Department of Robotics & Mechatronics Engineering
University of Dhaka

Course code : RME 4111
Course name : Advanced Robotics Lab

Experiment no : 02
Experiment name : Static analysis of a human wrist.

Group no : 02
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Objective:

- Asses the stability of the wrist joint under different loading conditions
- Analyze the effects of wrist position and posture on joint mechanics

Theory:

The study of the mechanical behaviour and stability of the human wrist under static loading circumstances is a component of static analysis. This examination offers important information regarding the wrist joint's strength, structural integrity, and range of motion, which are crucial for comprehending its functional capabilities and creating therapies for diseases affecting the wrist or ergonomic concerns.

The wrist joint in humans is a complicated one made up of numerous bones, ligaments, tendons, and muscles. It allows for a number of movements, including circumduction, radial and ulnar deviation, flexion, and extension. The coordinated motions of the muscles, tendons, and ligaments around the joint help to make these movements possible.

The wrist joint is subjected to external stresses or loads during static analysis, similar to those that are encountered during grasping, lifting, or pushing actions. To assess the mechanical behaviour of the wrist, it is essential to comprehend the distribution and amplitude of these forces. The congruency and alignment of the joint surfaces, the strength of the supporting muscles, and the health of the ligaments all play a significant influence in wrist stability.

The human wrist can be statically analysed using a variety of techniques, such as computational modelling, finite element analysis (FEA), and experimental testing. The wrist's biomechanics can be thoroughly analysed using computational models and FEA simulations, which offer information on stress distribution, deformation, and potential failure spots. To evaluate forces, displacements, and stresses directly, experimental testing entails applying regulated loads to cadaveric or artificial wrist models.

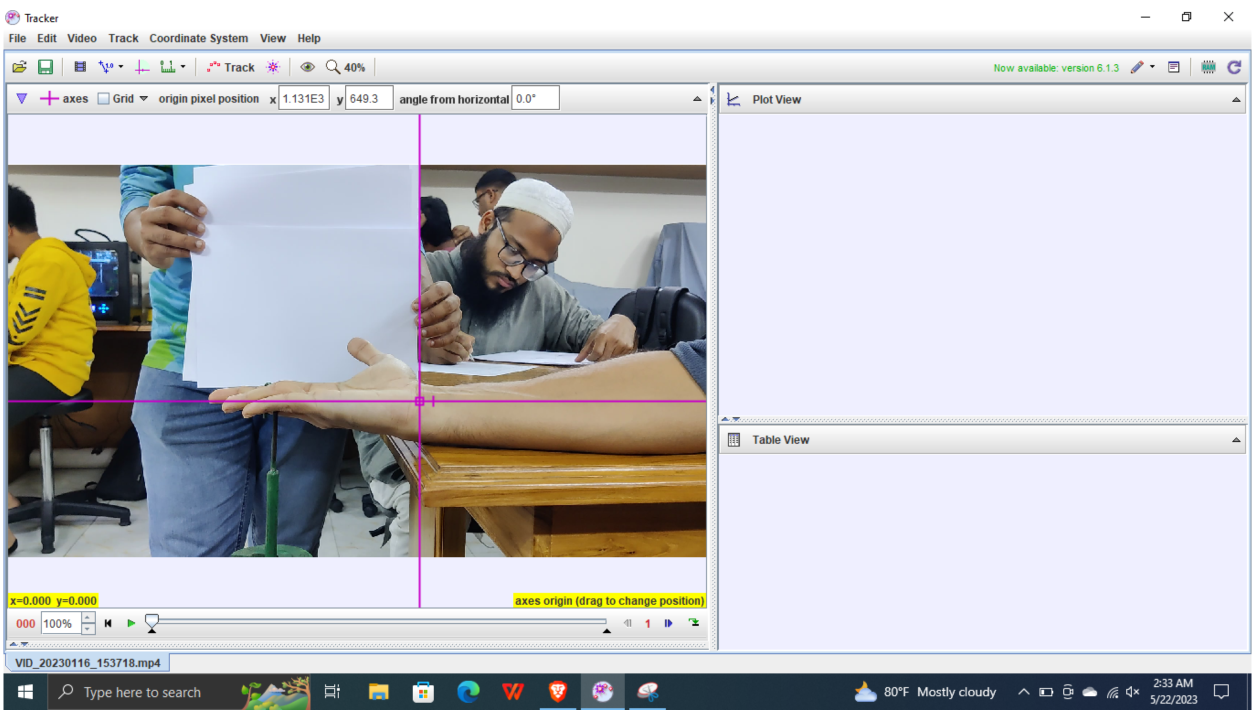
Researchers and professionals can better understand the mechanical behaviour of the human wrist by performing static analysis. This information can guide the creation of solutions like orthotics, rehabilitation exercises, or ergonomic improvements and assist in identifying possible stability or overloading problems. Additionally, static analysis advances our understanding of wrist biomechanics, resulting in better clinical procedures and treatments for disorders involving the wrist.

Equipment:

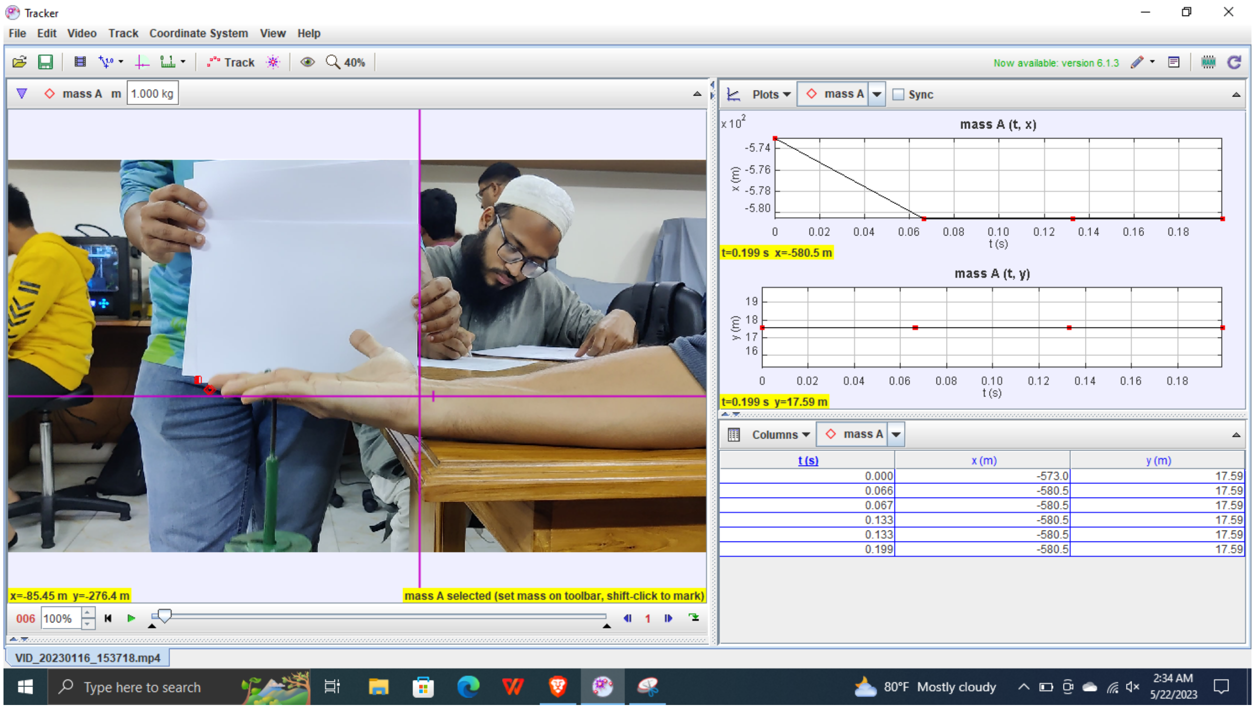
- Tracker Software
- Weights
- Hand

Procedure:

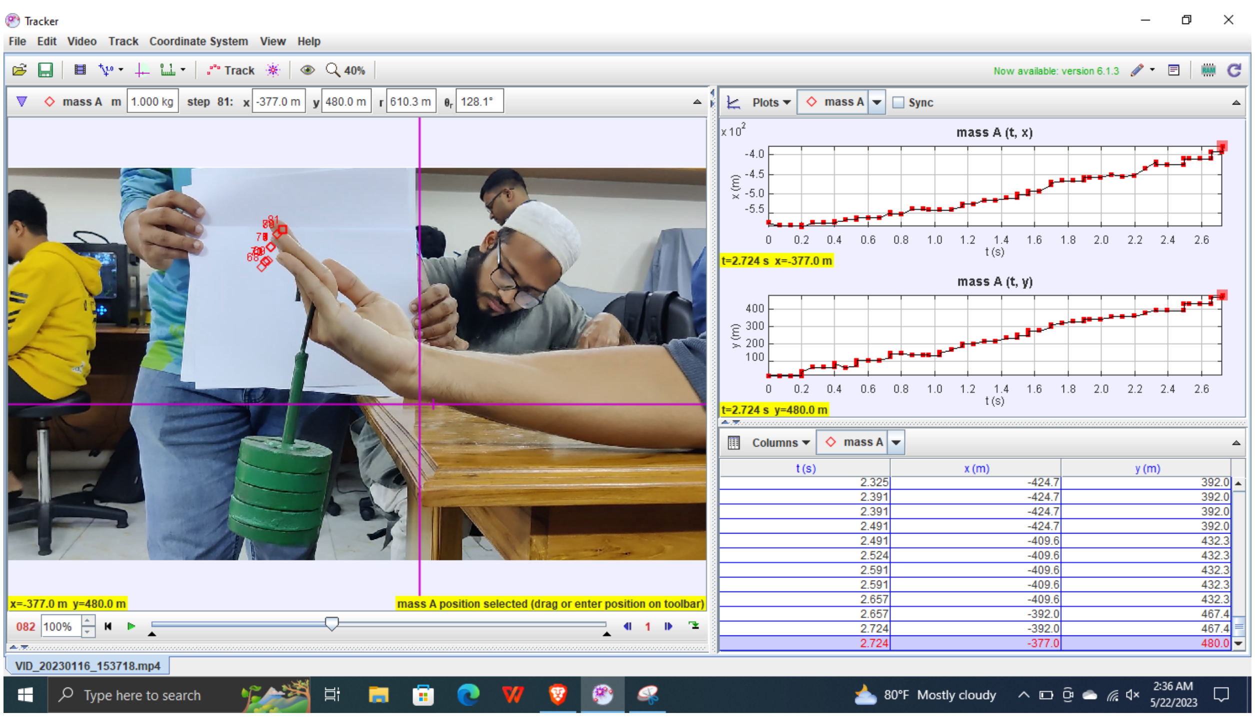
- Selection of origin in the video



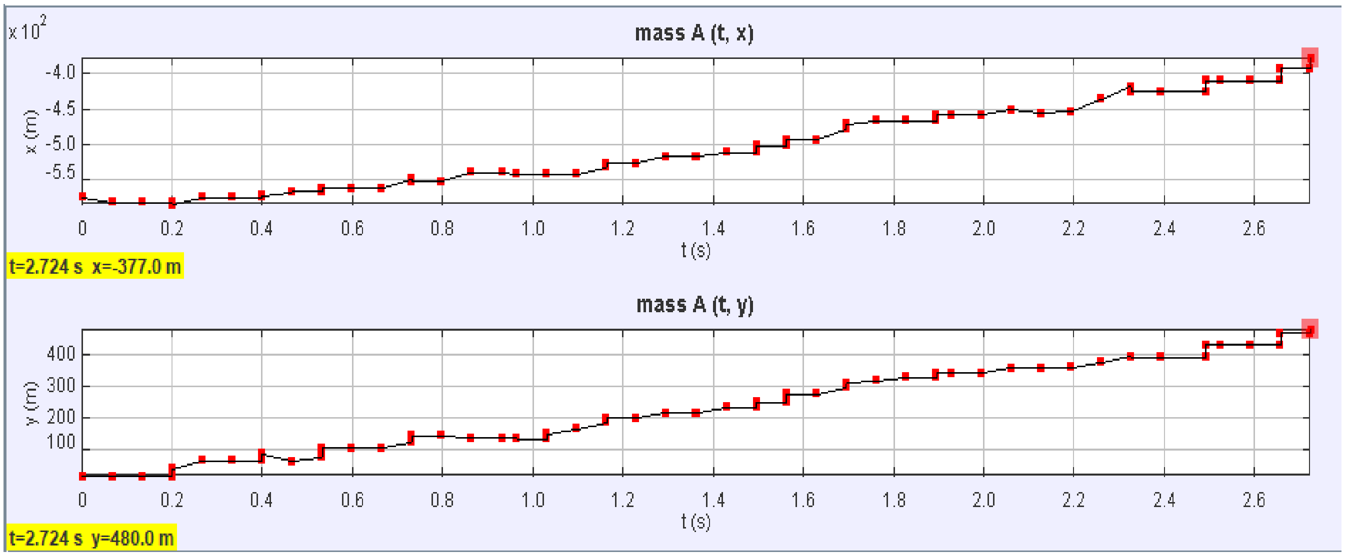
- Point mass selection in the video



- Simulation of the selected points through the video



Result:



Discussion:

According to the experiment's findings, the values of mass a(t,x) and mass a(t,y) grow when the hand lifts a load. This observation can be explained by the greater load's impact on the wrist joint and encircling muscles.

The muscles in the wrist and forearm contract when the hand is raised with a load in order to defy gravity and maintain the desired position. Together, these muscles can provide the strength and stability needed to support the load. The consequence is an increase in the mass readings in both the x and y directions, which shows an increase in the force produced by the muscles.

It is possible to interpret the rise in mass a(t,x) and mass a(t,y) as the wrist adapting to the added weight. To produce the necessary force, the muscles must contract more forcefully, which raises the mass readings. This rise in mass values shows the effort made by the wrist to resist the pull of gravity and support the load.

Additionally, proprioceptive processes may be activated as a result of the rise in mass measurements. The ability of the body to perceive its position and movements in space is known as proprioception. The sensory receptors in the muscles and tendons transmit signals to the central nervous system as the load increases, causing the wrist muscles to contract more vigorously in an effort to maintain stability.

Experiment no-02

Experiment name- Static analysis of human wrist.

Group no-02

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16.03.2023

Angle of wrist, $\alpha = 45^0$

Mass, $m = 2kg$

Horizontal weight, $W_h = mg\cos\alpha = 2\times9.81\times\cos(45^0)$
$= 13.87N$

Vertical weight, $W_v = mg\sin\alpha = 2\times9.81\times\sin(45^0)\ N$
$= 13.87N$

Average weight, $W = \sqrt{W_h^2 + W_v^2 + 2W_hW_v\cos\alpha}$

$= \sqrt{(13.87)^2 + (13.87)^2 + 2\times13.87\times13.87\times\cos45^0}$

$= 21.6$ kg

Acceleration, $a = 0.149\ ms^{-2}$

Force, $F = W\times(g+a) = 21.6 \times (9.8 + 0.149)$ N
$= 214.9N$

Torque, $T = FR\sin\alpha = 214.9 \times 0.145 \times \sin 45^0$ Nm
$= 22.03$ Nm

$R = 14.5 cm = 0.145 m$

$r = 2.5 cm = 0.025 m$

$A = 2\pi r R = 2 \times \pi \times 0.025 \times 0.145 = 0.022 m^2$

$$S_{compression} = \frac{F\cos\alpha}{A} = \frac{214.9 \times \cos 45^\circ}{0.022} N$$

$$= 6694.14 N$$

$$S_{stress} = \frac{F\sin\alpha}{A} = \frac{214.9 \times \sin 45^\circ}{0.022} N$$

$$= 6694.14 N$$