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Editorial

The Use of Motion Capture Technology to Aid in the Reduction of Injuries in the Work Place

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EDITORIAL

The traditional ergonomic evaluations have relied heavily on observation of the task in question. This has either been onsite or via video. While it has always been preferred to perform the evaluation on site, sometimes it is not practical. In this case, video is the only option. There are many disadvantages to using video recording of the task, one being it is one dimensional. Physiological movements are multi planar and not captured as such on video, making it difficult to do a thorough analysis. Having done numerous ergonomic evaluations over the past two and a half decades, I have done some video recorded evaluations and they are far from optimal. It has only been in the past several years with the advancement of wireless motion capture technology that has made video recorded work tasks superior to on-site observation.

Over the last twenty years, there have been significant strides in wireless motion capture technology. What is at the heart of this technology? Maybe it would be more accurate to ask, what is at the SURFACE of this technology? It is miniature MEMS inertial sensor technology. Micro-Electromechanical System (MEMS) is a micro sized machine that has both mechanical and electronic components. This miniaturization can range from several millimeters to just shy of one micrometer (slightly less than the diameter of a human hair). These sensors are divided into two types; accelerometers and gyroscopes [1].

MEMS inertial accelerometers (available in 1D, 2D, and 3D versions) consist of a mass-spring system within a vacuum. During acceleration of a limb (picking up a box, for instance) on the accelerometer, there will result in a displacement of the mass in its mass-spring system. MEMS gyroscopes have a tiny vibrating mass that oscillates, for example, at tens of kHz and the mass is suspended in a spring system. When the gyroscope is rotated, the rotation exerts a perpendicular force to the direction of motion and to the axis of rotation. This force on the mass is larger when the mass is further away from the center of rotation. The oscillating mass receives a different read-out on either side of the oscillation, thus registering a measure for the rate of turn [2].

Combing a trio of gyroscopes and a trio of accelerometers into a self-contained system that measures linear and angular motion is called an Inertial Measurement Unit (IMU). An IMU can either be pivoted or rigid support, giving the output of the integrating quantities of angular velocity and acceleration (referred to as the rate-integrating gyroscopes and accelerometers) in the body frame (as in the above example, of the arm with picking up a box). The IMU quality is not only affected by the sensing elements within it, but also by the quality of the signal processing pipeline. This pipeline consists of 3 pieces: sampling (high frequency), a meticulously designed digital low pass filtering, application of the calibration model and Strap down Integration (SDI) at 2 kHz. SDI determines the current position from an initial position using measurements of angular velocity and specific force obtained by the inertial sensor. When this entire signal processing pipeline is designed properly, the data will have a high fidelity. This high fidelity makes for extremely accurate descriptions of movements, thus better precision with regards to measured body motions during the observed task. The recorded data can lead to clues at what point during which motion there may be deleterious effects on the body [3].

The digital recording of human movement is the essence of motion capture technology. This movement data is retrieved in either of two methods; wireless sensors (IMU) which are fitted on the body with adjustable straps, or are fitted (wired IMU) on the body with a Lycra (or similar material) suit. The adjustable straps each contain a battery with a life of about 6 hours and can be fitted to whichever joint is being analyzed. A series of joints can be analyzed wirelessly at one time, up to about 20 joints. The set up time is about 10 minutes and the wireless indoor range is 20 meters and outdoor range is 50 meters. The suit contains a single battery with a life of 9.5 hours and has about 20 wired sensors with on body recording. The set up time is also about 10 minutes with the wireless indoor range of 50 meters and outdoor range is 130 meters. Both methods offer wireless data link. The suit collection method allows for more accurate data recording and broader recording range. There are also gloves that allow for finger motion tracking.

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The software programs available offer real-time data streaming, 3D animation, video, as well as graphs. This output supports segment kinematics (including angular velocity), segment global positions, joint angles, and substantial sensor data. There is also a built-in time code and remote control plugins, handling data rates at high speeds, and exports this data to various formats. This enables significant flexibility in data analysis of work task data. Some software programs also utilize GPS technology, thus enabling the tracking of users partaking in activities that do not feature defined foot/floor contact such as, driving forklifts, machine repair or maintenance, or operating cranes, etc. These programs also feature; a scalable biomechanical model, allowing up to several hardware setups, and support different calibration routines.

While the technological aspects are quite impressive, what about accuracy in ambulatory settings, such as the workplace? A plentitude of research findings indicate that measuring shoulder, elbow, and lower limb kinematics, during the tasks tested in ambulatory settings, as being very accurate. The set up process for use in the workplace requires either use of Wi-Fi or WPS. The body pack has an optional USB connection to have the Wi-Fi downloaded to the body pack on the suit or WPS can be used for multiple IMUs as in the use of the straps. The calibration is applied to the software with the worker standing in an erect posture and then walks for about 10 seconds to initialize the software motion capture engine. This enables the software to give readings on joint position, angular velocity, etc. Once the calibration is done, the transmitter from the body pack is connected to the Wi-Fi at the location. Worker body dimensions are put into the computer for the most accurate readings and your ergonomic evaluation is ready to begin. There is even an antenna that can be plugged in to the body pack for remote recordings utilizing GPS technology. This feature allows for analysis of delivery drivers, yard workers, etc. The use of the antenna requires a magnetic calibration to locate true north [4].

Once the worker begins with the work task, digital recording begins and body mechanics are analyzed. This information can also be processed through various software programs to give spinal loading data, simulation, analysis, and validation of human interactions with industrial environments via Virtual Reality (VR), angular velocity levels at various joints to determine if this velocity at the joint is excessive, and other important data to allow for work task modifications to reduce the likelihood of injury.

Overall, this technology enables 3D animated, real time data analysis that can be processed through various software programs to give highly detailed information to help improve the safety of the worker by refining the ergonomics of the task. It also does this with such precision that adjustments can be made for each worker on the same task since individual worker body dimensions are inputted into the system. This feature allows for determining if a particular worker can safely manage the task, even with ergonomic adaptations. The same worker's data can also be put into prerecorded files of other work tasks to see if he or she could perform that task safely.

It is this type of video recording that takes observation beyond just visual to data analysis comparison to safe, validated ergonomic parameters, as was never possible before. The possibility of ergonomic analysis of the entire work force at a manufacturing facility is now available. This analysis can even be done periodically to monitor workers over time to determine if they are maintaining proper biomechanics during the work task, since the worker's data is stored for each particular work task. The ease of use, including wireless data transmission and quick set up of sensors, make for an affordable solution in the fight to reduce MSDs and joint injuries in the workplace.

REFERENCES

1. Cutti AG, Giovanardi A, Rocchi L, Davalli A, Sacchetti R. Ambulatory measurement of shoulder and elbow kinematics through inertial and magnetic sensors. Med Biol Eng Comput. 2008;46(2):169-178.

2. Lebleu J, Gosseye T, Detrembleur C, Mahaudens P, Cartiaux O, Penta M. Lower limb kinematics using inertial sensors during locomotion: Accuracy and reproducibility of joint angle calculations with different sensor-to-segment calibrations. Sensors (Basel). 2020;20(3):715.

3. Lebel K, Boissy P, Nguyen H, Duval C. Inertial measurement systems for segments and joints kinematics assessment: Towards an understanding of the variations in sensors accuracy. Biomed Eng Online. 2017;16(1):56.

4. Kobsar D, Charlton JM, Tse CT, Esculier JF, Graffos A, Krowchuk NM, et al. Validity and reliability of wearable inertial sensors in healthy adult walking: A systematic review and meta-analysis. J Neuroeng Rehabil. 2020;17(1):62.