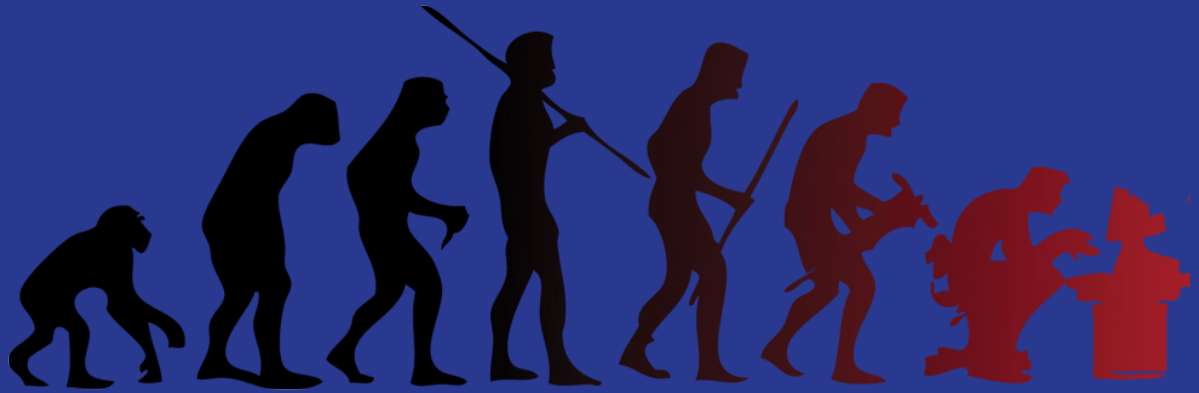
Automatic Assessment of Surgical Ergonomics - Checkpoint Presentation (Group 17)



Project Summary

- Using Intel RealSense D415 and Cubemes SDK, find all essential angles from this estimate, apply ROSA and RULA algorithms
- Ultimately output analysis of how long an individual is in danger zones, scores for each

RULA

RULA Employee Assessment Worksheet

Task Name: Date:

A. Arm and Wrist Analysis

Step 1: Locate Upper Arm Position:

Step 1a: Adjust...
If shoulder is raised: +1
If upper arm is abducted: +1
If arm is supported or person is leaning: -1

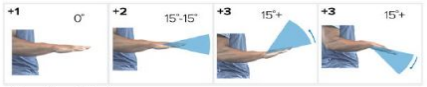
Upper Arm Score

Step 2: Locate Lower Arm Position:

Lower Arm Score

Step 2a: Adjust...
If either arm is working across midline or out to side of body: Add +1

Step 3: Locate Wrist Position:



Step 3a: Adjust...
If wrist is bent from midline: Add +1

Step 4: Wrist Twist:
If wrist is twisted in mid-range: +1
If wrist is at or near end of range: +2

Wrist Twist Score

Wrist Score

Step 5: Look-up Posture Score in Table A:
Using values from steps 1-4 above, locate score in Table A

Posture Score A

Step 6: Add Muscle Use Score
If posture mainly static (i.e. held>1 minute),
Or if action repeated occurs 4X per minute: +1

Muscle Use Score

Step 7: Add Force/Load Score
If load < 4.4 lbs. (intermittent): +0
If load 4.4 to 22 lbs. (intermittent): +1
If load 4.4 to 22 lbs. (static or repeated): +2
If more than 22 lbs. or repeated or shocks: +3

Force / Load Score

Step 8: Find Row in Table C
Add values from steps 5-7 to obtain Wrist and Arm Score. Find row in **Table C**.

Wrist & Arm Score

Scores

Table A

Upper Arm	Lower Arm	Wrist Score 1 Wrist Twist 1	1 2	2 Wrist Twist 1	2	3 Wrist Twist 1	2	4 Wrist Twist 1	2
1	1	1	2	2	2	2	3	3	3
	2	2	2	2	2	3	3	3	3
	3	2	3	3	3	3	3	4	4
2	1	2	3	3	3	3	4	4	4
	2	3	3	3	3	3	4	4	4
	3	3	4	4	4	4	4	5	5
3	1	3	3	4	4	4	4	5	5
	2	3	4	4	4	4	4	5	5
	3	4	4	4	4	4	5	5	5
4	1	4	4	4	4	4	5	5	5
	2	4	4	4	4	4	5	5	5
	3	4	4	4	5	5	5	6	6
5	1	5	5	5	5	5	6	6	7
	2	5	6	6	6	6	7	7	7
	3	6	6	6	7	7	7	7	8
6	1	7	7	7	7	7	8	8	9
	2	8	8	8	8	8	9	9	9
	3	9	9	9	9	9	9	9	9

Table C

Wrist / Arm Score	Neck, Trunk, Leg Score 1	2	3	4	5	6	7+
1	1	2	3	3	4	5	5
2	2	2	3	4	4	5	5
3	3	3	3	4	4	5	6
4	3	3	3	4	5	6	6
5	4	4	4	5	6	7	7
6	4	4	5	6	6	7	7
7	5	5	6	6	7	7	7
8+	5	5	6	7	7	7	7

Scoring (final score from Table C)
1-2 = acceptable posture
3-4 = further investigation, change may be needed
5-6 = further investigation, change soon
7 = investigate and implement change

RULA Score

B. Neck, Trunk and Leg Analysis

Step 9: Locate Neck Position:

Neck Score

Step 9a: Adjust...
If neck is twisted: +1
If neck is side bending: +1

Step 10: Locate Trunk Position:

Trunk Score

Step 10a: Adjust...
If trunk is twisted: +1
If trunk is side bending: +1

Step 11: Legs:
If legs and feet are supported: +1
If not: +2

Leg Score

Neck Posture Score	Table B: Trunk Posture Score 1 Legs 1	2	2 Legs 1	2	3 Legs 1	2	4 Legs 1	2	5 Legs 1	2	6 Legs 1	2
1	1	3	2	3	3	4	5	5	6	6	7	7
2	2	3	2	3	4	5	5	5	6	7	7	7
3	3	3	3	4	4	5	5	6	6	7	7	7
4	5	5	5	6	6	7	7	7	7	8	8	
5	7	7	7	7	7	8	8	8	8	8	8	
6	8	8	8	8	8	8	8	9	9	9	9	

Step 12: Look-up Posture Score in Table B:
Using values from steps 9-11 above, locate score in Table B

Posture B Score

Step 13: Add Muscle Use Score
If posture mainly static (i.e. held>1 minute),
Or if action repeated occurs 4X per minute: +1

Muscle Use Score

Step 14: Add Force/Load Score
If load < 4.4 lbs. (intermittent): +0
If load 4.4 to 22 lbs. (intermittent): +1
If load 4.4 to 22 lbs. (static or repeated): +2
If more than 22 lbs. or repeated or shocks: +3

Force / Load Score

Step 15: Find Column in Table C
Add values from steps 12-14 to obtain Neck, Trunk and Leg Score. Find Column in **Table C**.

Neck, Trunk, Leg Score

based on RULA: a survey method for the investigation of work-related upper limb disorders, McAtamney & Corlett, Applied Ergonomics 1993, 24(2), 91-99

ROSA

Section A - Chair

Chair Height — **AREA SCORE** 0

Non-Adjustable (+1)

Knees at 90° (1)	Too low - Knee Angle <90° (2)	Too High - Knee Angle >90°(2)	No foot contact on ground (3)	Insufficient Space Under Desk - Ability to Cross Legs(+1)

Pan Depth — **AREA SCORE**

Non-Adjustable (+1)

Approximately 3 inches of space between knee and edge of seat (1)	Too Long - Less Than 3" of space (2)	Too Short - More than 3" of Space(2)

Armrests — **AREA SCORE**

Non-Adjustable (+1)

Elbows supported in line with shoulder, shoulders relaxed (1)	Too High (Shoulders Shrugged) /Low (Arms Unsupported) (2)	Hard/damaged surface (+1)	Too Wide (+1)

Back Support — **AREA SCORE**

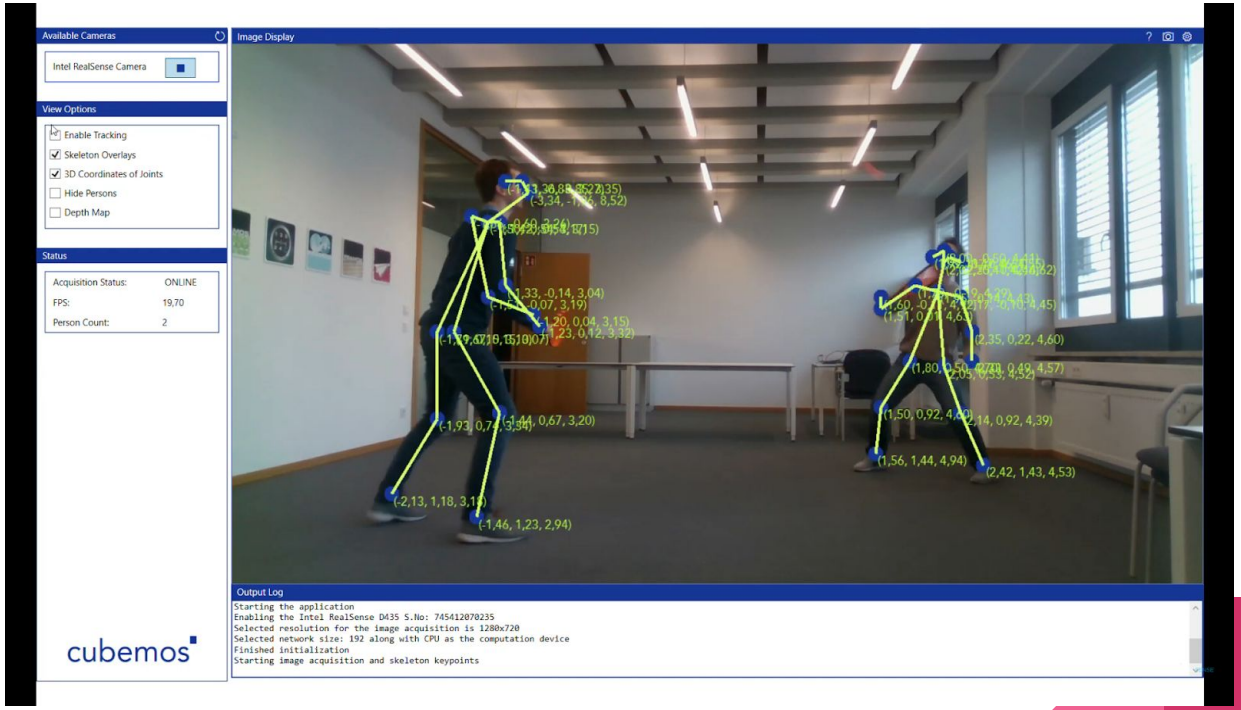
Back Rest Non-Adjustable (+1)

Adequate Lumbar Support - Chair reclined between 95°-110° (1)	No Lumbar Support OR Lumbar Support not Positioned in Small of Back (2)	Angled Too Far Back (Greater than 110°) OR Angled Too far forward (Less than 95°) (2)	No Back Support (ie Stool, OR Worker Leaning forward) (2)	Work Surface too High (Shoulders Shrugged)(+1)

DURATION | **CHAIR SCORE**

Chair	Monitor and Telephone	Mouse and Keyboard		ROSA FINAL SCORE

Skeleton Tracking SDK for Intel® RealSense™ Depth Cameras

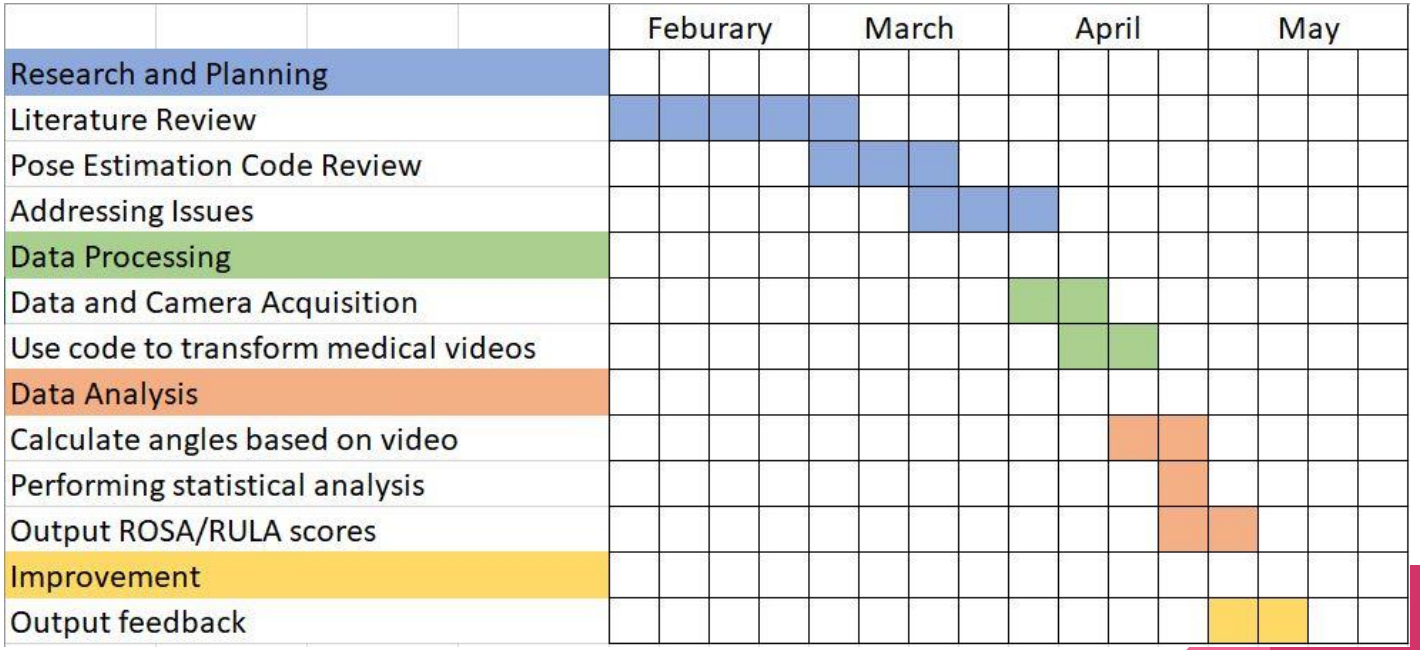


https://www.intelrealsense.com/skeleton-tracking/

Deliverables

Minimum	C++ code/documentation computing RULA and ROSA for a picture - 4/25
Expected	Process videos for RULA/ROSA scores, implement user interface for wrist dependency/other possible dependencies, ask questions for more parts of difficult analysis - 5/4
Maximum	Implement a training algorithm with manually labeled images to calculate parts where user input is required - past 5/5

New Key Dates



Addressing Problems

1) How will we prove that the angles generated by the code correspond to a ground truth? How would you design the experiments that calibrate the camera and code? How will the ground truth be measured?

To ensure the camera is working properly, we can find some extreme poses to be analyzed and see if the skeleton matches the pose created (i.e hands all the way out, front bending over). Calibrating the camera would require manual measurement of these poses using a protractor after these images have been printed out.

2) What specific modifications are you making to the RULA/ROSA, and what will the final scores look like?

Wrist score- changed from angles to supported/not supported due to camera angles making it difficult to see the wrist

ROSA chair related scores - user input (can train an algorithm with manually labeled images for maximum deliverable)

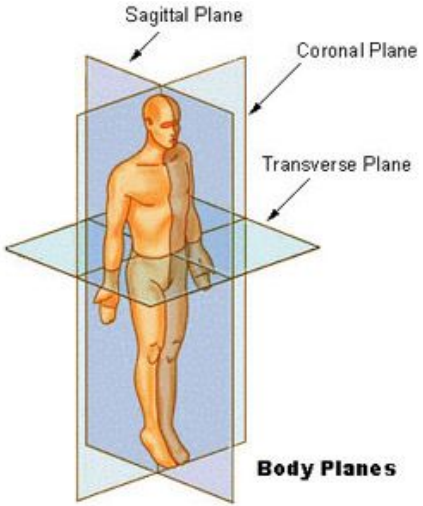
Addressing Problems

3) Can you make and present a schematic of which angles you will be measuring? Can you predict any challenges that we would need to overcome?

RULA requires a side view, while ROSA requires a frontal and side view, so the best angle would most likely be an aerial 45 degrees to either the right or the left in front of the surgeon, with feet visible if possible.

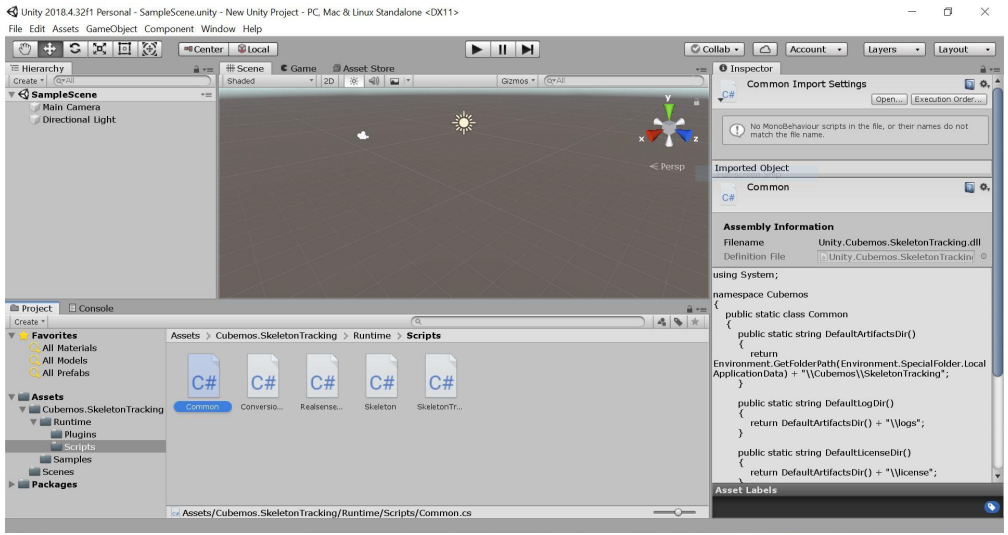
Potential challenges:

1) Some parts of algorithms are difficult to measure, even with an SDK (ie: whether chair has lumbar support, whether there are 3” space between the chair and back of knee, etc). To deal with this, we will result to manual input at the end of the video, or a trained algorithm with manually labeled images for our maximum deliverable.
2) For ROSA assessment, we will have to measure the body against a plane perpendicular to the ground. The coronal plane can be easily obtained but the sagittal plane would require us to perform additional calculations.



Currently

- Use Unity Hub and Microsoft Visual Studio as framework
- Use inbuilt function Vector3.Angle to calculate angle once it is obtained from the camera, which uses the formula $\alpha = \arccos[(\mathbf{a} \cdot \mathbf{b}) / (|\mathbf{a}| * |\mathbf{b}|)]$
- Figuring out how to glue together all components of the code to calculate all required angles and if it is possible to import data that is not in real-time



Plan

- Weekly Wednesday Galen meetings, Tuesday meetings with Dr. Galaiya
- Screen share for coding and SDK development
- Seminar presentations to explain benefits of RGBD cameras for RULA/ROSA (another question brought up by our clinical advisor)
- Camera and data arriving within the week- data!

Questions?