TITLE PAPER

**ABSTRACT**

**CCS Concepts**

**• Information systems~Multimedia information systems   • Computing methodologies~Virtual reality • Information systems~Multimedia information systems   • Human-centered computing~Graphical user interfaces • Applied computing~Life and medical sciences.**

**General Terms**

Design, Experimentation, Performance.

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**Keywords**

Virtual Rehabilitation; Rare Diseases; Physical Therapy; Numbness; Tingling; Range-of-motion; Grip strength.

# INTRODUCTION

Definition of Rare Diseases (one paragraph)

Public and private health institutions have expressed the main objective "ensuring conditions in which people can be healthy," generating solutions if unexpected or persistent health problems or environmental factors appear that put large populations at risk.

Health institutions work with professionals from different areas to investigate the causes that put the lives and health of the populations at risk in order to prevent, mitigate or suppress the inconveniences generated. However, this action does not happen with the diseases known as rare, which affect few subjects and are dispersed in the world with a variety of disorders and symptoms due to genetic variations or to the stage of appearance in the subject.

Rare Diseases (RD), or "orphan diseases", are often serious, chronic and progressive diseases, they are named depending on the prevalence of the disease in each country. The European Union considers a rare disease if 1:2,000 subjects has that disease (Eurordis, 2014); in Norway 1:10,000 subjects have that diseases (Helsenorge, 2016); in Taiwan 1:10,0000 subjects (mediographic, 2015); in Italy 1:20,000 subjects (mediographic, 2015); in the United States 1:5.000 subjects (Cortés, 2015; Genetic and Rare Diseases Information Center, 2017a); in Japan 1:2,500 subjects (Cortés, 2015).

There are about 5.000 to 8.000 RD, 80% are of genetic origin and the difference is due to bacterial or viral infections, environmental factors or allergies ([Alonso, Hawrylak, & Gómez, 2010](#_ENREF_4); [Boycott et al., 2013](#_ENREF_26); [Institute of Medicine National Academies of Sciences, 2010](#_ENREF_108)). Those generate alterations in the performance of activities of daily living (ADLs). Despite their severity, some rare diseases are compatible with a good quality of life if diagnosed early and treated optimally [4].

Patients with rare diseases, in addition to facing the symptoms of their pathology, must experience the lack of knowledge and experience of clinical experts, adding the limitations of access to health systems and low availability of drugs ([Antiñolo & Lozano, 2010](#_ENREF_7)); this causes delays in diagnosis, inadequate treatment and even harmful treatment which could affect the subjects in their mental, behavioral and sensory abilities ([Budych, Helms, & Schultz, 2012](#_ENREF_29)).

The most common RDs are: Huntington's Disease, Spina Bifida, Fragile X Syndrome, Guillain-Barré Syndrome, Crohn's Disease, Cystic Fibrosis, Duchenne Muscular Dystrophy and Amyotrophic Lateral Sclerosis[5] (2017).

The most frequent RD in infants are Osteogenesis or Imperfect Osteogenesis, Phenylketonuria, Oculocutaneous Albinism, Acondroplasia and the least frequent is Encephalopathy [6].

Encephalopathy is a disease of the brain, which affects it structurally and functionally, including many age-related syndromes, with specific types of seizures and neurological characteristics. A subject with encephalopathy generally has 1) altered mental status; 2) decreased cognitive and intellectual ability; 3) lack of concentration; 4) involuntary muscle spasm; 5) rapid and involuntary eye movement; 6) tremors; 7) atrophy and/or muscle weakness; 8) dementia; 9) convulsions; and 10) loss of speech ability (Standen et al., 2015)

A particular type of encephalopathy is Epileptic Encephalopathy (EE) which has a panorama of genetic mutations (e.g., KCNQ2, SCN1A, SCN2A) associated with neurological disorders and epilepsies, which proliferate new types of rare diseases.

Subjects with EE have very frequent and severe seizures (Dulac, 2001; Nickels & Wirrell, 2017), which causes progressive brain dysfunction (Khan & Al Baradie, 2012), periods of regression in cognitive development (Berg 2010), mental and neurological deterioration at cognitive, sensory and/or motor level (Capovilla, Wolf, Beccaria, & Avanzini, 2013).

Brain dysfunction is a less serious disorder that causes learning issues in the children (dyslexia, dyscalculia, dysortography and dysgraphia), psychomotor disorders, disorders in cognitive processes (memory, reasoning and executive functions) and disorders of oral language [7].

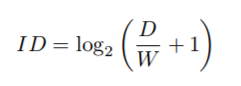
Memory loss causes Developmental Coordination Disorder (DCD). A subject with DCD experiences difficulties in the development of motor skills and deficits in spatial skills [8]

We are concerned about the effects of rare diseases; therefore, we developed an application (RARESPATIAL) in Unity with Leap Motion that supports the recovery of spatial skills (location and positioning) with order, constancy and fun. For application development we focus on the principles of Perfetti and Fitts Law.

Perfetti, also called Cognitive Therapeutic Exercise, is a rehabilitative method, which aims to activate cognitive processes in motor recovery, performing exercises with open eyes and closed eyes. This allows the recovery of perception, memory, language, etc., allowing the subject to relate to the outside world. This respects the progression of learning; therefore, its application has different levels of difficulty.

So, matching the movement limits and capabilities of humans with interaction techniques on computing systems is an important area of research in human‐computer interaction

The Fitts Law controls the limits of movement and human-computer interaction (HCI). It also states that the time required moving, acquiring or selecting a target with a pointer (e.g. mouse cursor, Leap Motion hand) is a function of the distance to the target (D) divided by the size of the target (W). These two geometric parameters are combined in the Difficulty Index (ID) [9], [10]

 (1)

The difficulty index is linearly proportional to the movement time (MT), the greater the distance and the smaller the size of the target, the more time it will take. According to its law, fast movements and small targets result in higher error rates, due to speed-precision compensation.[9]

 (2)

When comparing experimental conditions, measuring the human performance (TP) is recommended. This provides a single measure, the combination of speed and precision in reaching a target, averaging over the range of difficulty indices. The performance has the units of bits per second, analogous to the amount of information, and it is defined as the rate of difficulty over the movement time [9]

 (3)

The software strengthens the cognitive perception, accelerates the reaction of the knowledge of the spatial location, with levels of teaching-learning and validation or playability. The basic level with 2 panels (top-down or left-right), intermediate level with four panels (left-up, left-down, right-up, right-down) and the advanced level with 9 panels (left-up, left-down, right-up, right-down, left-center, right-center, up-center, lower-center and middle-center).

The application provides a teaching process, then a learning process and finally a process of verification of the learning level by interacting with the application through Leap Motion.

The software to interact in the teaching-learning process uses visual-auditory feedback and for the validation process uses auditory and tactile feedback in virtual environments.

In this article, we present the results of experimenting with learning spatial skills with healthy children ages 5 to 10. We intend to evaluate the effectiveness of the Fitts Law and Perfetti method and the performance of movement in virtual environments.

# RELATED WORK

Examples of Virtual Rehabilitation in patients with neurological disorders.

Examples of Virtual Rehabilitation in childhood with disorders (children with Cerebral Palsy, children with Autistic spectrum disorders, etc)

Técnica de perffeti con las 2 etapas que tiene, describiendo las 2 etapas, pasado en el correo de Sergio.

Rehabilitacion virtual donde se ha aplicado la técnica perfetti, pasados en el correo.

There are no studies of technological systems based on virtual Rehabilitation for children with epileptic encephalopathy by using the perfetti method.

# METHODS

## The Participants

1. Grupo de control de niños de 5 años. Grupo experimental de niños de 9 y 10 años (10 niños) Muestras independientes por tener edades diferentes. Niños sin ningún tipo de lession sin desordenes.
2. Analizar de la varianza ttest SPSS o R. Graficas de Barras percentiles
3. Reacción a nivel kinematico Tiempos de reacción, Tiempo para completar la tarea.
4. Memoria espacial a corto plazo.
5. Validar en base a la ley de Fitts. En función del grado de complejidad que quieres alcanzar un obejtivo, te custa mas ti
6. Los tiempos para completar una tarea son mayores en función dela edad de un niño.
7. seran

## The System

Our technological system is comprised of

## VR exercises

# PROCEDURE

Before the first session, the therapist tested all the participants

Figure 2. Participant using the system.

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# RESULTS

# DISCUSSION AND CONCLUSIONS

# ACKNOWLEDGEMENTS

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