



Virtual reality supported design and manufacturing suitable for use in hand and wrist function disorders

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ABSTRACT

Physical therapy and rehabilitation therapies are long-term results that require patience and stability. Therapies; depending on the region and degree of disorders can sometimes be painful and difficult. The design to be proposed with this study; it is designed to help patients who need physical therapy for hand and ankle discomforts more easily and in a fun way, which can be painful and boring. With the designed product, it is aimed to enable the patients to make the necessary movements in their homes. This design is intended to be made of lightweight material that can be worn on the hand and which does not interfere with movement. In addition to that, this design is planned to be used in conjunction with virtual reality environment including fine motor movements such as unlocking, holding small parts, needle threading and limited solutions in the literature and market. Supported by games developed on the base of Unity, physical therapy is expected to motivate patients, and patients are expected to adhere to treatment programs and to achieve more efficient results.

Introduction

While the opportunities and conveniences provided by technology are becoming more and more ingrained in our lives, it also brings some negativities with changing life cultures. Industry 4.0 is based on the fact that people obtain products by managing systems, automations and machines, which are not based on human power. Individuals who have acquired the culture of fulfilling their needs through information systems can unconsciously remove many vital functions that provide a healthy life, such as being active and benefiting from the sun. In addition to this, of course, people can experience physical damage that cannot be easily repaired in births, traffic and unexpected accidents. In patients with reduced mobility for any reason, patients may need to be treated in physical therapy centers to restore the lost movements. Physical therapy and rehabilitation treatments are processes that give long-term results and require patience and stability. Treatments; sometimes it can be painful and difficult, depending on the area and degree of discomfort.

In this study, it is aimed to design a solution that will help patients who need physical therapy for hand and wrist disorders to perform painful and sometimes boring rehabilitation treatments in an easier and more enjoyable way.

Our aim is to make physical therapy movements funny with the game that uses gloves which are worn on the hand, has sensor support and can be followed on a monitor with a wireless connection. With this design, the physical therapy process will be more enjoyable and the patient will be motivated for treatment.

In this design, it is aimed to develop a product for the discomfort, experienced in the hand and wrist regions that includes fine motor movements, which are not found in the examples in the literature and the market. To enable patients to perform fine motor movements; it is planned to present a virtual reality environment that includes movements such as unlocking with a key, holding small parts, threading a needle. With the help of this design, patients will be able to perform the necessary movements at home if they wish. It is aimed that the product planned to be developed will be suitable for both adults and pediatric patients.

It is aimed to offer a local product alternative to centers and patients with virtual reality-based treatment methods, instead of products which are imported with high budgets.

Material and Method

Proper use of hand and wrist disorders virtual reality aided physical therapy device

It is a priority to gain the qualifications that are not found in the literature and the market in the ailments experienced in the hand and wrist regions. It is aimed to produce a local product and offer a local alternative to the domestic market for the centers and patients that offer virtual reality-based treatment methods imported with high budgets.

The method to be followed in the development of the system can be explained as follows;

- The product to be developed should be aimed at both adult and pediatric patients,
- A product that covers fine motor movements should be developed,
- For patients to make fine motor movements; it is necessary to present a virtual reality environment that covers unlocking with a key, holding small parts, threading the needle,
- Must be cost effective,
- The material to be used should be durable, suitable for use in the clinical environment, cleanable, flexible enough to not prevent movement, it is considered to use an elastomer material that can meet all these features in production.

The working principles of the system can be explained as follows;

1. Sensor infrastructure to be used in the product;

- It should be in a structure that will not prevent flexion, extension, radial-ulnar deviation, pronation-supination movements and should also allow fine motor hand movements,
- At the joint points of DIP, PIP, MCP in four fingers; in the thumb, it should be at the IP, MCP, CMC joint points,
- It should be of the bending or flex sensors type and should allow transferring the joint angles to the computer.

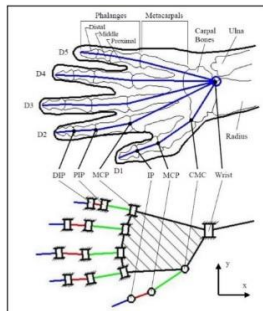


Figure 3. Display of joints where sensors should be placed

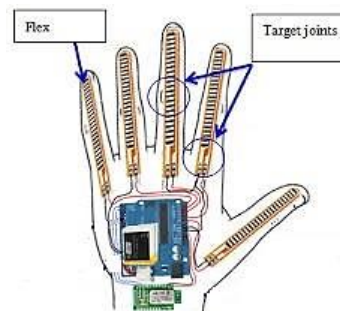


Figure 4. Placement of sensors.

2. The virtual reality infrastructure to be used in this design;

- Ability to process and interpret motion angles received from sensors,
- Having game options that will enable patients to perform fine motor movements in addition to the basic motor movements of the hand and wrist,
- Determining the number of sets required for each movement with the calibration process to be performed for the first use, specific to the patient,
- Comparing the movement angles of the patient with the movement angles of the healthy person currently kept in the database,
- It should include motivating elements such as taking the patients who perform the movements correctly and precisely to the next level.

3. In the reporting processes of the design;

- Graphical display of movement-based proficiency levels and completion times of the exercises performed,
- When the patient is online, it will be possible to send the daily status reports to the doctor by e-mail and to keep the patient under remote control.

Discussion

In this study, first of all, market research was conducted and the devices preferred in physical therapy and rehabilitation processes were examined. Then, a literature review was made and academic studies on the subject were examined. Findings are summarized as follows:

The working principles of “Rapael Smart Glove” can be explained as follows;

- Features a wearable technology on the hand,
- Bending Sensor infrastructure is available,
- The sensor is a 9-axis motion and position sensor consisting of 3 acceleration channels, 3 angular velocity channels, and 3 magnetic field channels that measure wrist movements,
- It has a wireless connection,
- It is made of elastomer material,
- Supports forearm supination/pronation, wrist flexion, extension, radial-ulnar deviation, finger flexion and extension movements, (Rapael Smart Glove Brochure, 2016)

The working principles of “Armeo@Spring” can be explained as follows;

- It can be applied in patients with stroke, multiple sclerosis (MS), spinal cord injury, cerebral palsy, subsequent brain damage, burning cases, recovery from humerus fracture,
- Can make an objective assessment,
- Increased performance feedback,
- Includes hand functions exercise,
- Has arm support,
- It has mechanical support.

The working principles of “Armeo@Senso” can be explained as follows;

- In addition to the features of the Armeo@Spring product, it is suitable for use at home with remote control after the first training given by a therapist. (Hocoma Armeo Brochure, 2018),
- There is a tool for the hand,
- There are 3 motion sensors on the wrist, elbow and chest.

In the literature review, it is noticed that;

- Different materials,
- Different sensor infrastructures are preferred,
- There are studies on the ailments experienced in different limbs,
- It has been observed that different physical therapy movements can be supported.

Conclusion

We aim to provide an enjoyable treatment opportunity for patients with neurological and orthopedic disorders in the hand and wrist region.

In addition, we want to diminish the amount of money used to import products by producing these innovative products domestically.

References

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- [2] Hocoma Armeo Brochure, (2019, February), URL: https://knowledge.hocoma.com/wp-content/uploads/2018/12/bro_ArmeoTC_ResearchBrochure_20190218_WEB-1.pdf
- [3] Hocoma Armeo Spring, URL: <https://www.hocoma.com/solutions/armeo-spring/>



Figure 5. Neofect Rapael Smart Glove [1]



Figure 6. Hocoma\Armeo@Spring [2]



Figure 7. Hocoma/Armeo@Senso [3]