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Distance Measuring Device Over Body Surface

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Nerve conduction studies help to diagnose muscle and nerve diseases and point to the underlying cause and potential treatments. Conduction studies involve stimulating nerve at different points along its course and recording the response with an electrode, conduction velocity is determined by dividing the distance traveled by the time it takes the impulse to travel that distance. While the measurement of time is done electronically and is very accurate, measurement of distance in every commercial laboratory is done by marking the skin and measuring the distance with a flexible tape measure. Such distance measurement is highly error prone and leads to erroneous results and misdiagnosis. We present a device to measure distances along the body surface. It eliminates examiner error in the measurement of distance. It delivers an operator-independent and reproducible measurement and thereby increases accuracy of test results and avoids misdiagnosis. Furthermore, the device saves a significant amount of time. Stopping to pull out a tape measure, reading it and entering the data into the computer, all adds time to the length of the procedure. The measurement device eliminates these steps thereby increasing efficiency. It also transmits the measured distances directly to the computer, thus eliminating error in data entry. The device uses the established optical mouse technology at its core. It can measure displacements with a 0.0635 mm resolution. It is based on a commercial chip set, ADNS-5030 from 'Avago Technologies.' The system consists of an optoelectronic sensor which measures changes in position by optically acquiring sequential skin surface images (frames) and mathematically determining the direction and magnitude of movement. The sensor only needs to be pointing at but not touching the skin. The main advantage of this approach is that it is contactless, eliminating the need for disinfection. Although, current limitation of the device is in measuring accurately over non-planar surface due to its considerably large size making it difficult to maneuver over bumpy surfaces. Initial results for measurement studies performed over a diverse subject pool (in terms of skin color, hair density) results are promising with an error less than 9% for distances over 75 mm. A reduction in size of the device would lead to more accurate results as smaller size would help in easy maneuverability. Future implementations will exploit the contactless feature and integrate the measurement in the stimulus probe, reducing testing time and the need to operate multiple devices.

Exoskeleton Solutions to Bone and Muscle Atrophy Within Microgravity Environments

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Weakening of muscle and bone tissue after merely a week of exposure to a microgravity environment has been demonstrated to adversely affect the physiological health of astronauts . Innovative solutions meant to replace traditionally bulky resistance-based devices are highly sought by burgeoning private space travel companies as well as other ambitious spaceflight programs that require a robust and effective solution for long durations in microgravity . The purpose of this study is to explore the unique contributions of exoskeleton technology in providing an effective, compact and elegant preventative device through assessing the current ability of exoskeleton technologies in stressing the body, formulating design requirements of an exoskeleton device and highlighting the areas of exoskeleton development that require further work in the realization of a robust microgravity-atrophy solution. An understanding of the abilities and shortcomings of current exoskeleton technologies is necessary to develop and streamline advanced forms of today's space physiological devices . The physiologically familiar structure of an exoskeleton, being built around the human form, would also provide for a greater degree of compactness, affecting everything from launch expenses to living arrangements in any space module. A more effective and persistent method of stressing the body will ultimately allow for a drastic decrease in bone and muscle atrophy, requiring less therapy should any space traveler return to a gravity environment as well as preventing various related ailments during their time in space. In conducting the study, a literature search was performed to identify fundamental design parameters. Designs were then formulated to best fit the required design specifications with difficult or absent features being noted. Initial design concepts based on traditional resistance-based solutions were also developed to further characterize the particular requirements that an exoskeleton would be required to fulfill. These design concepts were then steadily revised into a potential force generation mechanism and device architecture based on factors including human comfort, force generation, effective ranges of motion, materials and geometry. An appraisal of current exoskeleton technology in actualizing the proposed designs and design specifications provides a basis for analysis. The study has uncovered the strong points in exoskeletal designs as well as the major hurdles that, once crossed, will allow exoskeletal technologies to be a viable application in bone and muscle therapies, both in microgravity environments as well as gravity environments. A large hurdle lies in current exoskeleton technologies still utilizing bulky components but past trends have demonstrated a reliable miniaturization in the technology. Particularly important exercises and ranges of motion have been identified and initial designs formulated based on the physiological requirements. The study has demonstrated the need for more efforts in formulating innovative solutions to space-based physiology problems as well as explicitly listing design parameters required for any potential exoskeleton solution.

