**Three classes of eye movements:** Gaze Stabilization with body movement Optokinetic Nystagmus (OKN) Vestibulo-ocular reflex (VOR) Foveal gaze shifts with attention shifts Saccades Asymmetric vergence **Foveal Maintenance of stationary** & moving external objects Fixation Pursuit Vergence

#### VOR holds gaze steady





less.





#### Head vs. Eye Pursuit



#### Derivation of "Saccade"







Saccade









Saccade

#### **Visual Search Saccades**



#### Micro-Fixation Saccades

![](_page_8_Figure_1.jpeg)

#### Reading Gaze Shifts

Вы, мой стих не блещет новизной, Разнообразьем перемен нежданных. Не поискать ли мне тропы иной, Приемов новых, сочетаний странных?

Я повторяю прежнее опять, В одежде старой появляюсь снова. И кажется, по имени назвать Меня в стихах любое может слово.

Всё это оттого, что вновь и вновь Решаю я одну свою задачу: Я о тебе пишу, моя любовь, И то же сераце, те же силы трачу.

Всё то же солнце ходит надо мной, Но и оно не блещет новизной.

![](_page_9_Figure_5.jpeg)

Ь

#### Three degrees of freedom describe eye rotations about 3 axes

![](_page_10_Figure_1.jpeg)

![](_page_11_Figure_0.jpeg)

Horizontal Vergence

![](_page_12_Figure_0.jpeg)

#### **Hierarchy of Oculomotor Control**

**Final Common Pathway- executes movement** 

**Pre-motor nuclei- coordinates movement** 

Supra-nuclear centers- plans movement

#### **Final Common Pathway**

Motor nuclei of cranial nerves III, IV and VI provide innervation that produces force applied by individual muscles.

Movements of all speeds and types (version and vergence) are controlled here.

# Pre-motor nuclei: choreograph complex movements

These brainstem centers and cerebellum coordinate combined actions of several muscles.

They orchestrate direction, amplitude, velocity and duration of eye rotation.

This level computes the innervation necessary to achieve a desired eye rotation

### **Supra-nuclear pathways: Plan objectives**

Plan the desired direction and distance of gaze with eyes and head rotations.

Transform sensory afferent into motor efferent commands.

Includes cortical areas and the superior colliculus.

# Hierarchy of Oculomotor Control

![](_page_17_Figure_1.jpeg)

Closed loop camera illustrations and Visigraph demonstration

## Iso Vergence Circle

![](_page_19_Figure_1.jpeg)

Points A and B have the same Vergence angle. So do Points C and D.

Points A and C have the same **Version** angle. So do Points B and D.

This shows the Iso-Vergence Circle in the visual plane.

Iso version lines or directions.