

Audio Visual Hand Grip Trainer

Renuka singh¹, Deepika², Baljit kaur³, G.K Balaji⁴

^{1,2,3,4}Chitkara School of Health Sciences, Chitkara University, Punjab

Abstract - Hand grip plays a major role in activities of daily work and living. Various extrinsic and intrinsic factors influence Hand grip, Feedback through audio visual aids during practice plays a vital role in retaining hand grip strength during rehabilitation and thereby facilitating in the cortical reorganization. Available devices for hand grip training fails to consider audio visual feedback in retraining hand grip, in newly designed audio-visual feedback trainer for strengthening hand grip will be add on effective tool in the field of hand rehabilitation. The device is designed with a small ball pump and get inputs connected with an audio-visual display unit through the connecting tube. The newly designed audio-visual hand grip trainer will be an effective adjunct tool to improvise the hand grip strength for better daily functions.

Index Terms - Biofeedback, Audio-visual, Hand grip strength, Hand rehabilitation.

INTRODUCTION

Hand function has great significance for occupational performance, daily activities and sports the greater the difficulties with hand function, the impairment in skills get severely affected [1]. Hand grip and hand function rely on various extrinsic and intrinsic factors, the stability provided by the arches of the hand becomes mandatory for the mobility in hand to perform functions. The main types of hand grips are Baseball batter grip, Hammer grip, Precision grip (tip to tip), Lateral Prehension, Hook grip, Key grip, and Tripod (pen) grip [2]. The extrinsic factors which include environmental factors (ultraviolet radiation, chemical irritants), physical activities (work-related, recreational sports, and hobbies), nutrition, and traumatic injuries. And the intrinsic factors involves genetic factors, endocrine factors, metabolic disorders, diseases (osteoarthritis, rheumatoid arthritis, osteoporosis) beside soft tissues (muscles, tendons, blood vessels, nerves), hard tissues (bone, hyaline cartilage, fingernails) and other pathological changes. Cerebrovascular accident [3] Carpal tunnel syndrome,

Arthritis of hand, Postmenopausal women [4] Vibration devices, Osteoporosis, Hypothenar hammer syndrome & hand-arm vibration syndrome also show remarkable deficits in hand grip. [5]

There are few similar products such as Jamar Hydraulic Hand Dynamometer (JD), Jamar and Dexter, Jamar and baseline to measure hand grip strength by providing different features and facilities for measuring hand grip strength. The pressure dynamometer fails to emerge with audio -visual feedback and also consumes high cost [6]. Newly designed Grip Trainer device may provide effective strengthening through its audio-visual feedback mechanism. The device would be beneficial for the patients, suffering from auditory and visual impairments. This device will give auditory feedback to the visually impaired patients via means of different sounds and visual feedback to the auditory impaired patients in the form of different colored lights.

Hand grip strength is crucial to perform most of the daily functions. A significant audio -visual based hand grip trainer may be effective in various clinical practice settings and rehabilitation centers as an effective adjunct tool for both evaluating and retraining hand grip strength in the field of hand rehabilitation.

MATERIAL AND METHODS

Material Required:

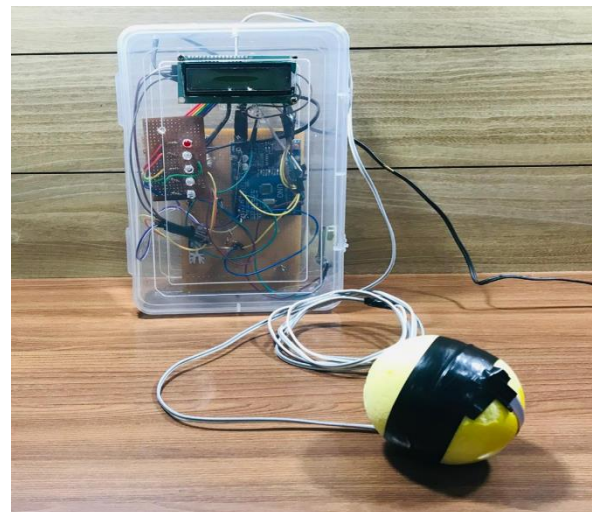
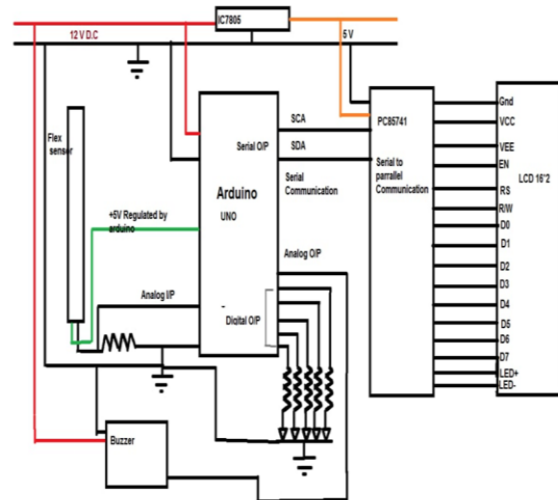
- Flex sensor 2.2':
It is a variable resistor whose terminal impediment increases when the sensor is contorted. It is a sensor that checks the proportion of shirking or bowing, and block of sensor segment is changed by bending the surface.
- LCD – 16 X 2:
The LCD works on the expedite modulating property of light. It has 16 areas and 2 lines, so it has 32 characters through and through and each character will be made of 5X8 pixel spots.

- **Voltage regulator 7805:**
Three terminal straight voltage regulator IC with a fixed output voltage of 5V. comprising of 3 pins data, ground and output.
1.Input (Pin -1)- A positive unregulated voltage is given to this pin.
2.Ground (Pin-2)- it is common to both input and output.
3.Output (Pin -3)-the output regulated 5V is taken at this pin of the IC
- **Resistor:**
It is a dormant electrical fragment to make impediment in movement of electric stream.
 $R=V/I$ Where, V = Voltage, I = current.
- **LED bulb:**
It is a semiconductor diode which ignites on supply of when voltage is applied.
- **Jumper wire:**
Also called jump wire is an electrical wire, with a connector or pin at each end, interconnected to the components of a breadboard or prototype or test circuit, internally or with other equipment or components, without fixture
- **Universal PCB:**
General printed sheets are normal for prototyping electronic circuits and for exploratory affirmation of circuit conceptualization.
- **Sponge ball [smiley ball]:**
Fragile ball not more than 7cm in diameter, which is compressed by hand and constrained by fingers.
- **Arduino uno:**
Open-source microcontroller board. The board is equipped with sets of cutting edge and straightforward data sticks interfacing to various expansion sheets and circuit.
- **Microcontroller:**
Devices to control the exercises and features of product. Input from the device administered by deviating signals to different parts of the body.

CONSTRUCTION

The voltage regulator, IC7805 is put in service to constraint the voltage in this device designing of the basic configuration was done by testing flex sensor 2.2" which measure the amount of deflection or bending and resistance of sensor elements is diversified by bending the surface. The material used

for testing the grip strength was a smiley ball which is at distance of 1 meter. The flex sensor is attached on it, along with that one microcontroller was also installed in order to restraint the action and provide the output to five LED's. SDA (Serial Datal) wire is employed to transient the data from Arduino uno to 5.LED's while, the application of SCL is for the synchronous clock in between Arduino to the PC85741 chip. also, it provides sound signal which is connected to buzzer. the buzzer sound also changes with respect to applied force that is displayed on 16*2 LCD screen. the spongy ball was placed in palmar surface.



MECHANISM OF WORKING

The working of circuit is dependent on angular bend of flex sensor. The resistance of flex sensor is changed when the flex sensor is bent. A potential difference

circuit is created by inserting a fix resistance in series with the flex route & voltage between the terminal of fixed resistance is mean as shown in circuit. When the subject is sitting on a chair, with his/her feet properly in contact with floor and asked him/her to squeeze the smiley ball on which the flex sensor is attached the resistance of the flex sensor changes depending upon the force applied the change in resistance is divided into 5 parts by the microcontroller. The microcontroller processes the signal and gives output to 5 LED's and it also gives sound signal which is connected to the buzzer, the sound of buzzer also changes with respect to applied force. The strength with which the patient/client will squeeze the rubber part of the device will determine the amount of lights glowing and production of sound. The frequency of sound is varied between 11 Hz-800Hz, And the applied force is also displayed on a 16X2 LCD screen.

PROCEDURE

The patient will be made to sit on a chair, with feet properly in contact with floor. A table will be placed in front of the patient on which apparatus for measuring grip strength will be placed, the height of the table should be adjusted according to the patient. The therapist will sit adjacent to the side which is to be strengthened/tested. Patients arm positioning will be demonstrated by the therapist, each subject will be instructed to place her/his left hand on her/his right thigh and assume a position of adducted and neutrally rotated shoulders. For the hand to be tested, the elbow was flexed to 90°, the forearm will be resting on the table and the subject will be asked to hold the ball in her/his hand and grasp it, and the fingers will be flexed as needed for a maximal contraction. Each subject will be instructed to breathe in through her/his nose and blow out through pursed lips as a maximum grip effort would be made. At this time, a verbal command of "Squeeze! Harder! Harder! Relax!" will be given by the therapist. All these instructions should be made loud, clear and given before starting. The strength with which the patient/client will squeeze the ball of the device will determine the amount of lights glowing and production of sound. If the patient would apply 50% of his/her strength then 50% lights of the device would glow and 50% of sound would be heard. While the patient/client is squeezing the rubber part of the device the therapist should instruct the patient/client to

"squeeze the rubber part as hard as possible" with his/her full strength.

DISCUSSION

The aim was to contrive a cost efficient, therapist friendly and portable audio-visual hand grip trainer. Audio-visual hand grip trainer is a mechanical device construct to setback the drawbacks emerged from the present available mechanical Jamar Hydraulic Hand Dynamometer (JD) [7], Jamar and Dexter, Jamar and baseline to measure hand grip strength by providing different characteristic and potential for measuring hand grip strength. The pressure dynamometer fails to emerge with audio feedback and it is also highly expensive. [6] Hand Grip strength is reported to be an important predictor of dexterity. [8] The potentiality of human hand to assure a myriad of position and to apply only the precise amount of pressure necessary to hold an object is owned to the mobility and stability supplied by the skeleton. [9]

Biofeedback therapy is an instrument-based learning process that is based on operant conditioning techniques. Which involves using visual, physical and/or auditory feedback to guide the patient to give their optimal performance. Feedback on correct motor performance enhances motivation, while feedback on incorrect exercise performance is more effective in facilitating skill improvement. Feedback from any skill performance is acquired through task-intrinsic feedback mechanisms and task-extrinsic feedback. Task-intrinsic feedback is provided through tactile visual, proprioceptive and auditory cues to a person who performs the task. Task-extrinsic feedback or augmented feedback includes verbal encouragement, charts, tones, video camera material, computer generated kinematic characteristics.[10] Neurostimulation techniques can induce neural plasticity making it possible for cortical reorganization, motor recovery in patients, improvement of cognitive functions and transfer of spatial knowledge in the everyday living environment.[11]

The audio-visual hand grip trainer is effectual in measuring hand grip strength. Newly designed Grip Trainer device may provide effective strengthening through its audio-visual feedback mechanism. The device would be beneficial for the patients with visual and audio impairments. This device will give auditory

feedback to the visually impaired patients through means of different sounds and visual feedback in the form of different colored lights. Hand is the primary piece of our body and is utilized for exercises of daily living activities such as eating, dressing, bathing and activities in various Occupations. The newly developed Audio-Visual Hand grip Trainer will be a beneficial adjunct tool in the field of Hand Rehabilitation for gaining functions with audio-visual feedback mechanism providing an effective motor-learning to the patients and strengthen the neural plasticity and cortical reorganization circuits in the brain.

Declaration of Interest Statement: no conflict of interest

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