

# AhG8: Measurement of User Exploration Behavior for Omnidirectional (360°) Videos with Head Mounted Display



Ashutosh Singla, Stephan Fremerey, Alexander Raake (TU Ilmenau Germany)  
Peter List, Bernhard Feiten (Deutsche Telekom AG Germany )

# Introduction

- Reporting on the exploration behavior of users while watching omnidirectional (360°) videos
- Are users exploring 360° video equally in terms of yaw and pitch direction?
- What is the percentage of time spent on different viewports?

# Dataset (4K)

## Target Bit-rates

- 1, 2, 5, 8, 15 Mbps



Content 1: Harbor



Content 2: KiteFlite



Content 3: Trolley

# Experimental Set-up

- Developed a framework for recording the head movements
  - Compatible with HTC Vive and Oculus Rift
- Rift's coordinate system is used
  - Positive yaw values: turning head left
  - Positive pitch values: pitching head upwards
- Yaw and pitch values - measured every 0.14 s
  - For 10 s long video sequences, approx. 72 values were recorded
- Subjects sit on a Rotating chair
  - Subjects were instructed to freely move while watching the videos

Oculus Rift  
-2160×1200  
-110° FOV  
- Whirligig player

29 Participants  
-14 Females  
-15 Males  
- Avg. age = 25.62  
- Median age = 25

# Experimental Results (1/8)

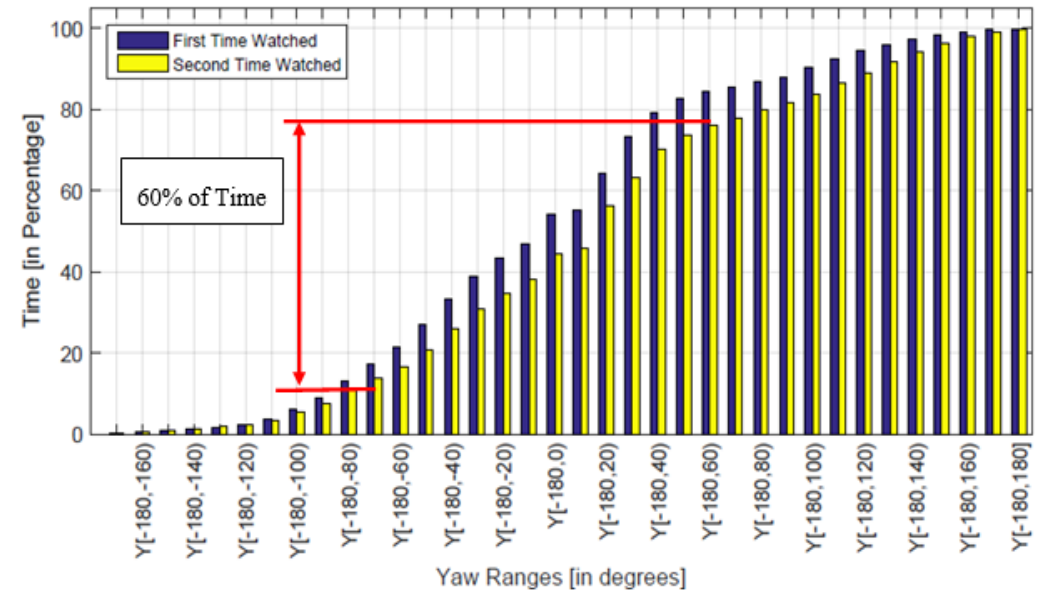
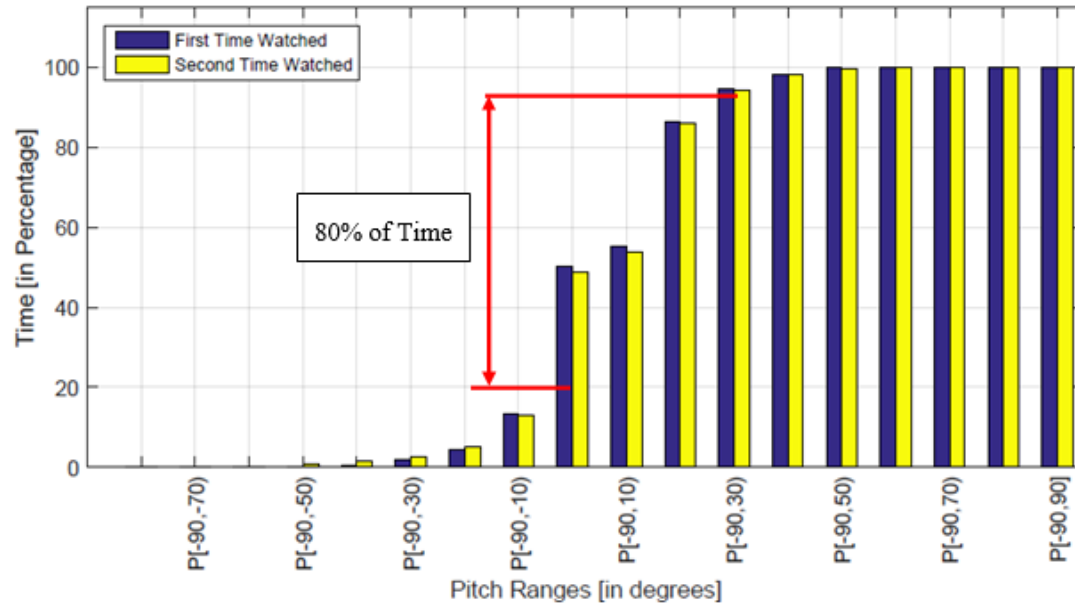


Figure 1a: Cumulative Histogram of yaw and pitch interval for Content 1

# Experimental Results (2/8)

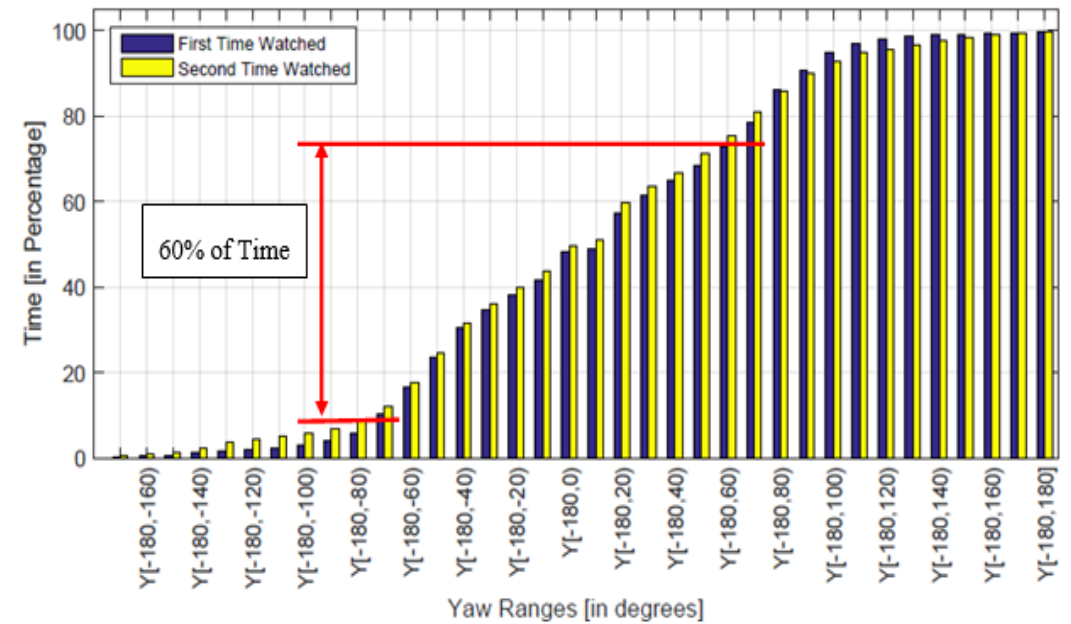
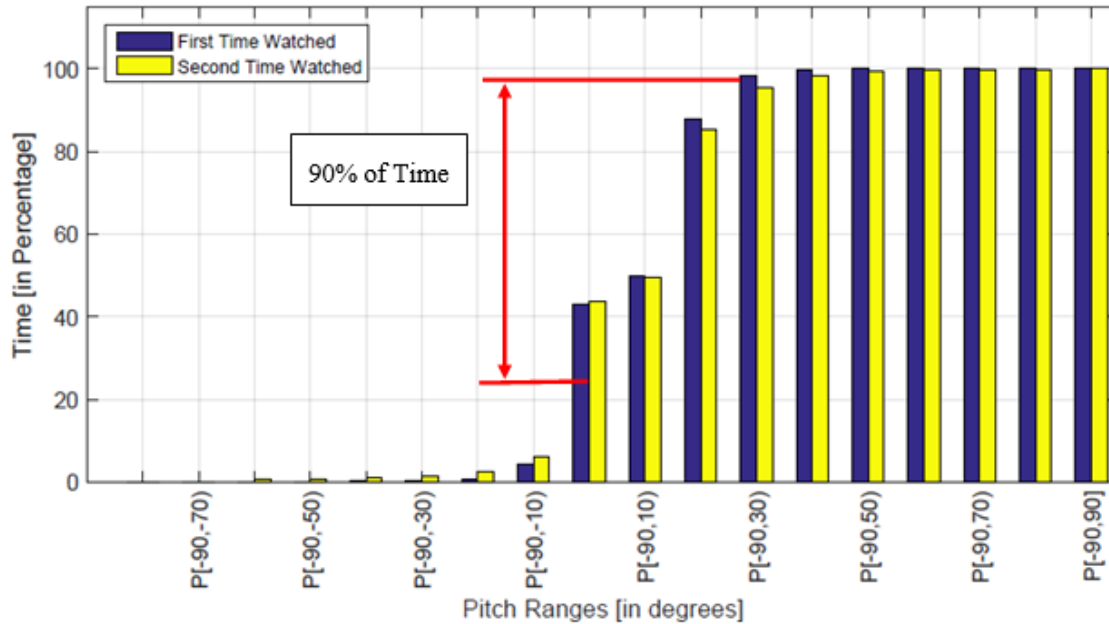


Figure 1b: Cumulative Histogram of yaw and pitch interval for Content 2

# Experimental Results (3/8)

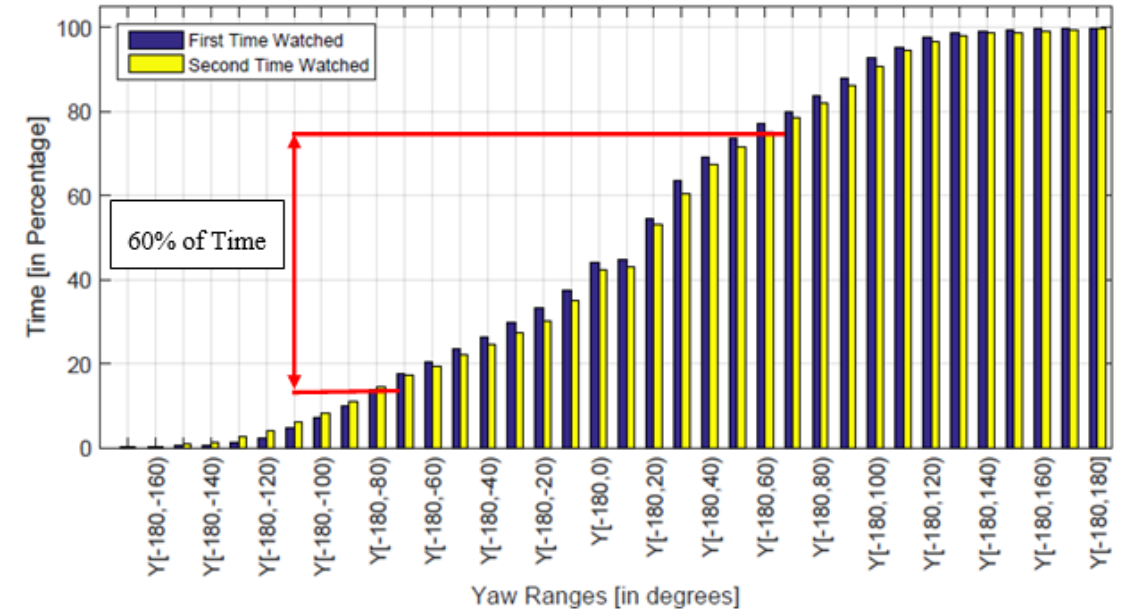
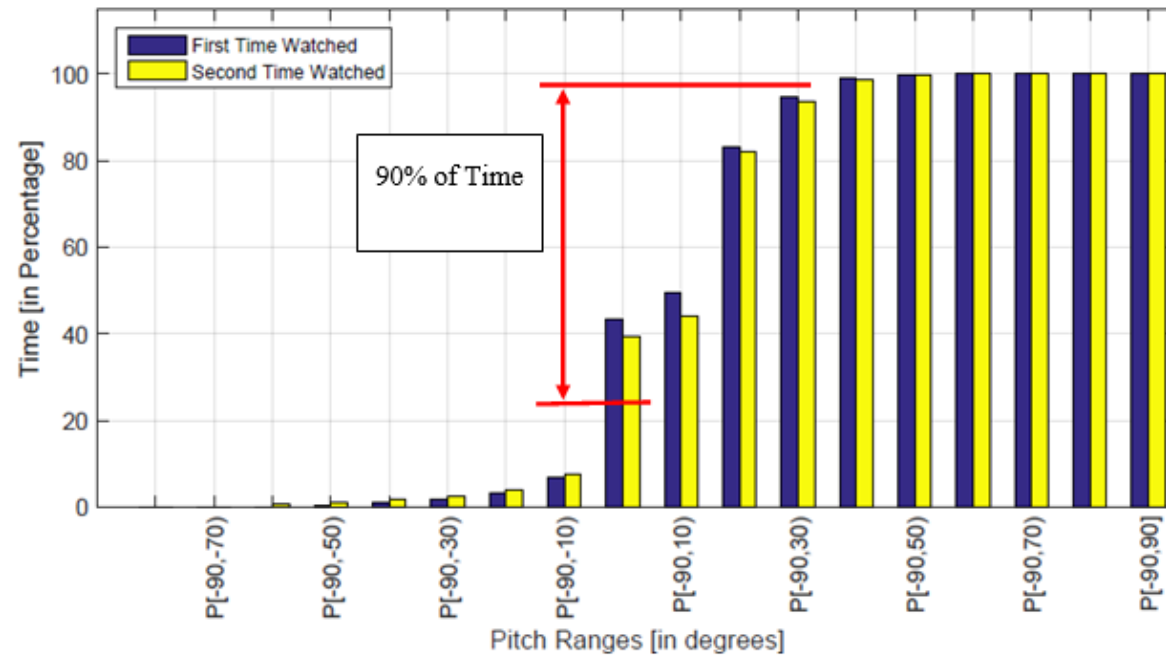


Figure 1c: Cumulative Histogram of yaw and pitch interval for Content 3



# Experimental Results (4/8)

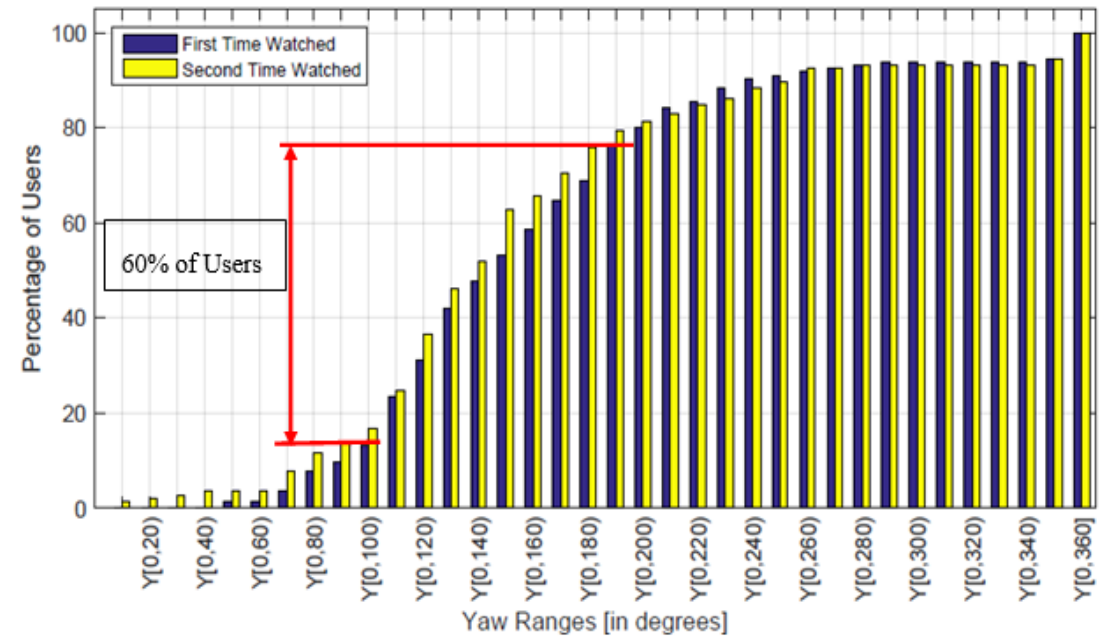
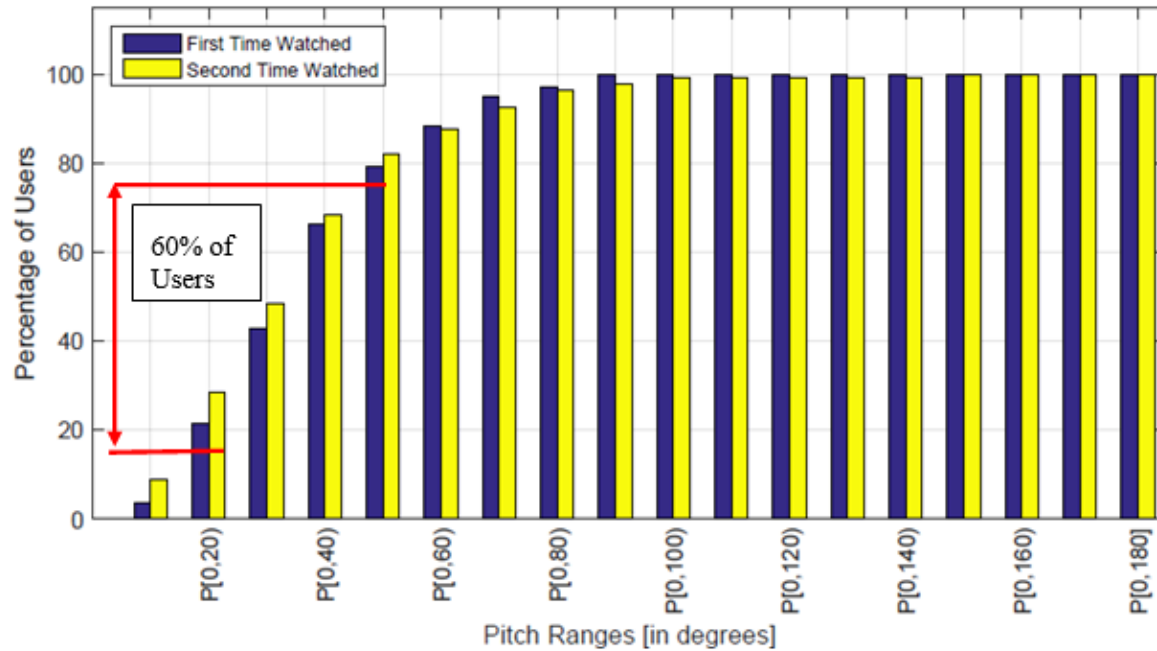


Figure 2a: Cumulative Histogram of relative yaw and pitch ranges for Content 1



# Experimental Results (5/8)

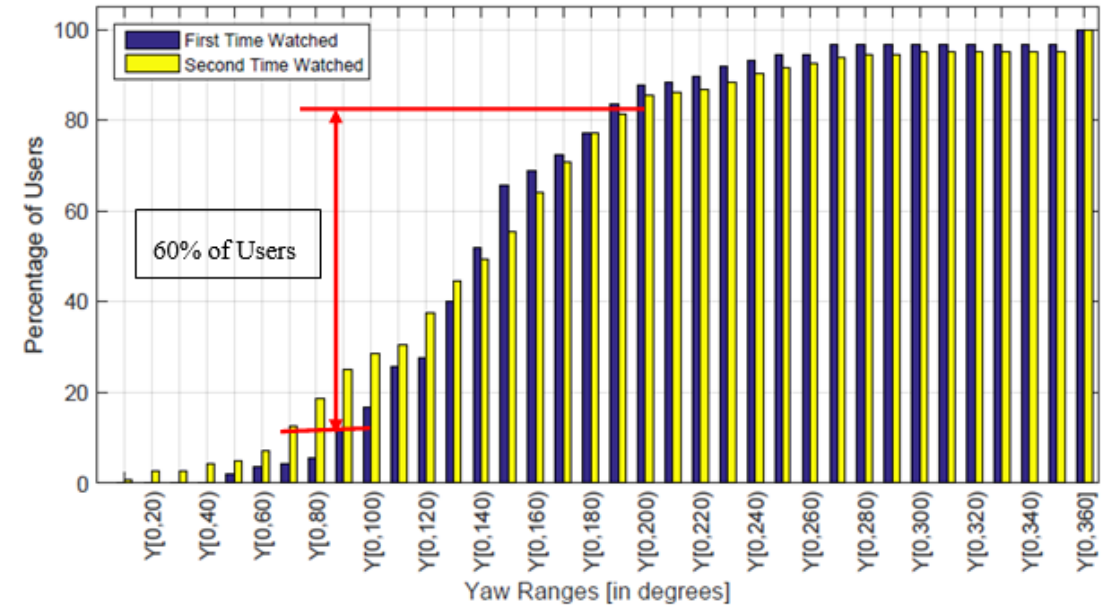
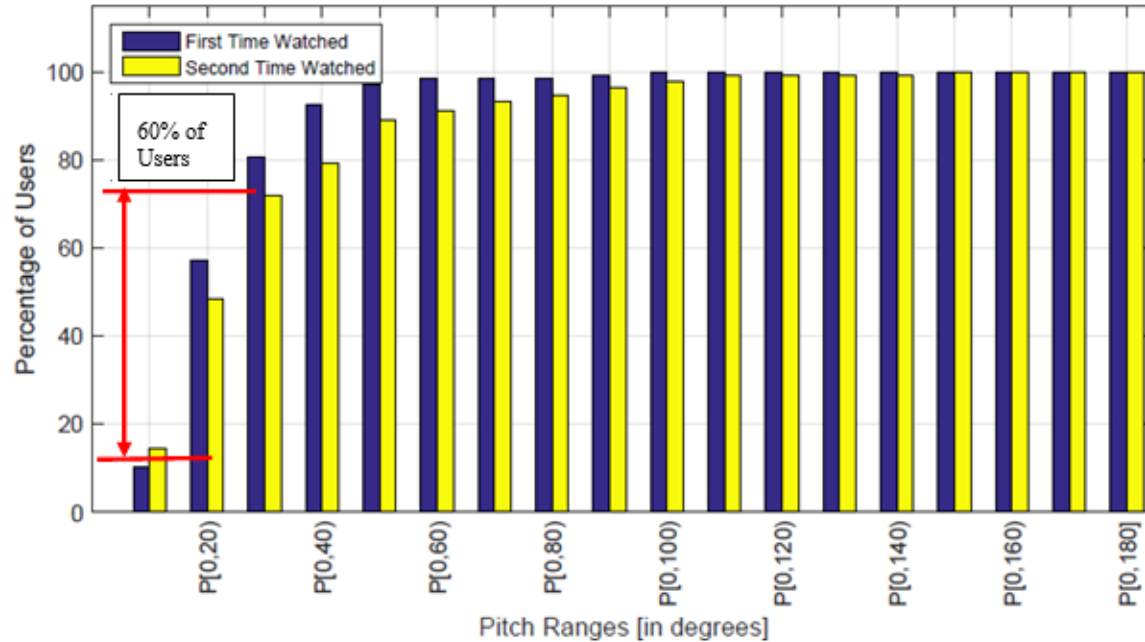


Figure 2b: Cumulative Histogram of relative yaw and pitch ranges for Content 2

# Experimental Results (6/8)

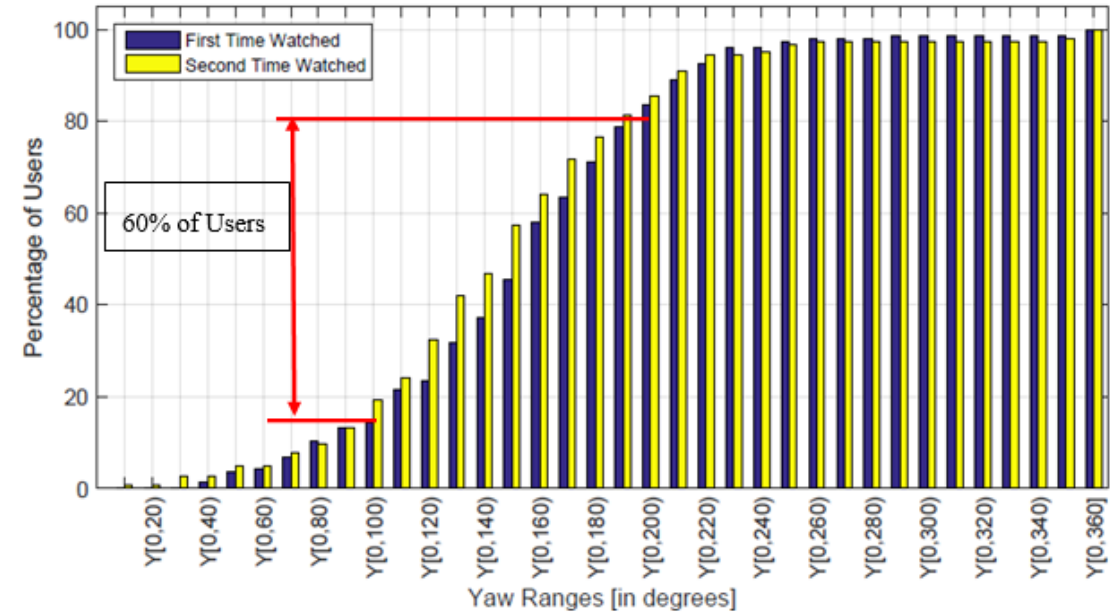
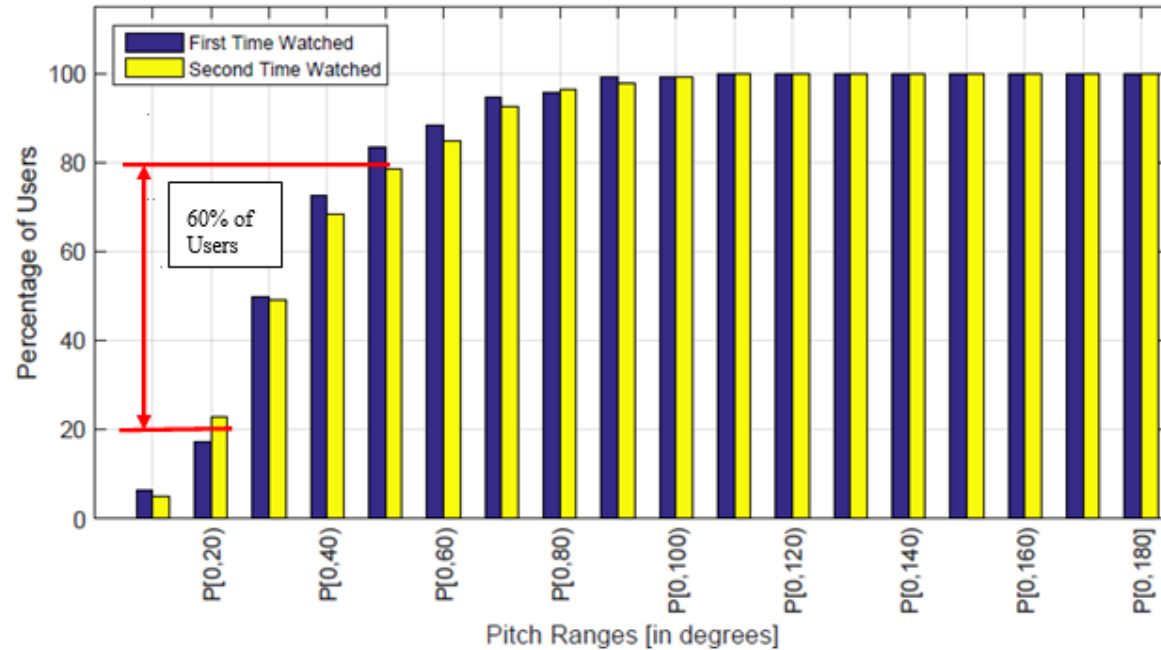


Figure 2c: Cumulative Histogram of relative yaw and pitch ranges for Content 3

# Experimental Results (6/8)

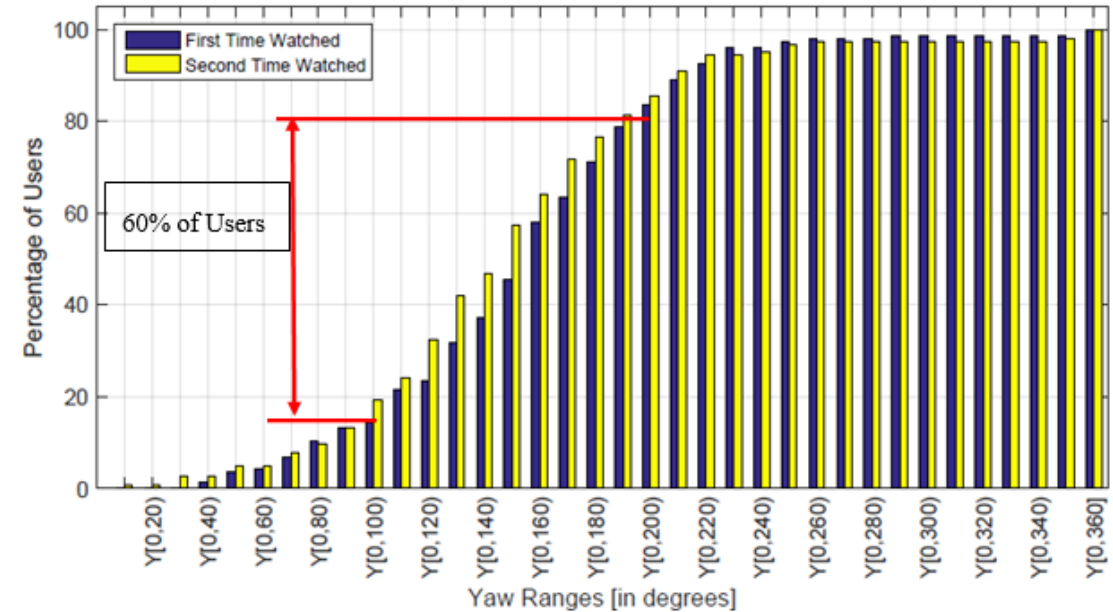
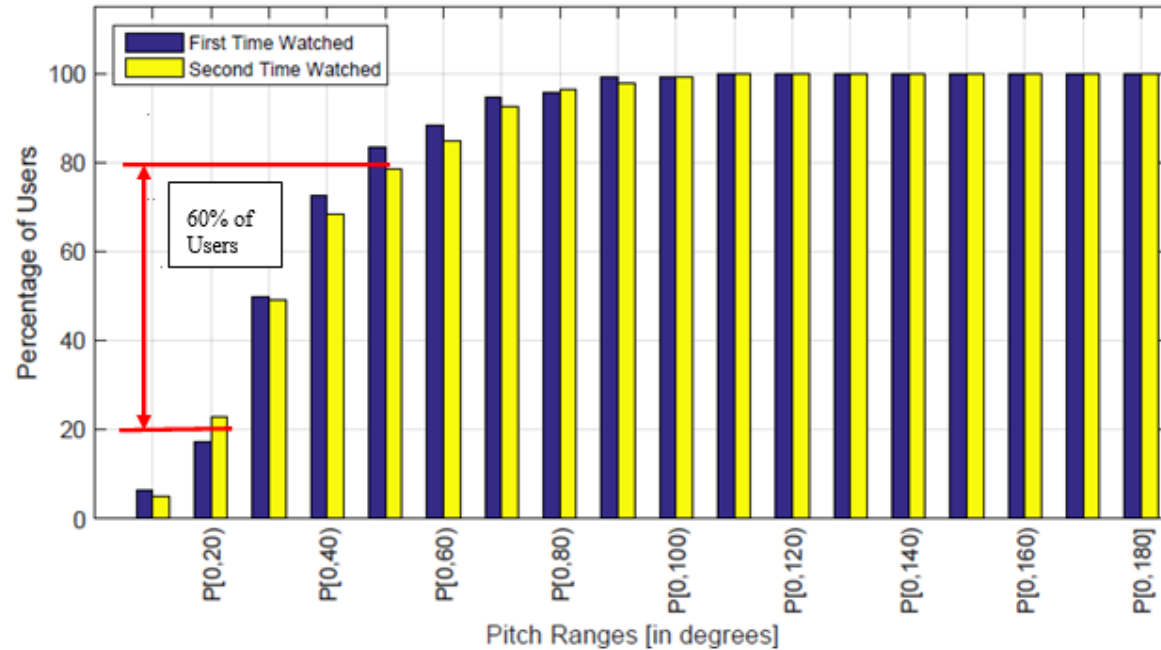
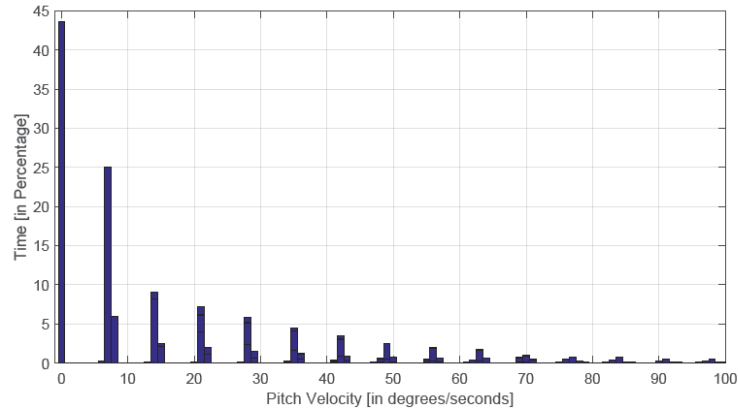
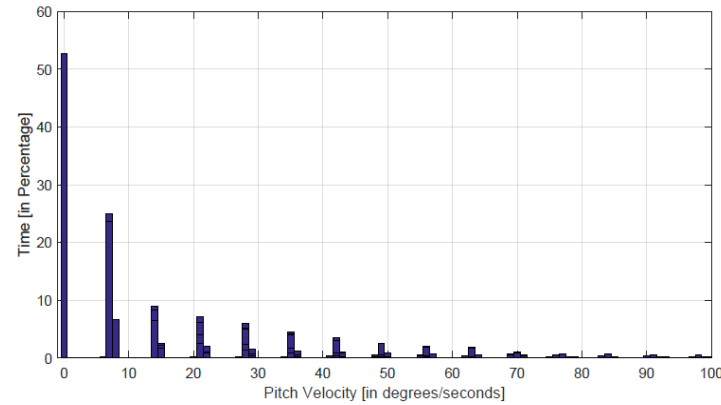


Figure 2c: Cumulative Histogram of relative yaw and pitch ranges for Content 3

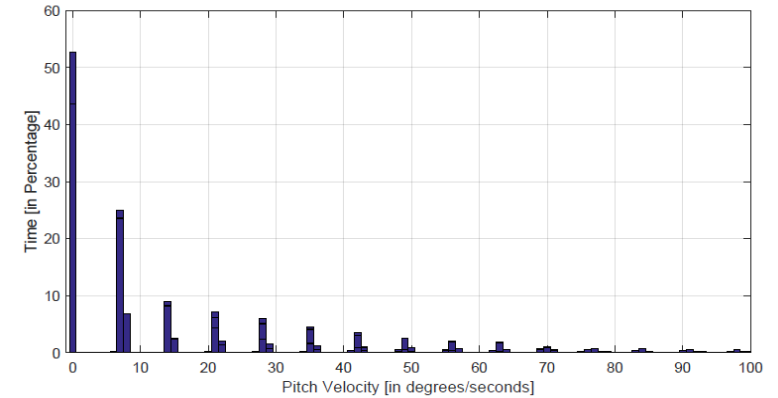
# Experimental Results (7/8)



Content 1



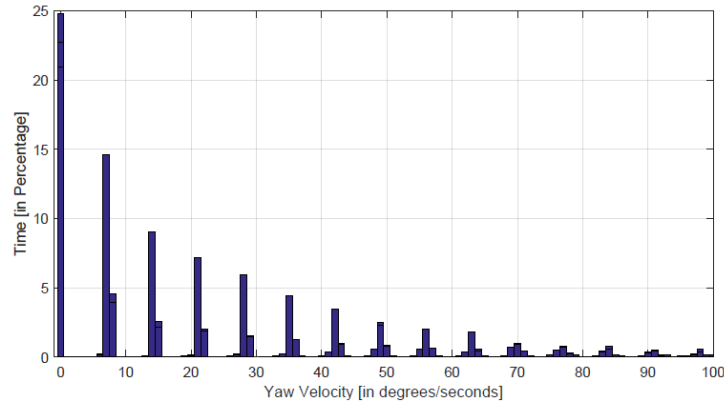
Content 2



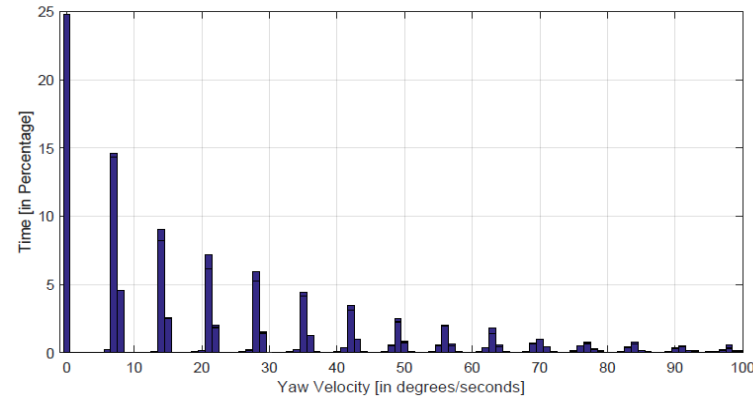
Content 3

Figure 3: Histogram of pitch velocities for all stimuli

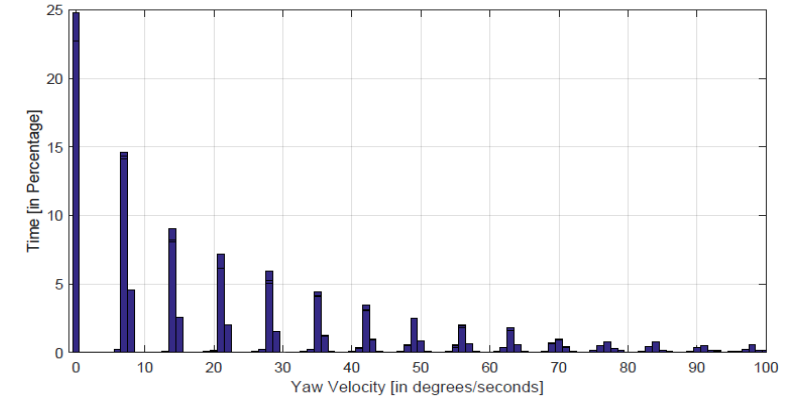
# Experimental Results (8/8)



Content 1



Content 2



Content 3

Figure 3: Histogram of yaw velocities for all stimuli

# Conclusion

- Subjects did not explore the complete yaw and pitch ranges
  - Yaw: Subjects prefer to move their head instead of rotating the chair
  - Pitch: Subjects don't feel comfortable to vertically move their head
  - Almost no subject explored the pitch range between  $[-90, -50]$  and  $[50, 90]$  and yaw range between  $[-180, -140]$  and  $[140, 180]$
- Relative exploration range
  - Pitch:  $30^\circ$
  - Yaw:  $100^\circ$
- Histogram of yaw and pitch velocities
  - Pitch: 45% stationary
  - Yaw: 25% stationary

# Questions/Suggestions

