Project Plan Proposal

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Our project focuses on using computer vision to develop an algorithm to automatically assess surgical ergonomics via the ROSA (rapid office strain assessment) and RULA (rapid upper limb assessment) protocols. ROSA focuses on the overall posture of individuals in a seated position while RULA focuses solely on the position of the upper limbs. Our team members are Eric Han and Boyoung Zhao, and our mentors are Max Li, Dr. Deepa Galaiya, and Dr. Eric Formesiter.

Surgical procedures often require the adoption of long hours of awkward body postures combined with static muscular loads. These factors can contribute to increased compressive, shear, and tensile forces on musculoskeletal tissues, which can severely impact physiological health in the long term. For example, jobs that require neck flexion greater than 15 to 20 degrees are associated with tension myalgia.[1] Also, observational posture studies indicate that surgeons spend >50% of their time in the operating room with head in flexion, thus increasing their risk for musculoskeletal disorders of neck.[2] Not only do individuals need to be aware of their posture during surgical operations, but corporations themselves can be negatively impacted as well. Suboptimal working postures are associated with poor work efficiency, which can impact costs and patient safety. In fact, back pain alone costs U.S. employers $7 billion per year in lost work days and productivity.[3] On the other hand, an optimized surgical setting has been shown to improve task efficiency and performance, while maintaining the health of the workers. This is why it is of utmost importance to safely monitor workplace ergonomics and be well informed of the dangers of bad posture. Having an automated ergonomic assessment system in place at work will very much help with this task.

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[1] (Ariens GAM et al. Occup Environ Med. 2001)
[2] (Kant IJ, Int Arch Occup Environ Health, 1992)
[3] (EHS Today, 2017)

Our approach is to use MATLAB code to implement a human pose estimation algorithm that will essentially transform the human body into a “stick-figure” like frame. Using this frame, we can closely approximate the positions of the body and calculate the orientation in 3D space. From these calculations, we can find all of the essential angles of the body and limbs according to the RULA and ROSA worksheet and finally return a numeric value that informs the user if any change is required to his or her posture.

Our minimum deliverable will be a MATLAB software that computes the RULA and ROSA scores given a simple picture. Our expected deliverable will be the same software but instead will be capable of processing video footage and returning the scores. Our maximum deliverable will be able to return text feedback based on statistical analysis about any prolonged positions where the REBA score would be too high.

The timeline for our project would be having the human pose estimation software successfully working on a frame of test data by March 4th. Before that, we would review the literature listed below and also make sure we understand the human pose estimation software package. We would be able to calculate all required angles by March 11th. By March 16th, which is the day of our checkpoint presentation, we would be able to compute basic RULA and ROSA scores on a picture. However, this score may or may not be accurate and we will not be able to say that we can calculate scores for all pictures. By March 25rd, we should meet our minimum deliverable. By April 5th, we should be able to input basic videos into our program and calculate all angles. By April 15th, our program should meet our expected deliverable. From April 15th to the day of our presentation, which is on May 6th, we will be working to fix any remaining issues and attempting to construct our max deliverable. Assigned responsibilities will be Eric focusing on the MATLAB code and Boyoung on the methodologies and analytical aspect of the project.

The first dependency is the computer vision toolbox, which we must need in order to analyze medical videos as it  provides algorithms, functions, and apps for designing and testing computer vision, 3D vision, and video processing systems. Resolving this dependency will include re-installing MATLAB with this toolbox and understanding the intricacies of the functions. The human pose estimation package software is another dependency, which we need in order to transform human body orientation into “stick-figures”. Resolving this dependency will require finding such a package and then analyzing the code behind it as well as the deep-learning methods used to construct the code. Of course, we also have to rely on the medical images and videos provided by Dr. Galaiya and Dr. Formesiter. If these images and videos are not given to us, we will have to rely on recording our own videos and images and using this as test data. Another dependency is the wrist orientation. Since ROSA and RULA both look at wrist orientation, we have to calculate the precise angle of the wrist in every frame. However, after discussing this matter with our mentors, we decided that this is both unnecessary and unfeasible due to the fact that surgeons do not rotate their wrists in the manner shown and that the gowns often cover up the wrist. To resolve this dependency, we will assign a score of +1 if the wrist is supported and +3 if the wrist is not supported. The gowns also lead to another dependency, which is that we cannot accurately find the angles of the torso and limbs if the gowns are too baggy and cover up the exact location of the body. To resolve this dependency, we most likely need to have the surgeons either wear tighter gowns or perhaps wrap some sort of rubber band around their waist, arm, and thigh area. The positioning and number of cameras is a dependency because the assessment scores will vary based on where the camera is located. For example, if there is only one camera located on the left side of the surgeon, strains on the right forearm or right leg of the surgeon may not be factored in the assessment. However, it is unrealistic to have cameras on both sides since we were informed by Dr. Formeister that there is often medical equipment in the way. To resolve this dependency, Dr. Formeister suggested we can strap a small camera to the equipment if we notice that data from left and right side cameras significantly differ. Our last dependency is the ROSA and RULA worksheets, which we can find on the internet.

Our plan for managing this project is to set up meetings weekly with Dr. Galaiya and Dr. Formeister starting next Wednesday at 4:00 pm EST. With regards to the technical aspect, we will consult Max Li for any input regarding MATLAB coding issues and difficulties resolving any bugs or obstacles. In addition, we will both meet via voice chat and screen share during coding so that we can both contribute equally to the assignment.

Our reading list includes


- Jóźwiak Z, Makowiec Dąbrowska T, Gadzicka E, Siedlecka J, Szyjkowska A, Kosobudzki M, Viebig P, Bortkiewicz A. Zastosowanie metody ROSA do oceny obciążenia układu mięśniowo-szkieletowego na komputerowych stanowiskach pracy [Using of the ROSA method to assess the musculoskeletal load on computer workstations]. Med Pr. 2019 Dec 3;70(6):675-699. Polish. doi: 10.13075
- Davudian-Talab, Amirhossein & Azari, Gholamreza & Badfar, Gholamreza & Shafeei, Asrin & Derakhshan, Zainab. (2017). Evaluation and Correlation of the Rapid Upper Limb Assessment and Rapid Office Strain Assessment Methods for Predicting the Risk of Musculoskeletal Disorders. Internal Medicine and Medical Investigation Journal. 2. 155. 10.24200.
- Namwongsa S, Puntumetakul R, Neubert MS, Chaiklieng S, Boucaut R (2018) Ergonomic risk assessment of smartphone users using the Rapid Upper Limb Assessment (RULA) tool. PLoS ONE 13(8): e0203394.
- Rodrigues, Mirela Sant'Ana et al. 'Differences in Ergonomic and Workstation Factors Between Computer Office Workers with and Without Reported Musculoskeletal Pain'. 1 Jan. 2017.
- AIP Conference Proceedings 1883, 020034 (2017); https://doi.org/10.1063/1.5002052 Published Online: 14 September 2017

- Dabholkar, Twinkle Yogesh et al. “Objective ergonomic risk assessment of wrist and spine with motion analysis technique during simulated laparoscopic cholecystectomy in experienced and novice surgeons.” Journal of minimal access surgery vol. 13,2 (2017): 124-130. doi:10.4103/0972-9941.195574
- Gómez-Galán, M.; Callejón-Ferre, Á.-J.; Pérez-Alonso, J.; Díaz-Pérez, M.; Carrillo-Castrillo, J.-A. Musculoskeletal Risks: RULA Bibliometric Review. Int. J. Environ. Res. Public Health 2020, 17, 4354. https://doi.org/10.3390/ijerph17124354