Prediction and Mitigation of USAF Aircrew Injurious Postures

Biomedical Engineering

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Context

Helicopter pilots are often exposed to pain and discomfort due to poor posture during flight. This condition, known as helo hunch, can lead to long term injury to the neck and lower back. In order to mitigate these effects on pilots, changes must be made to the cockpit or the flying techniques used in the air. Changes cannot be made until the posture of the pilots is quantified and analyzed to determine what is causing this unwanted condition.

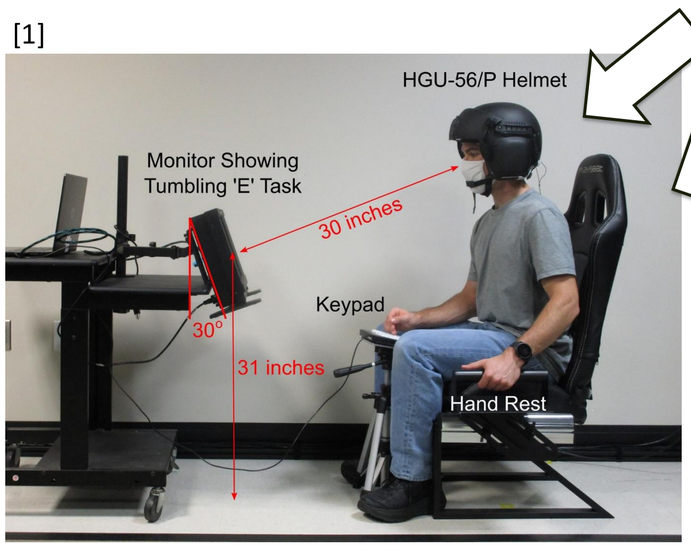
Problem Statement

The team will design a method or product that allows Department of Defense (DoD) engineers to assess and quantify the postures of aircrew members in a manner that could help in finding a solution to helo hunch.

Helmets and NVGs increase tension on the neck

Bent forward seating leaves spine in an unnatural position

[1]



Fatigue and Chronic pain…

How can we quantify the posture data?

Design Approach

The team selected the combined use of MATLAB and the Xsens system as the final design approach to improve pilot safety. Pilot posture is able to be tracked during the entire flight using the Xsens system. The posture is then analyzed using the MATLAB code that utilizes the Rapid Entire Body Assessment (REBA). The graphical user interface within the MATLAB program displays the maximum joint angles required to fill out the REBA scorecard. Plus, it breaks down all the joint scores, including adjustments. With the easy-to-use interface, you can upload a single Excel file (CSV) generated from the Xsens software to begin determining the risk of musculoskeletal disorders.

[2]

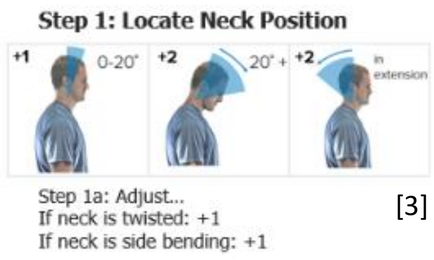
\+ MATLAB

=

User Friendly Compatible with Excel
Real-time Data Capture

Results

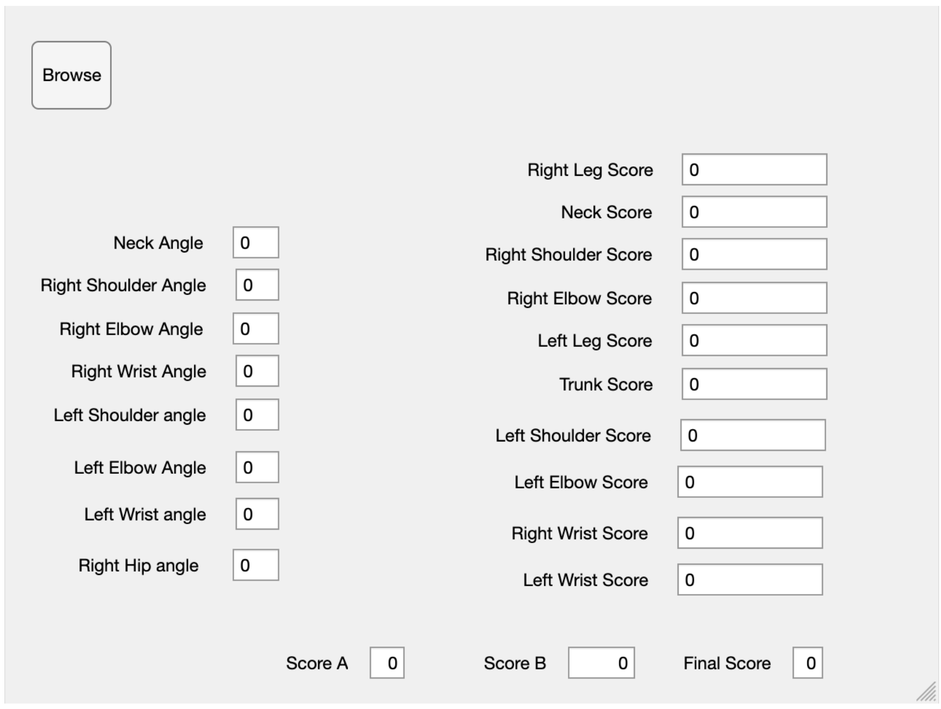
Below shows how the score are taken for the neck. If the joint angle is between 0-20º, the score is a +1. Anything above 20º or below 0º is a +2. If the neck is in any way twisted or bent, an additional point is added to the neck score. The REBA scorecard has criteria like this for each of the body parts, as well as some other adjustments.



[3]

If the final REBA score is equal to 1, then the position is acceptable and the risk is negligible; if the score is between 2 or 3 the posture has a low risk and may need changed; if the score is between 4 and 7, then the posture has a medium risk and will need to be changed soon after further investigation; if the final score is between 8 and 10, there is a high risk of musculoskeletal disorders and the posture must be investigated and changes; finally, if the score is 11 or higher the risk of musculoskeletal disorders is very high and a change must be made.

Results (continued)



The code we created uses the REBA test criterion and outputs scores for each body part (legs, arms, trunk, and neck). The maximum joint angles, the individual scores, the A, B, C scores, and the final REBA score are shown in the graphical user interface.

Conclusions

By using Xsens and MATLAB, a code was created that utilizes the REBA scorecard technique. After gathering joint angle data with Xsens system, an excel file is saved and imported into the MATLAB code. The code outputs REBA scores for each body part (legs, arms, trunk, and neck), as well as a final REBA score. Having these scores readily available within the code is imperative when attempting to make pilots aware of which body part has the most potential for injury so they can adjust.

Score	Level of MSD Risk
1	negligible risk, no action required
2-3	low risk, change may be needed
4-7	medium risk, further investigation, change soon
8-10	high risk, investigate and implement change
11+	very high risk, implement change

[3]

The code may be a huge step towards finding a solution such as redesigned seating, better NVGs and head gear, or even a newly designed cockpit. Helicopter pilots and other professionals who spend a significant amount of time using electronic devices should be educated about the risks associated with helo hunch and should be encouraged to take steps to prevent or manage this condition.

About the Presenters

We are all members of the college of engineering at Wright State University. We are currently all seniors studying biomedical engineering.

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References

[1] P. Le, “Exploring the Interaction Between Head-Supported Mass, Posture, and Visual Stress on Neck Muscle Activation,” *Sage Journals*. [Online]. Available: https://journals.sagepub.com/doi/full/10.1177/00187208211019154.
[2] D. Hardawar, “Xsens body suits are getting even better at motion capture,” *Engadget*, 13-May-2021. [Online]. Available: https://www.engadget.com/2017-06-17-xsens-motion-capture.html.
[3] M. Middlesworth, “A step-by-step guide to the reba assessment tool,” ErgoPlus, 27-May-2022. [Online]. Available: https://ergo-plus.com/reba-assessment-tool-guide/.