INTERNATIONAL INSTITUTE OF INFORMATION TECHNOLOGY
HYDERABAD

CROSS/ROADS\
LINKING MOBILITY SOLUTIONS

IRF WORLD ROAD MEETING 2017
/ 14-17 NOVEMBER / DELHI / INDIA /

Effect on Visual Acuity and Discomfort from high-beam Glare in naturalistic Conditions on Indian Roads

Rohan Bhatial
MS student
IIT Hyderabad
rohan.bhatial
@research.iiit.ac.in

Dr. Kavita Vemuri
Proffesor
IIIT Hyderabad
kavita.vemuri
@research.iiit.ac.in

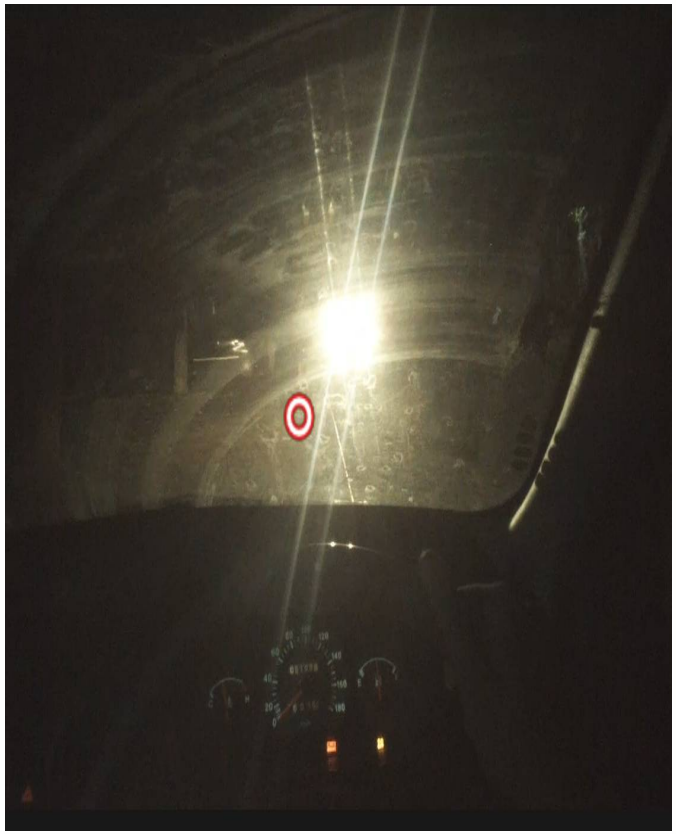
Aim

Consolidated study on night time driving on Indian roads in-order to understand whether pupil diameter changes and gaze point fixation time affects biological motion detection in mesopic light conditions and high-beam glare from an oncoming car

Scan path of driver while tracking pedestrian movement

Problems

- Flash blindness caused due to high beam
- Disability glare and discomfort glare cause significant loss of visual acuity
- Human eyes are not adapted to mesopic light conditions
- Multiple issues with Indian roads and driver ethics



Related Work(i)

- Glare from high beam causes temporary vision loss and dark spots (Theeuwes et al., 2002)
- The decrease in the background luminance due to the bright light and the angle of incidence of the light increases the effect of the glare (Alfredinck, 1996)
- There is a correlation between visibility and headlamp characteristics like intensity, spatial distribution of beam pattern and spectral power distribution (Clark et al., Flannagan et al.,1999, 2000, Bullough et al., 2003)

Related Work(ii)

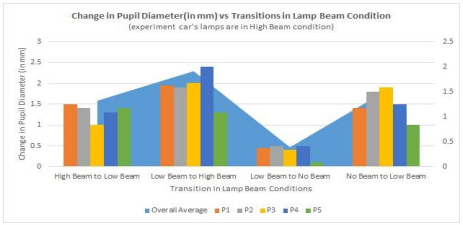
- Over 140,000 persons killed on Indian roads in 2015 increasing by 4.6% from 2014 (Road Accidents in India-2015, TRW, MRTH, Govt of India)
- Pedestrian Behavior (Kwan & Mapstone 2006), pedestrian's clothes (Wood, et al., 2005) and pedestrian's estimation of recognition distance of oncoming cars at night (Rosenberg 2010) have made vital observations.

Experiment: Method(i)

Data Collection using wearable eye tracker → Analysis and extracting key features → Pattern recognition and correlation

- Full HD wide angled camera for front view
- Gyro and accelerometer
- Microphone
- 2 cameras per eye for tracking

- Pupil diameter
- Gaze point fixation
- Manual event tagging
- Time-stamps
- Heat-maps



- Transition analysis for different states of headlamps of oncoming cars
- Gaze tracking for pedestrians

Experiment: Participants(ii)

Experiment 1 (E1)
- Participants - 5 (P1:P5)
- Age Group - 18-24 years
- Driving Experience - min 1 year on India Roads

Experiment 2 (E2)
- Participants - 2 (O1,O2)
- Age Group - 40-50 years
- Driving Experience - >10 year on India Roads

All participants had a valid Indian driving license and significant experience of driving during night time on Indian roads.

Experiment: Procedure(iii)

Experiment 1 (E1)

- Controlled experiment with 2 stationary vehicles facing each other at a distance of 25meter.
- Different sequences of state of headlamps were projected from one car on-to the other car with participants sitting on the driving seat wearing an eye tracker.
- Pedestrian Movement was also re-created.

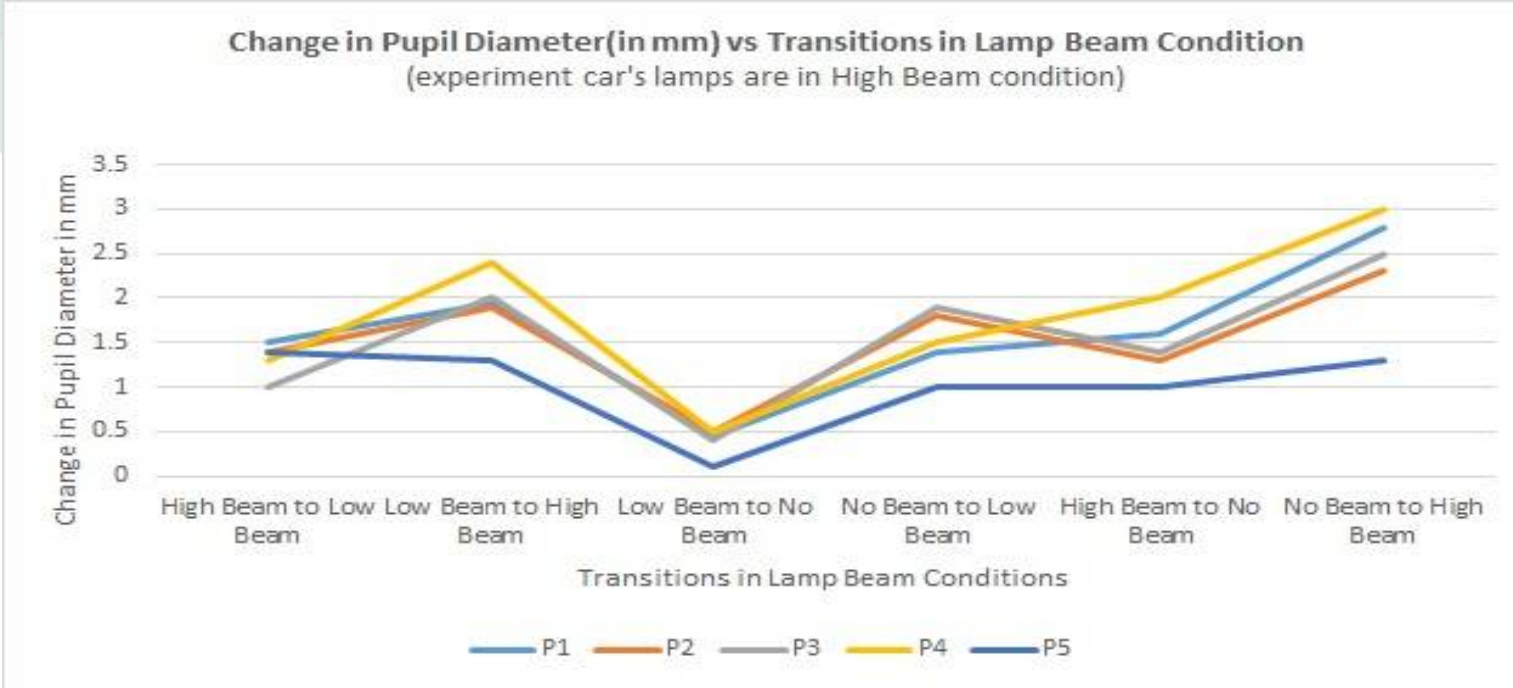
Experiment 2 (E2)

- Participants were made to drive under real traffic conditions.
- The route comprised of 4 lane highways with dividers and 2 lane highways without dividers in variable street lighting conditions.
- Random biological movement was analysed along with varied ambient lighting conditions.

Experiment: Results(iv)

E1-

- The rate of change of pupil can go as high as 2.7mm/s.
- Drop of 2.42mm as compared to 1.18mm when participant's car is in high beam and the oncoming car suddenly switches high beam on.



Experiment: Results(iv)

E1-

- Ability to detect in terms of gaze point fixation time of all 5 participants was different for different lighting conditions
- Fixation time of >1 second was enough to detect and predict pedestrian movement.

Beam Condition (oncoming car)	**High Beam**		**Low Beam**		**No Beam**	
	Fixation Time(s)		**Fixation Time(s)**		**Fixation Time(s)**	
Participants	**High Beam**	**Low Beam**	**High Beam**	**Low Beam**	**High Beam**	**Low Beam**
P1	***<0.5***	***<0.5***	***>2.5***	***Clear visibility***	***Clear visibility***	***1.7***
P2	***<0.5***	***<0.2***	***>2.5***	***>1***	***Clear visibility***	***>4***
P3	***<0.5***	***No visibility***	***>3***	***>2***	***Clear visibility***	***>1.2***
P4	***<1***	***<0.5***	***>3.5***	***>2.5***	***Clear visibility***	***4***
P5	***<0.5***	***No visibility***	***>3***	***>2***	***Clear visibility***	***>1.6***

Experiment: Results(iv)

E2-

- Confirms the observations from E1 in real time environments.
- Stable pupil size on a 4 lane highway in comparison to a 2 lane highway without divider.
- Street lights played a major role in biological motion detection.
- Difference of 0.5mm -1mm was seen in pupil size when oncoming vehicles were using low beam instead of high beam.

Future Work

- With so much data there is more scope to quantify the dangers of night time driving on Indian roads.
- Extensive studies can be done on both the driver and pedestrian behaviour patterns.
- Scope of doing a comparative analysis between different participant profiles to map factors like age.
- Possibility of advanced driver assistance solutions (ADAS) specially designed for Indian roads and drivers using cheap Lidars and cameras.

A person dies on Indian roads every 4 minutes !

Do we care?