## Project Name

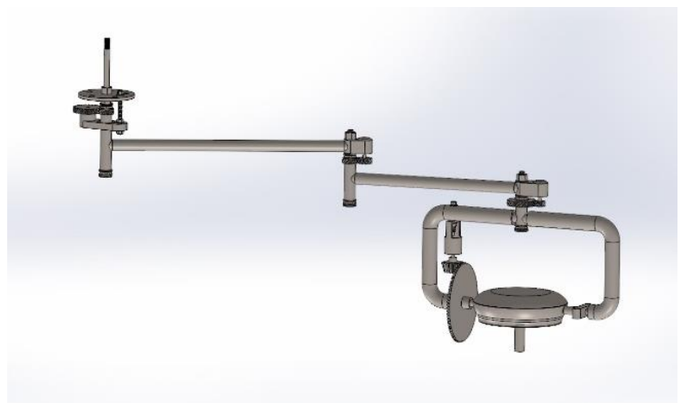
Automated Operation Theater Light

## Problem addressed

During surgery, doctors face many obstructions on wound areas due to shadows of equipment and their hands. They have to manually change the position of light which distracts them while performing surgery. This issue is being faced by doctors all around the world.

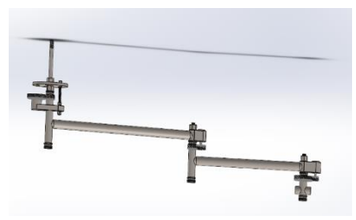
## Proposed solution

An autonomous OT  light which enables adjustment by looking at the shadow and hand of the doctors. It will detect the wound area and doctor's hand over it and adjust itself accordingly which minimizes human intervention in adjustment.

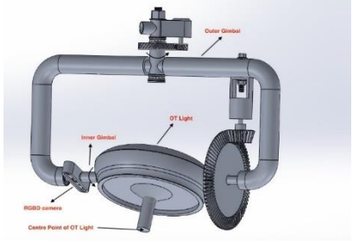


## Mechanical aspect

***OT light arm* :-** The arm of OT Light has two degrees of freedom (DOF). It has two arms made of hollow stainless steel pipe and three servo motors. One motor is placed at the end of the arm which controls the movement of the gimbal placed below. The arm is allowed to move in one plane to make it more stable. One end of the arm is fixed and attached to the ceiling. Screw with thrust bearing  has been used at the joint of the arm.

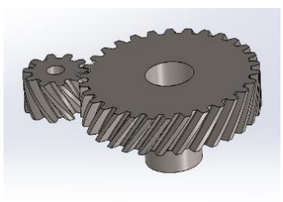


***OT light gimbal* :-** It handles the orientation and direction of OT Light. It holds LED lights, depth cam, servo motors and crown & pinion which controls the angle of projection of light on the wound. The gimbal can rotate about its axis and light beneath it can also rotate with the help of a servo motor attached to it. We can control the angle of projection of OT light by giving command to the servo motor.




***Gears* :-** Two types of gears have been used in this model :-

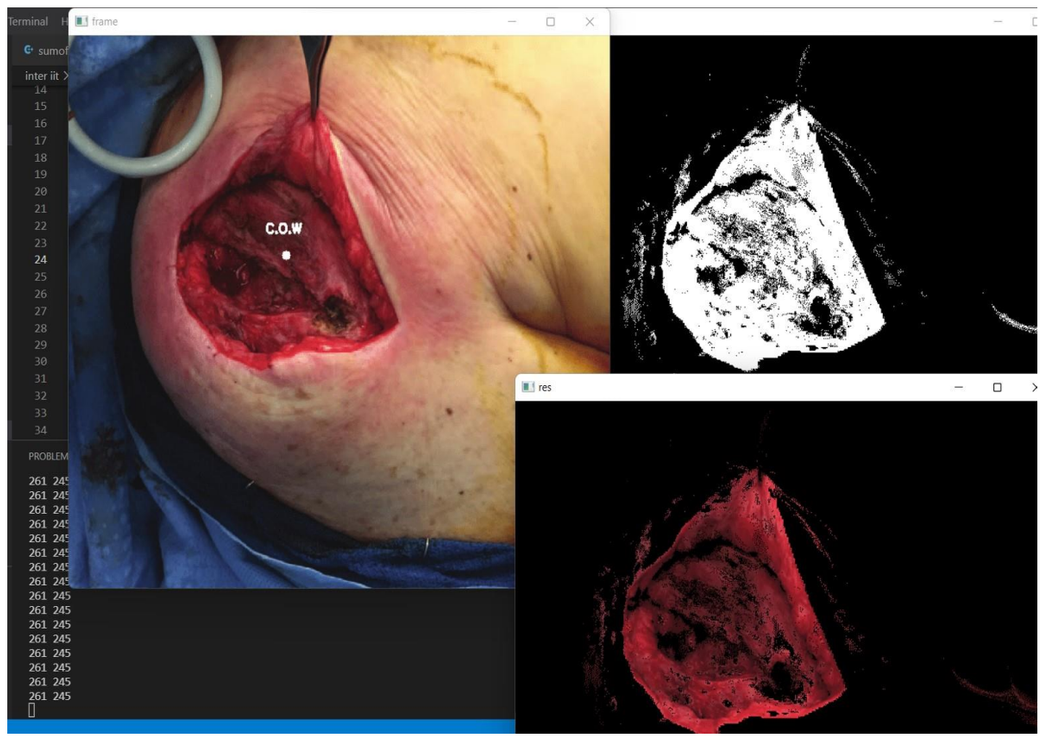
1. ***Helical gears :-*** It is used in moving the arms of the OT light with help of servo motors. Helical gears have been preferred over others because it reduces vibration and generates very less noise. It is very durable and has high load carrying capacity.



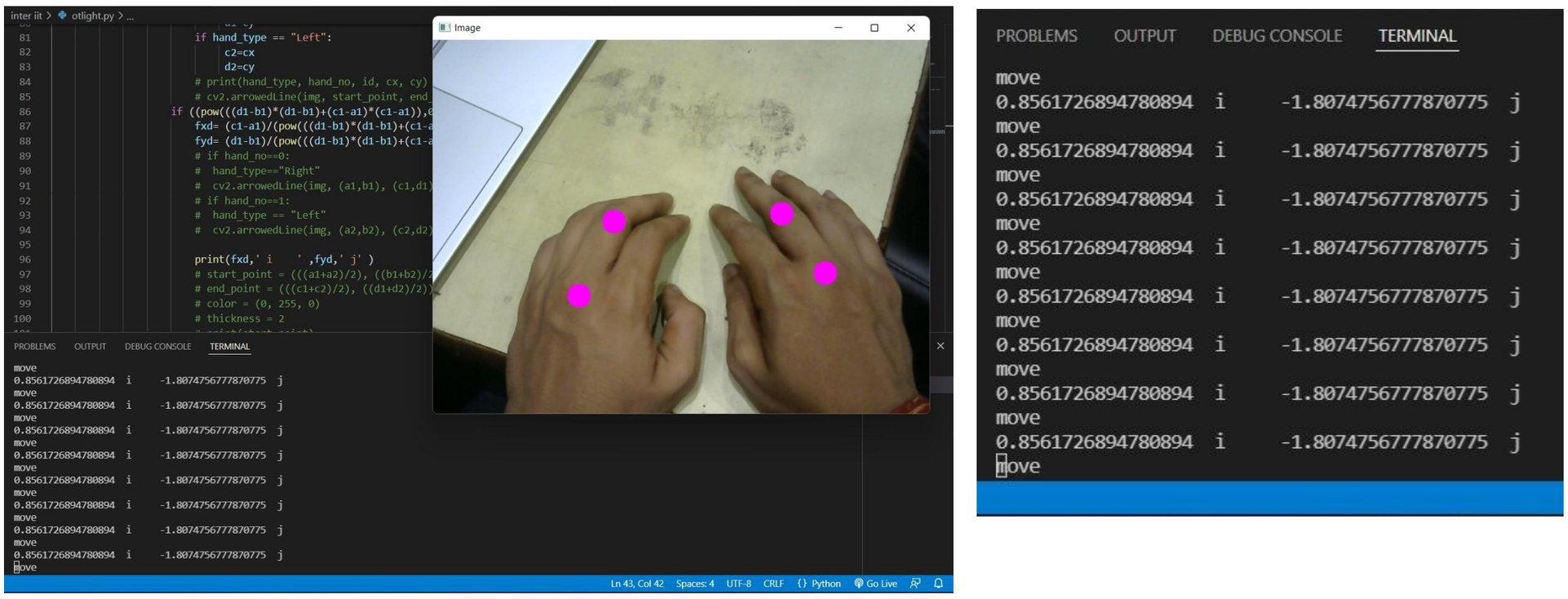
2. ***Crown & Pinion :-*** Pinion is attached to the motor placed on the gimbal which moves the crown. The crown is attached to the LED OT Light. The gear ratio has been taken such that the projection angle can be calculated with rotation of the motor.

## Working methodology

1. First, the RGBD camera will detect wound with the help of OpenCV. After getting the contour of the wound it will find the center coordinate of the wound ( COW ).



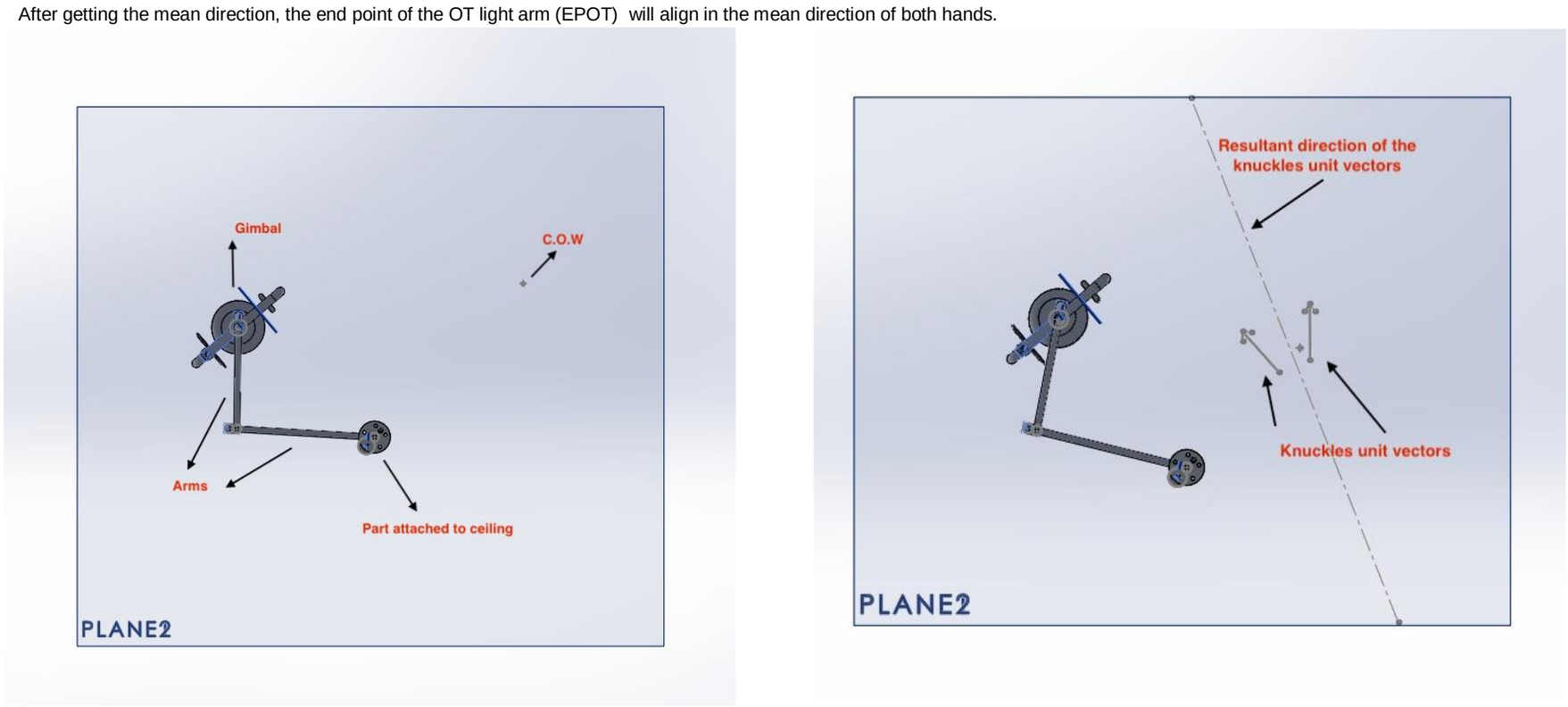

2. As the operation starts, the RGBD camera will detect the surgeon's hands. Using OpenCV we can detect the approximate mean direction of the hands by finding the mean direction of metacarpals of middle fingers of both the hands.



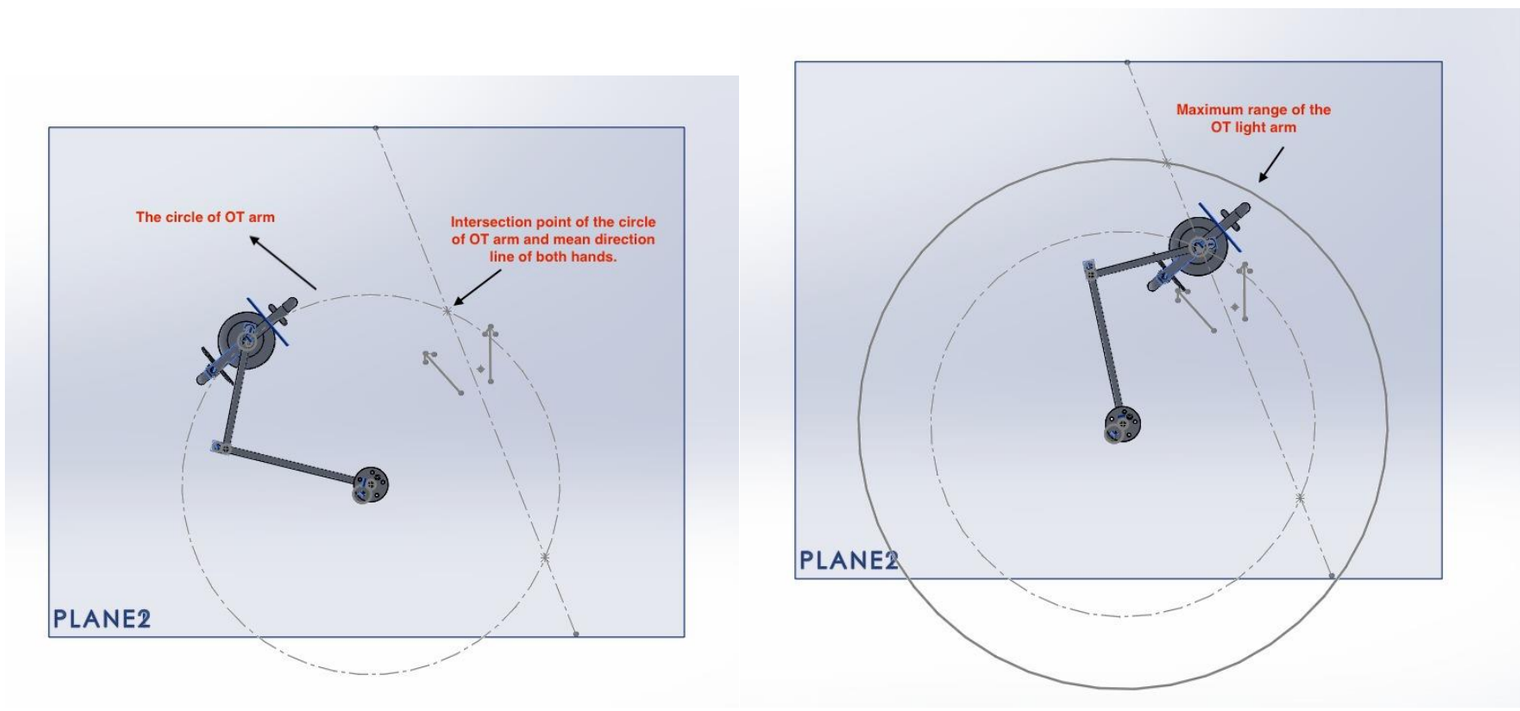




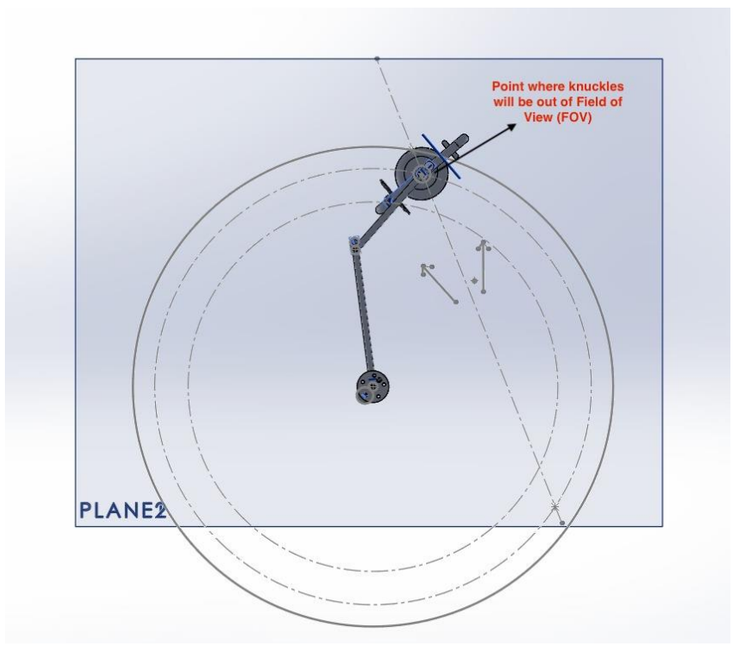
3. After getting the mean direction, the end point of the OT light arm (EPOT) will align in the mean direction of both hands.



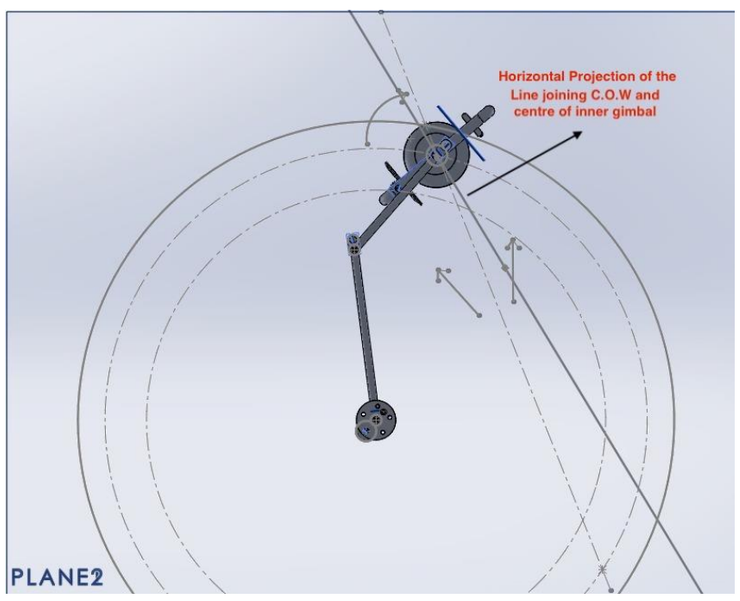

4. This can be done by moving EPOT to the intersection point of the circle of OT arm and mean direction line of both hands.

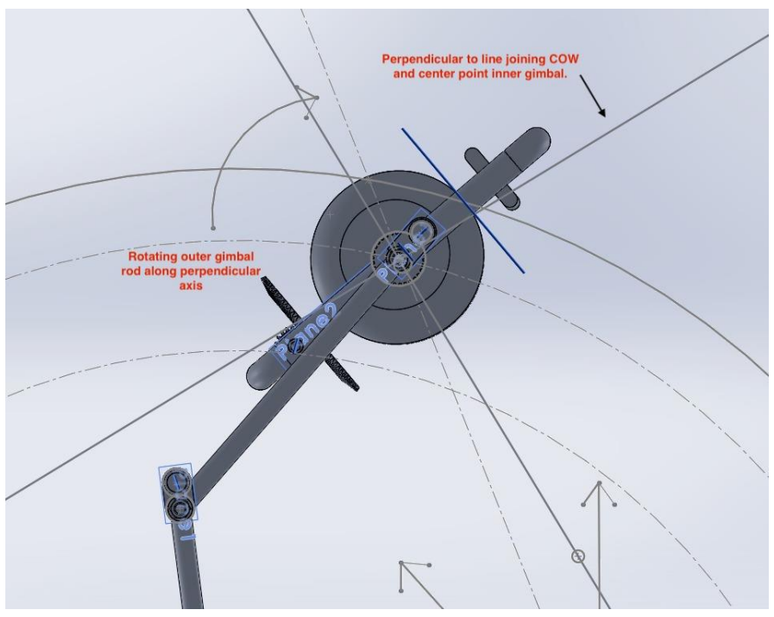


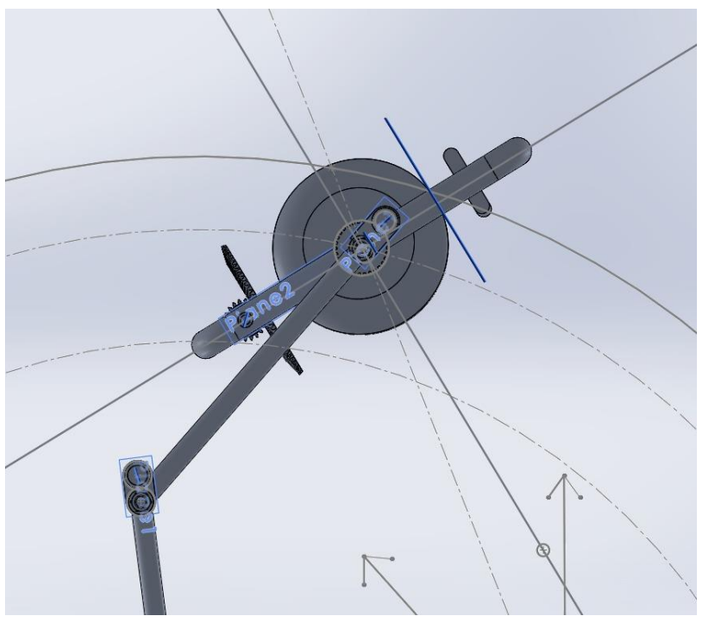
5. Then the EPOT will move on the mean direction line until the RGBD camera stops detecting the knuckles of the surgeon's hands.



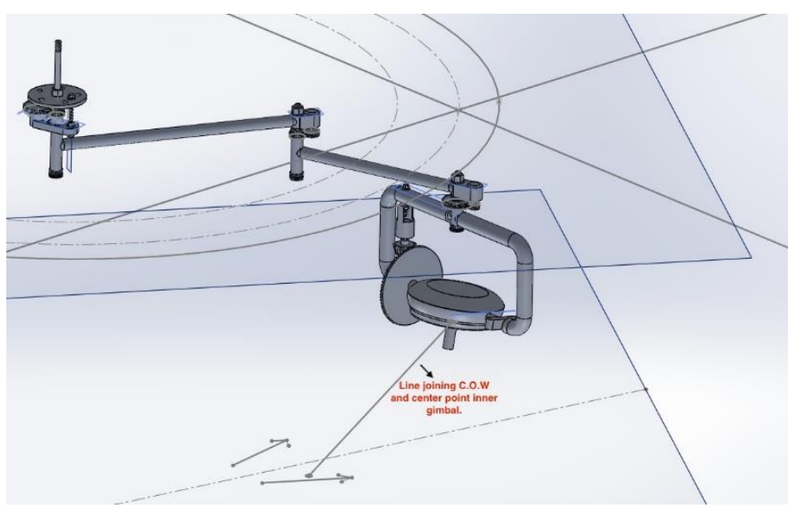

6. Now the horizontal part of the OT light outer gimbal will align itself perpendicular to the horizontal projection of line joining COW and center point inner gimbal.

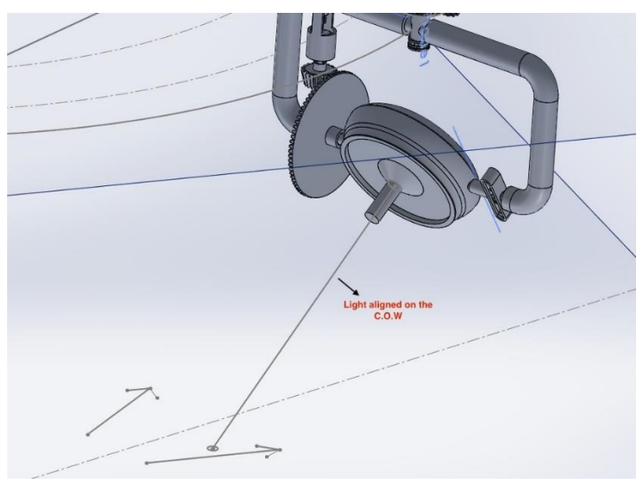


7. Lastly the hanging light will align along the line joining COW and center point of OT light.



## Electronics aspect

- ***High Torque DC Servo Motors :-*** It is used to control the movement of the OT Light. According to their ability to bear the stall and handling torque of the OT Light, four servo motors, two of 10 RPM, one of 60 RPM and another one of 100 RPM is used.
- ***RGBD camera :-*** Real Sense Depth Camera D435i w/IMU is used for detection of wound area and doctor's hand and also monitoring the position of OT light head.
- ***Arduino :-*** Arduino is needed for controlling the servo motors by taking the result from openCV which uses the RGBD camera to detect wound and give path for the OT Light adjustment.
- ***OT light :-*** LED OT light is used for illuminating the wound area during surgery. Lights having adjustable light intensity have been selected.

## Simulation

- OT light  simulation

## Future prospects

- Accommodate ML model to decrease the percentage of human intervention in the process.
- The model can be further improved for the inclusion of more than two hands by the doctors during surgery.

## References


- Inverse Kinematics
- openCV
- Robotic motion
- Research paper 1, Research paper 2


## Team members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