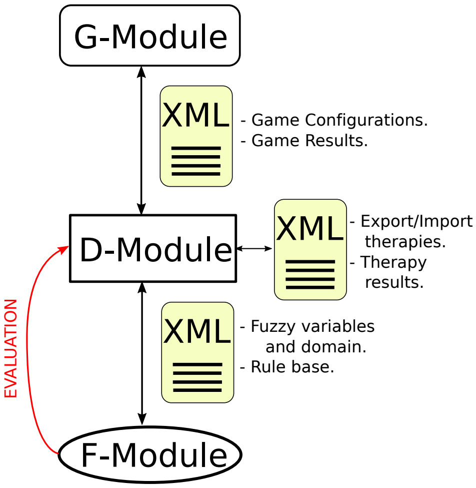


Fig. 2. Jkinect module composition

- G-Module: this module is the game interface that uses the Kinect device.
- D-Module: this module provides a visual interface for designing, generating, and sharing game configuration into XML files.
- F-Module: this module includes a connection with the JFML library which allows assessing the activity results on the basis of fuzzy systems designed according to FML.

The following sections explain in depth each of the modules shown in Fig. 2.

A. G-Module: game for gross motor activities

This module is in charge of generating a visual interface for the players (children with autism) using the Kinect device. For that, the Kinect library [23] is used for tracking bodies of players, while the OpenCV [37] library is used for image processing. These two libraries allow generating the game interface, placing the recorded child's body on a completely new virtual background, and placing the interactive elements in the new background.

The game interface, as Fig. 3 shows, is minimalist, since considering the target audience (children with autism) it must be clear and simple. The game is immersive, so the child is shown in the screen inside in a background image with objects which the child must reach with his/her body. The inner part of the interface has an indicator on the left side that increases each time that the children reach the object, a clock in the central part that shows the remaining time of the game, and finally a failure indicator on the right side that increases each time the children are not able to achieve the elements. Additionally, the therapist can pause and resume play when appropriate.

An additional feature of this module is that, as shown in Fig. 3, the patient and therapist can both appear in the game interface. However, as the application is focused on individual therapies, only the person closest to the Kinect, who has the shortest distance of *"spin shoulder"* joint (see Fig. 1), will

Fig. 3. Game interface

be able to interact with the game. This is an ideal feature for those cases in which children with autism need to perform the proposed activities with a mentor next to the child.

Moreover, at the end of the game, three additional files are generated. The first file is a video in ".avi" format with the captured RGB camera as video file. The second one is a text file with the sequence of X, Y and Z coordinates of the joints obtained from the Kinect library and the X and Y coordinates of each object, all of them associated to corresponding frame and game instant. The last file is an XML file with the results of the game as is shown below:

```xml
<?xml version="1.0" encoding="UTF-8"?>
<GameOutput>
   <name>Game_name</name>
   <description>Description_game</description>
   <patient>patient_ID</patient>
   <therapist>therapist_ID</therapist>
   <date>date</date>
   <time>time</time>
   <duration>seconds</duration>
   <score>Total_score</score>
</GameOutput>
```

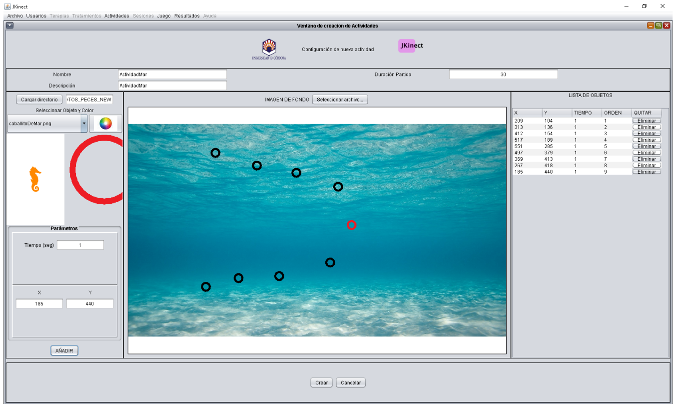
Code 1. Game output XML file

The position, color, time, images of the interacting elements as well as the background image and total game time, are specified by an XML file as input. The generation of the XML file by a visual interface is shown in the following section.

B. D-Module: Designer for activity configuration

This module carries out three main tasks. First, it presents a visual environment to create, import and export activities, Second, it generates an XML file which is used for launching the game module. Finally, when the game is finished, it receives another XML file with the results of the game as well as the text file with the coordinates of joints and objects. These data are processed to call JFML library and return the evaluation of the concrete activity, that is, the game.

The visual environment, which allows configuring the activities, has been encoded in the Java programming language to allow it to be extensible and multi-platform. Also, this module provides a visual interface using the Java2D library [38] that allows loading a background image that will appear in the game, as well as, drawing objects at specific positions in the background, setting the time of the objects and the total time of the game, among other graphic aspects.



Nombre: ActividadMar
Descripción: ActividadMar
Duración Partida: 30
Cargar directorio: ·TOS_PECES_NEW
Seleccionar Objeto y Color: caballitoDeMar.png

Parámetros
Tiempo (seg): 1
X: 185
Y: 440

LISTA DE OBJETOS

X	Y	TIEMPO	ORDEN	QUITAR
209	104	1	1	Eliminar
313	136	1	2	Eliminar
412	154	1	3	Eliminar
517	189	1	4	Eliminar
551	285	1	5	Eliminar
497	379	1	6	Eliminar
369	413	1	7	Eliminar
267	418	1	8	Eliminar
185	440	1	9	Eliminar

Fig. 4. Designing activity module interface

This visual interface, as shown in Fig. 4, has several elements. At the top, an expert can enter the name of the activity to be generated, a description of it and the time in seconds that the activity will take. The central area is a place where the expert can select an image as a background and position each interactive element one by one. Each interactive element can have a specific image, position, color and time. Once an element has been added, a list of the elements with their coordinates in the image, the time that the element will be on the screen to interact with it and the order can be seen on the right side of the interface. These elements can be deleted or added without any constraints. These features allow the therapist designing games so that the child with gross motor problems can perform the movements that the therapist wants. Also, without restricting time, the therapist can put an element that is difficult for the child to reach, and thus motivate the child to reach it and see how the children perform with different challenges.

The generation of activities through Jkinect offers two fundamental points. The first is that, according to Colombo-Dougovito et al [16], Jkinect provides a practical and simple way of sharing activities with other therapists. The second is that the generation of activities based on images and games allows a patient to be more motivated to play because the therapist can develop a personalized activity for the patient considering the patient's preferences as Case et al [17] pointed out.

The second task is the generation of the XML file which is used for launching the game module (see Section III-A). Once all the elements have been positioned, an XML file can be generated. This file can be exported or imported for its visualization or modification. The structure of this file can be seen in the following code:

```
<?xml version="1.0" encoding="UTF-8"?>
<GameInput>
<name>Game_name</name>
<description>Description_game</description>
<duration>seconds</duration>
<background>background_image.png</background>
<therapist>therapist_ID</therapist>
<objects>
   <element>
      <image>objectImage_1.jpg</image>
      <time>secondsExposure_1</time>
      <order>1</order>
      <positionX>X1</positionX>
      <positionY>Y1</positionY>
      <color>R1,G1,B1</color>
   </element>
   ...
   <element>
      <image>objectImage_N.jpg</image>
      <time>secondsExposure_N</time>
      <order>N</order>
      <positionX>XN</positionX>
      <positionY>YN</positionY>
      <color>RN,GN,BN</color>
   </element>
</objects>
</GameInput>
```

Code 2. Generated activity XML scheme

The last task of this module is the evaluation of the game. As it has been mentioned before (Section III-A), at the end of the game, an XML file and a test file are generated. The date of the game and the score are saved in the XML file. The coordinates of joints and objects are saved in the text file. These files are used to carry out the evaluation as is explained in the next Section III-C.

C. F-Module: Fuzzy rules with JFML for including expert knowledge

As we have mentioned before, JFML [27] is an open source Java library which is aimed at facilitating interoperability and usability of fuzzy systems. The main aim of F-Module is to integrate JKinect with JFML in order to evaluate the success degree of the game on the basis of fuzzy rules. Hence, the definition of input and output fuzzy variables as well as the knowledge base is required to conform the Fuzzy Rule Base System (FRBS). Once the FRBS is built, a game success degree can be obtained on the basis of the JFML motor inference.

F-Module can create an XML file with the FRBS according to the IEEE std 1855-2016. This FRBS can be defined by the expert therapist or by any user and it is compatible with the JFML library as input FRBS. In addition, the results of each game are represented in a text file which includes the coordinates of joints and objects as values of the fuzzy variables. By considering both files (FRBS and the game results) as input file in the JFML library, it provides a game success degree by making the fuzzy inference.

IV. STUDY CASE

In order to illustrate the potential of JKinect in the treatment of gross motor activities in children with autism, a study case is developed. Specifically, a case focused on the upper body where expert knowledge from a therapist and a evaluation of the success degree of the activities are considered. In subsection IV-A, the Fuzzy Rule Base System taking into account expert knowledge is defined while in subsection IV-C some evaluation results from different games are also shown.

A. Defining the Fuzzy Rule Base System

Several indicators and rules to define the assessment of the activity focused on the upper body are required for a therapist as an expert. For example, indicators such as the score, the time to reach objects and the posture of the child, etc. and rules such as “if the time to reach is high then the assessment is low”. By considering these indicators and rules the Fuzzy Rule Base System is defined. In this sense, on the one hand, the knowledge base where several fuzzy variables and their fuzzy terms is defined (subsection IV-A1). And on the other hand, the rule base by considering the expert knowledge is also defined (subsection IV-B).

1) Defining the Knowledge Base: Several fuzzy variables which are related with some indicators required by a therapist are defined. Concretely, five input variables and one output.

- $Score$ represents the game score. It is an input variable defined by the fuzzy terms *“LoScore”*, *“MedScore”* and *“HiScore”* in the domain $[0, 100]$ (Fig. 5). It is calculated following Eq. (1)

$$Score = \frac{gameResult}{N} \cdot 100 \quad (1)$$

where $gameResult$ is the total score obtained from the number of reached objects of the game (obtained from the output XML file mentioned in section III) and N is the total number of objects considered in the game.

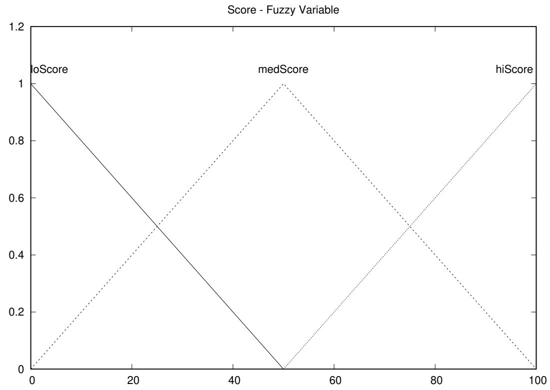


Fig. 5. Fuzzy Variable: Score

- $TimeSuccess$ represents the average time to achieve the object. It is an input variable composed by the fuzzy terms *“LoTime”*, *“MedTime”* and *“HiTime”* in the domain $[0, 100]$ (Fig. 6). It is calculated following Eq. (2).

$$TimeSuccess = \frac{\sum_{i=1}^{n} \frac{timeSuccess_i}{time_i}}{N} \cdot 100 \qquad (2)$$

where $timeSuccess_i$ is the time to reach the object i and $time_i$ is the time which the object i must be exposed. These values are also calculated from the output XML game.

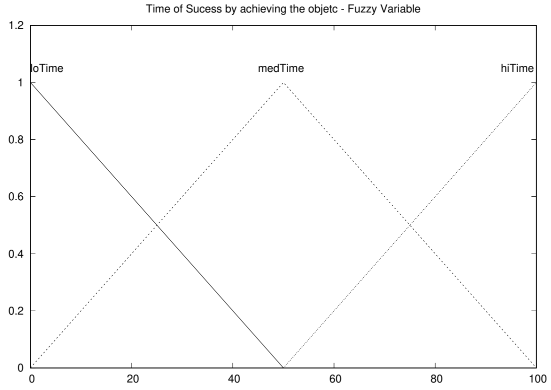


Fig. 6. Fuzzy Variable: TimeSuccess

- $PositionCamera$ indicates the position of the child respect to the Kinect camera. It is an input variable defined by the fuzzy terms *"Opposite"*, *"Sideways"* or *"Back"* (Fig. 7). The value of this variable is calculated as the difference of the x-position between *"Shoulder Left"* and *"Shoulder Right"* (see Fig. 1) following Eq. (3).

$$PositionCamera = \frac{\sum_{i=1}^{n} \frac{SL_i.x - SR_i.x}{|SL_i.x - SR_i.x|}}{N} \cdot 100 \qquad (3)$$

where $SL_i.x$ is the "x" coordinate of joint *"Shoulder Left"* corresponding to the i object and $SR_i.x$ is the "x" coordinate of joint *"Shoulder Right"* corresponding to the i object.

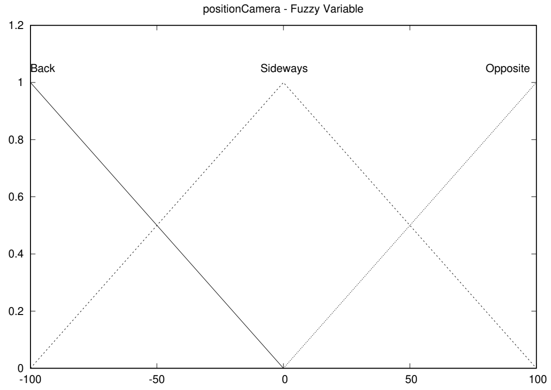


Fig. 7. Fuzzy Variable: PositionCamera

- $CorrectLeftArm$ and $CorrectRightArm$ indicate if the position of the arm (left or right) is correct or not. The position is not correct when the left arm reaches an object in right side and viceversa. In this sense, these input variables are defined by the fuzzy terms *"Correct"* and *"Incorrect"* in the domain $[-100, 100]$ (Fig. 8 and Fig. 9). Values are obtained following Eq. (4) and Eq. (5) respectively where position of the shoulders and hands are considered.

$$CorrectLeftArm = \frac{\sum_{i=1}^{n} \frac{SL_i.x - HR_i.x}{|SL_i.x - HR_i.x|}}{\mathrm{N}} \cdot 100 \qquad (4)$$

where $SL_i.x$ and $HR_i.x$ are the "x" coordinate of joint *"Shoulder Left"* and *"Hand Right"* for the object i respectively.

$$CorrectRightArm = \frac{\sum_{i=1}^{n} \frac{HL_i.x - SR_i.x}{|HL - i.x - SR_i.x|}}{\mathrm{N}} \cdot 100 \qquad (5)$$

where $SR_i.x$ and $HL_i.x$ are the "x" coordinate of joint *"Shoulder Right"* and *"Hand Left"* for the object i respectively.

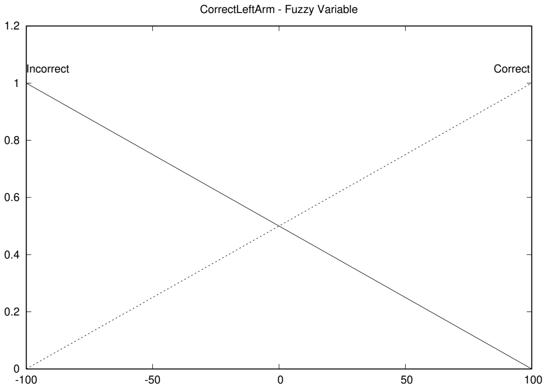


Fig. 8. Fuzzy Variable: CorrectLeftArm

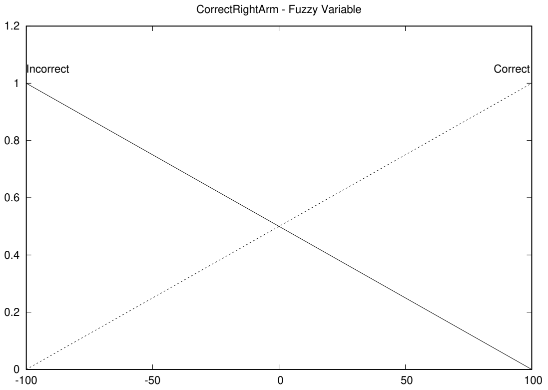


Fig. 9. Fuzzy Variable: CorrectRightArm

- $SuccessDegree$ represents the success degree of the activity from the point of view of the therapists. It is an output variable defined by the singleton fuzzy terms *“Null”*, *“Lo”*, *“Medium”* or *“Hi”* coded as 1, 2, 3 and 4 respectively.

B. Defining the Rule Base

Expert knowledge from the therapist in the form of rules is considered in order to evaluate the success of the activity. Specifically, 15 fuzzy rules have been defined. For the sake of simplicity, some of the rules are listed below although the XML file with the complete FRBS according to the IEEE std 1855-2016 can be downloaded from [1].

1) *IF PositionCamera IS Back THEN SuccessGrade IS Null*
2) *IF CorrectLeftArm IS Incorrect THEN SuccessGrade IS Null*

...

4) *IF PositionCamera IS Sideways AND CorrectLeftArm IS Correct AND CorrectRightArm IS Correct AND Score IS LoScore AND TimeSucess IS HiTime THEN SuccessDegree IS Low*

...

7) *IF PositionCamera IS Opposite AND CorrectLeftArm IS Correct AND CorrectRightArm IS Correct AND Score IS LoScore AND TimeSucess IS LoTime THEN SuccessDegree IS Medium*

...

15) *IF PositionCamera IS Opposite AND CorrectLeftArm IS Correct AND CorrectRightArm IS Correct AND Score IS HiScore AND TimeSucess IS LoTime THEN SuccessDegree IS Hi*

C. Some evaluation Results

In this subsection, some examples as games taking into account the Fuzzy Rule Base System defined in the previous section and the motor inference provided by the JFML library are shown.

1) Case 1: In this example game, the child was sideways and back to the camera. This position induces a negative value of *“PositionCamera”*. The rule 1 considers this situation so the *“SuccessDegree”* value must be *“Null”* coded with the value 1.

```
RESULTS
(INPUT): PositionCamera=-62.5, CorrectLeftArm=-21.6,
     CorrectRightArm=-19.8, Score=60.0, TimeSucess
    =42.6
(OUTPUT): SuccessDegree=1.0
```

Case 1. Game in which the child is back to the camera during a lot of time

2) Case 2: In this case, the majority of the objects has been reached crossing the arms, that is, with the hand which is not on the side of the object, as is shown in the negative values of the *“CorrectLeftArm* and *“CorrectRightArm* respectively. Hence, the rule 2 is fired and the output value is 1, which is the corresponding value for *“Null”* in *“SuccessDegree*.

```
RESULTS
(INPUT): PositionCamera=58.4, CorrectLeftArm=-22.4,
    CorrectRightArm=-21.3, Score=80.0, TimeSucess
    =46.7
(OUTPUT): SuccessDegree=1.0
```

Case 2. Game in which the child stays with crossed arm during a lot of time

3) Case 3: In this example, the child has been in a correct position, as is shown in the positive values of *“PositionCamera”*. Moreover, the objects have been reached with the correct hand, with positive values of *“CorrectRightArm”* and *“CorrectLeftArm”* variables. However, the child has reached few objects and the child has spent much time to reach the objects, as is shown with the values of *“Score”* and *“TimeSucess”* respectively. So, the rule 4 is fired and the value of *“SuccessDegree”* is *“Medium”* which is coded with the 2 value.

```
RESULTS
(INPUT): PositionCamera=100.0, CorrectLeftArm=100.0,
     CorrectRightArm=100.0, Score=20.0, TimeSucess
    =93.3
(OUTPUT): SuccessDegree=2.0
```

Case 3. Game which the position of the child has been good and the game has been slow

4) Case 4: In this case the child has developed a good game with a good position and reaching the objects in a correct way, as is shown in the values of the *“PositionCamera”*, *“CorrectLeftArm”* and *“CorrectRightArm”* variables. Also, all the objects have been reached in a few time, as is shown in the *“Score”* and *“TimeSuccess”* variables. Hence, taking into account the knowledge represented in the rule 15, the value of *“SuccessDegree”* is 4 which is the code of *“Hi”*.

```
RESULTS
(INPUT): PositionCamera=100.0, CorrectLeftArm=100.0,
     CorrectRightArm=100.0, Score=100.0, TimeSucess
    =20.0
(OUTPUT): SuccessDegree=4.0
```

Case 4. Game which has been well played

V. CONCLUSIONS

In this work, a new Java open-source software called JKinect, has been proposed. JKinect is born out of the necessity of providing a tool for designing and assessing activities for gross motor therapies on children with autism spectrum. This software provides a simple tool that can be used by therapists for the development of new activities in the rehabilitation of children with autism spectrum disorders which suffer from delays in the development of gross motor skills. The software has three modules, which could be used in an isolated way and it permits to go on with new modules with new necessities. The first module allows children to be visualized in a virtual environment to interact with different objects as a game. The second module collects information from the played games for tracking purposes. Also, this module allows generating and

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[1] http://www.uco.es/JFML

sharing new activities by configuring the visual elements of the game through XML files. This feature highlights due to experts can adapt any game to children's needs. The last module uses the JFML library to communicate JKinect with and in a simple way can generate fuzzy systems to provide decision support to the expert therapists and help them with their therapeutic tasks. As a study case, an with the aim of illustrate the benefits of JKinect in the treatment of gross motor activities in children with autism, four games were carried out. In these games, therapists used the all modules of JKinect software to design a particular activity and to incorporate expert knowledge as rules to evaluate the game. The results shown that JKinect is an intuitive and promising tool applying expert knowledge in the topic of children with autism. As future work, we propose to incorporate new modules in JKinect to automatically generate new customized activities for a child based on his/her evolution in the activities by incorporating machine learning techniques.

ACKNOWLEDGEMENTS

This work has been partially supported by the XXIV Own Program for Research Stay and the V Innovation and Transfer Program of the University of Córdoba.

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