Swansea University
Prifysgol Abertawe

On Discovering Road Traffic Information using Virtual Reality Simulations

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Definition of Key Terms

- On Discovering Road Traffic Information using Virtual Reality Simulations:

  - **Discovering Information**: Extracting meaning from data and visualisations.
  - **Road Traffic:** Vehicles on Motorways.
  - **Virtual Reality**: Graphical representation of simulated environment with immersion .
  - **Simulation:** Artificial reality built on mathematical models and rules taken from real world.

Overview of Paper

- Based on content from MRes Thesis.

- Goal:
  - Design a VR road simulation and show the use of real-time immersion and visualisation aids in discovering information.
  - Simulate a stretch of motorway and compare different scenarios results to that expected from real world observations.

Technology used

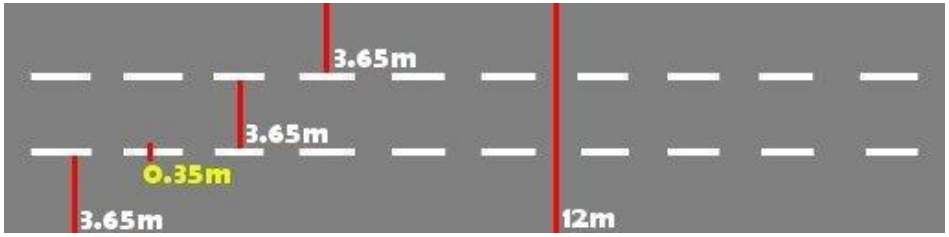
- Java (OOP)
- jME – Java Monkey Engine
  - OpenGL interface
  - Light Weight Java Games Library
  - Simplifies 3D development
- Eclipse used for development

Design Concepts

- Microscopic Simulation Model
  - Considers interaction of each element in simulation separately.
  - Lends itself well to principles of Object Oriented Programming.

- Car-Following Model
  - Each vehicle keeps up with the car ahead, without colliding with it.
  - Ordinary Differential Equations:
    - Position
    - Velocity
    - Vehicle Length
    - Net Distance (Bumper to Bumper)

Design: The Road



- British Motorway statistics take from UK Highway Agency*.
- Very simple 3 lane motorway

* http://www.ha-research.gov.uk/projects/index.php?id=85

7.2 Road Traffic: by type of vehicle: 1996-2006

Billion vehicle kilometres

	1996	1997	1998	1999	2000 [1]	2001 [2]	2002	2003	2004	2005	2006
Cars and taxis	359.9	365.8	370.6	377.4	376.8	382.8	392.9	393.1	398.1	397.2	402.4
Motor cycles etc	3.8	4.0	4.1	4.5	4.6	4.8	5.1	5.6	5.2	5.4	5.2
Larger buses and coaches	5.0	5.2	5.2	5.3	5.2	5.2	5.2	5.4	5.2	5.2	5.4
Light vans [3]	46.2	48.6	50.8	51.6	52.3	53.7	55.0	57.9	60.8	62.6	64.3
Goods vehicles [4]											
2 axles rigid	10.9	11.0	11.1	11.6	11.7	11.5	11.6	11.7	11.7	11.5	11.3
3 axles rigid	1.6	1.6	1.9	1.7	1.7	1.8	1.8	1.8	1.9	1.9	1.9
4 or more axles rigid	1.5	1.5	1.6	1.5	1.5	1.5	1.5	1.6	1.6	1.7	1.7
3 and 4 axles artic	3.3	3.2	3.0	3.0	2.7	2.5	2.3	2.2	2.2	2.0	1.9
5 axles artic	6.6	7.1	7.3	7.2	6.7	6.4	6.4	6.2	6.5	6.4	6.5
6 or more axles artic	2.3	2.5	2.9	3.3	4.1	4.5	4.8	5.0	5.4	5.5	5.7
All	26.2	26.9	27.7	28.1	28.2	28.1	28.3	28.5	29.4	29.0	29.1
All motor vehicles	441.1	450.3	458.5	467.0	467.1	474.4	486.5	490.4	498.6	499.4	506.4
Pedal cycles	4.1	4.1	4.0	4.1	4.2	4.2	4.4	4.5	4.2	4.4	4.6

1 The decline in the use of cars and taxis in 2000 was due to the fuel dispute.
2 Figures affected by the impact of Foot and Mouth disease during 2001.
3 Not exceeding 3,500 kgs gross vehicle weight.
4 Over 3,500 kgs gross vehicle weight.

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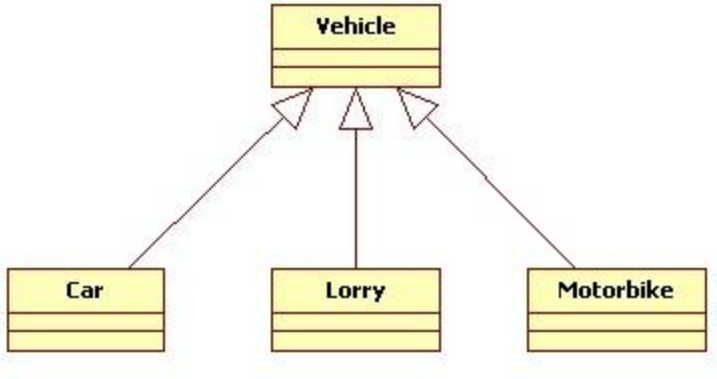
Design: The Vehicles



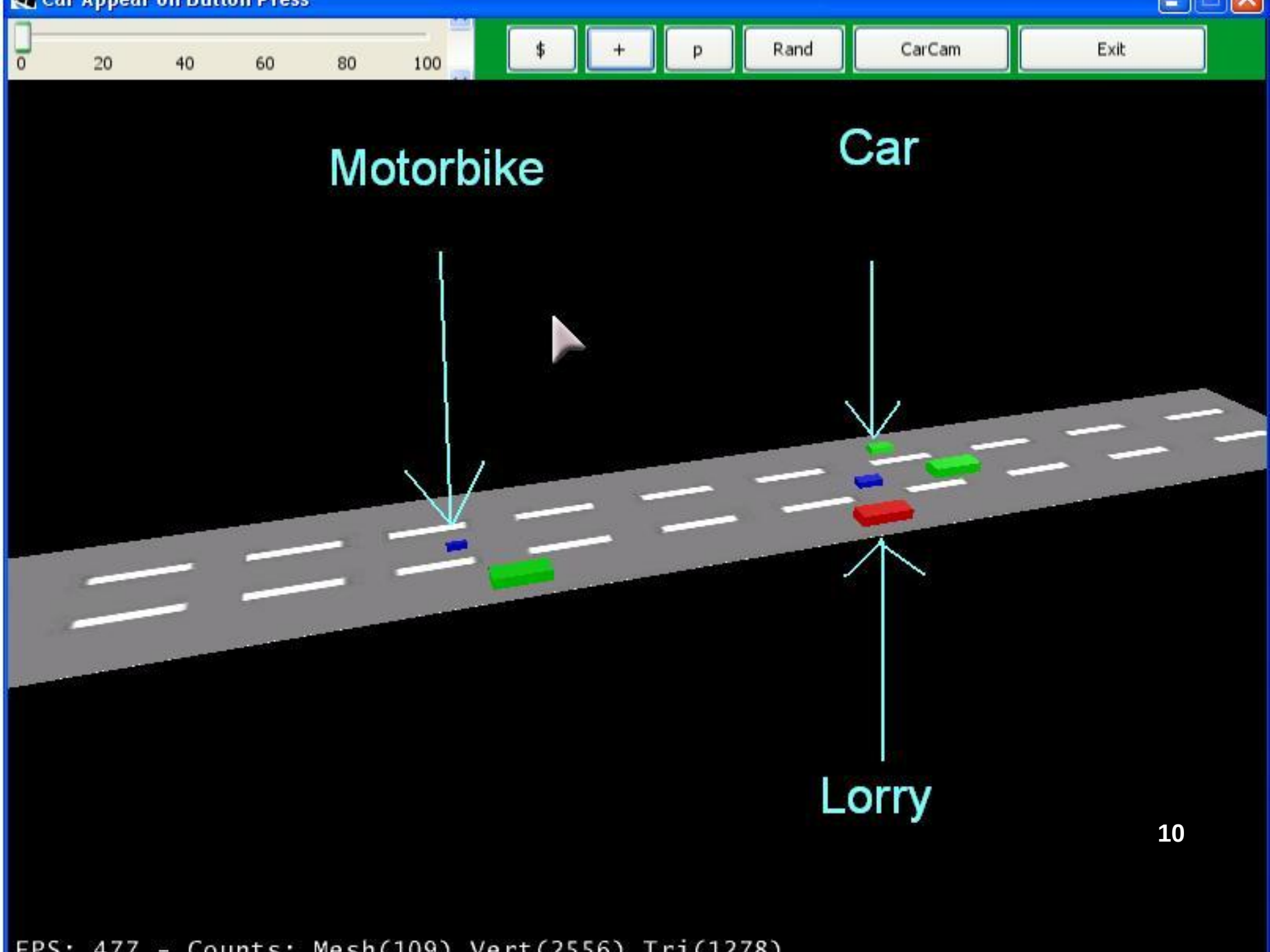
- Vehicle dimensions, speeds and distribution ranges defined using data researched from DfT* data.
- Vehicle Insertion:
  - Different per scenario
  - Poisson Distribution

* Department for Transport, “Transport Statistics for Great Britain 2007”, pp. 125.

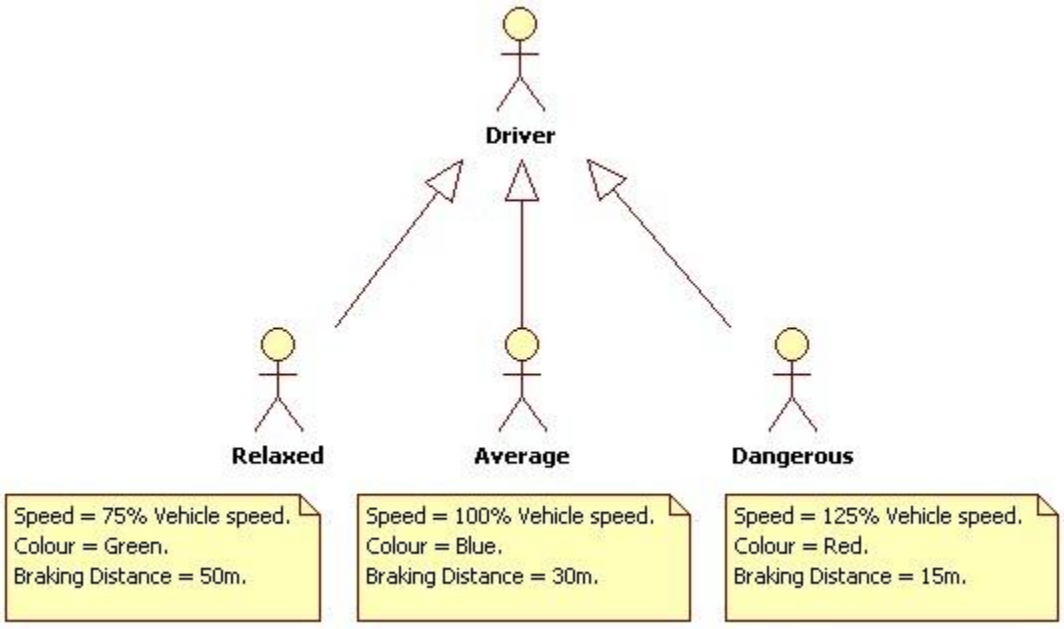
7.10 Vehicle speeds on non-built-up roads by road type and vehicle type: Great Britain: 2006

per cent

						Heavy goods vehicles [5]				
						Rigid			Articulated	
(a) Motorways [1]	Motor-cycles [7]	Cars	Cars towing	Light Goods [4]	Buses/ Coaches	2 axles [6]	3 axles	4 axles	4 axles	5+ axles
Under 50 mph	*5*	*5*	*16*	*5*	*6*	*8*	*13*	*16*	*9*	*10*
50-59 mph	*21*	*13*	*51*	*15*	*45*	*43*	*79*	*82*	*87*	*89*
60-64 mph	*8*	*12*	*19*	*13*	*40*	*15*	*6*	*1*	*2*	*1*
65-69 mph	*12*	*17*	*9*	*17*	*5*	*14*	*1*	*0*	*1*	*0*
70-74 mph	*15*	*20*	*4*	*18*	*2*	*10*	*0*	*0*	*1*	*0*
75-79 mph	*14*	*16*	*1*	*15*	*0*	*5*	*0*	*0*	*0*	*0*
80-89 mph	*18*	*15*	*0*	*14*	*0*	*4*	*0*	*0*	*0*	*0*
90 mph and over	*7*	*3*	*0*	*3*	*1*	*1*	*0*	*0*	*0*	*0*
Speed limit (mph)	70	70	60	70	70	..	60	60	60	60
Percentage more than 10 mph over limit	*25*	*17*	*5*	*17*	*1*	..	*0*	*1*	*1*	*0*
Average speed (mph)	70	70	57	69	59	61	54	53	54	53
Number observed (thousands)	3,288	448,555	3,405	62,215	2,184	29,904	2,825	1,770	8,289	41,265

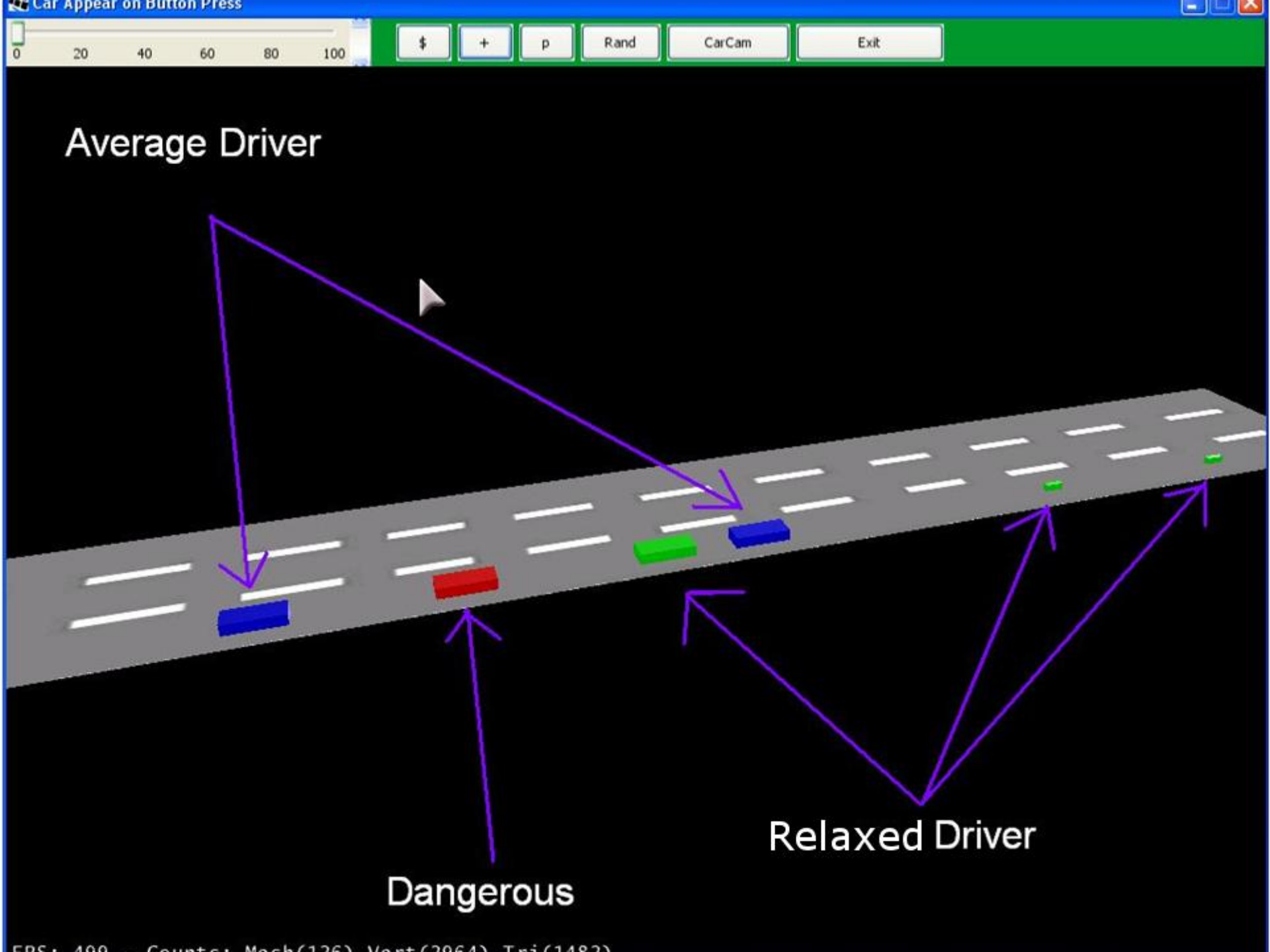

Car Appear on Button Press
0
20
40
60
80
100
$
+
p
Rand
CarCam
Exit
Motorbike
Car
Lorry
FPS: 477 - Counts: Mesh(109) Vert(2556) Tri(1278)

Design: The Driver Types

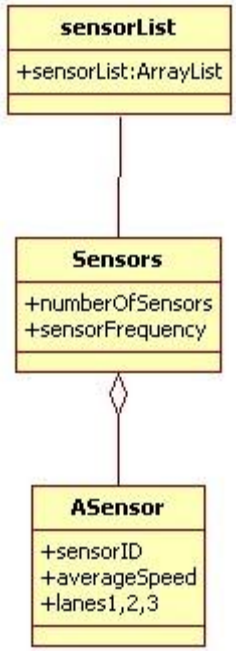


- Different driver types* assigned to vehicles in order to enhance realism of simulation.
- Vehicle colour determined by driver type to aid real-time analysis.

* Department for Transport, “Transport Statistics for Great Britain 2007”, pp. 131.


Car Appear on Button Press
0
20
40
60
80
100
$
+
p
Rand
CarCam
Exit
Average Driver
Dangerous
Relaxed Driver

Design: Sensors



- Sensors placed at intervals defined by road simulation scenario variable.
- Frequency of sensor checks defined by scenario

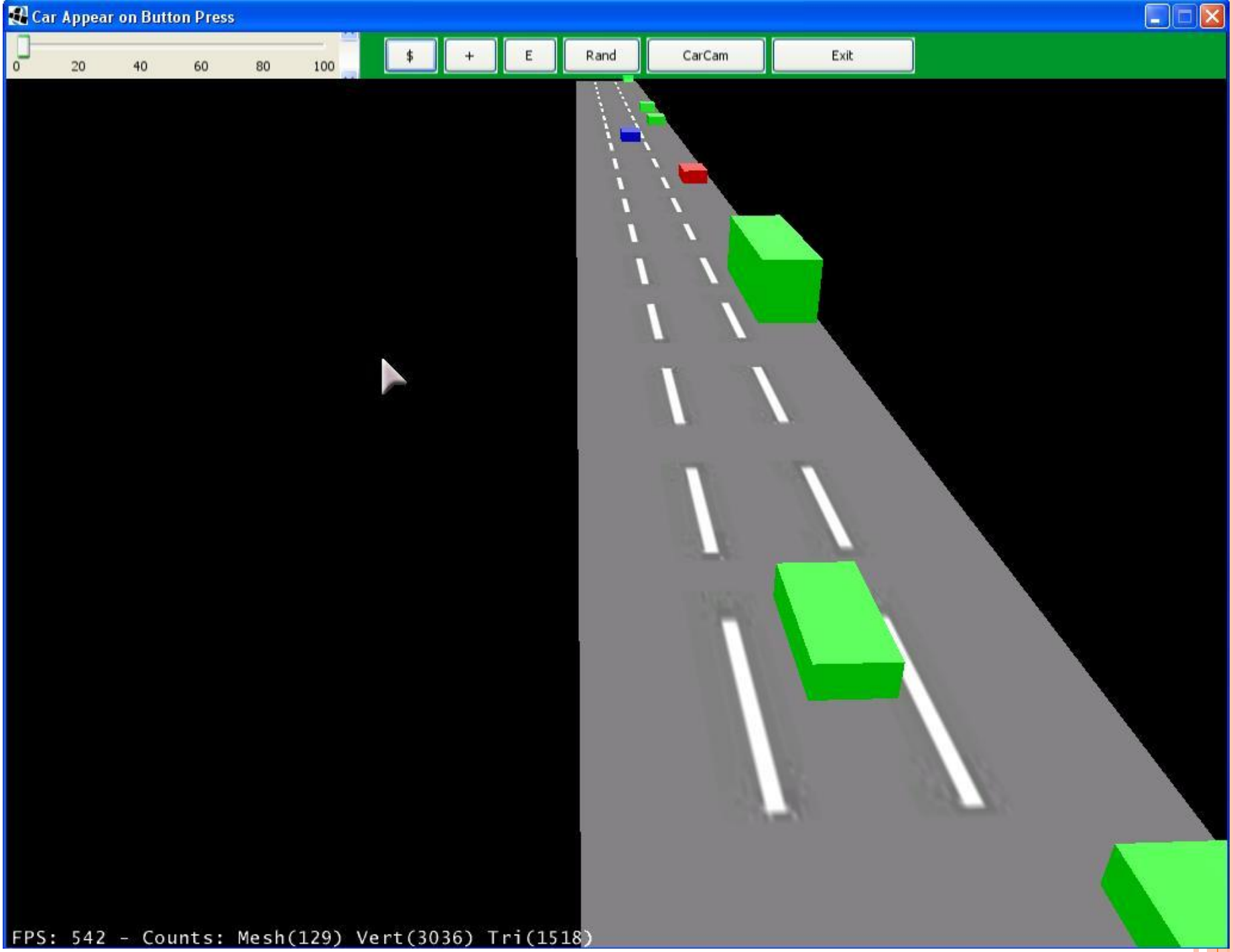
Design: Events

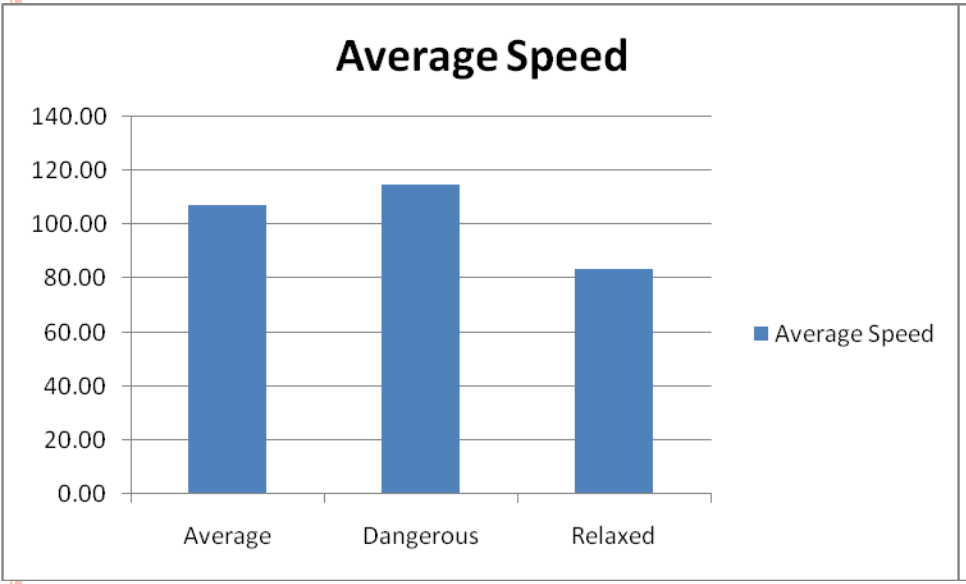
- Simulation also included events:
  - Broken down vehicle (Lane blockage)
  - Police Car (Mad driver with 150% speed)
  - Double Lane Blockage

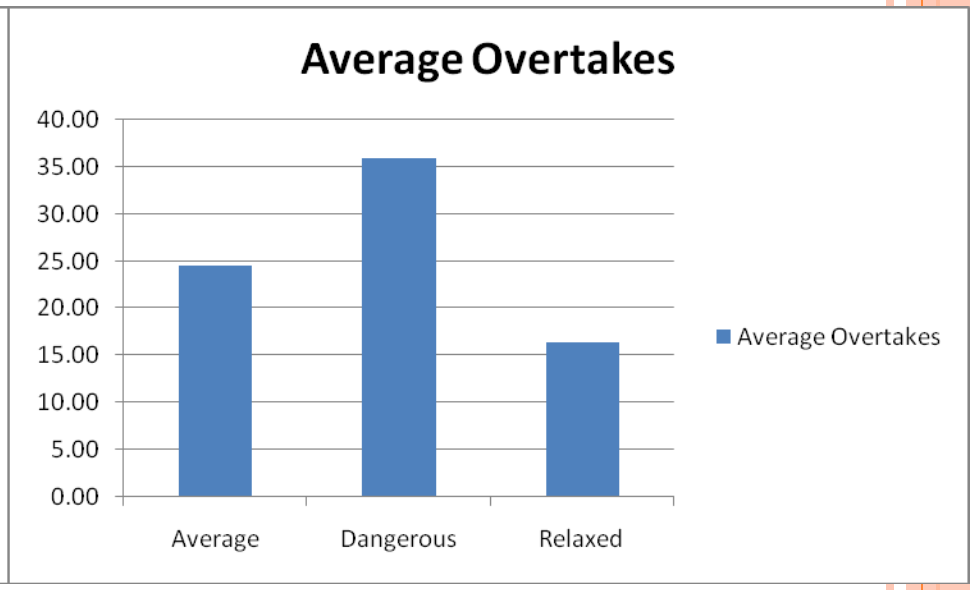
Scenario 1

- Very simple scenario
  - 10km Road
  - Sensors every 1km
  - Vehicle Insertion rate: 50 per minute

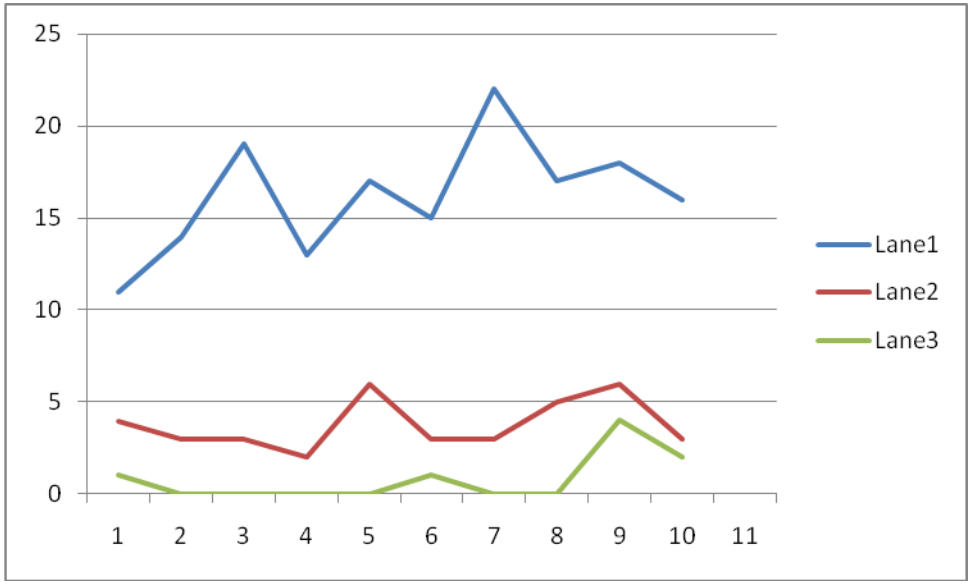
  - Uncongested Road expected


Car Appear on Button Press
0
20
40
60
80
100
$
+
E
Rand
CarCam
Exit
FPS: 542 - Counts: Mesh(129) Vert(3036) Tri(1518)



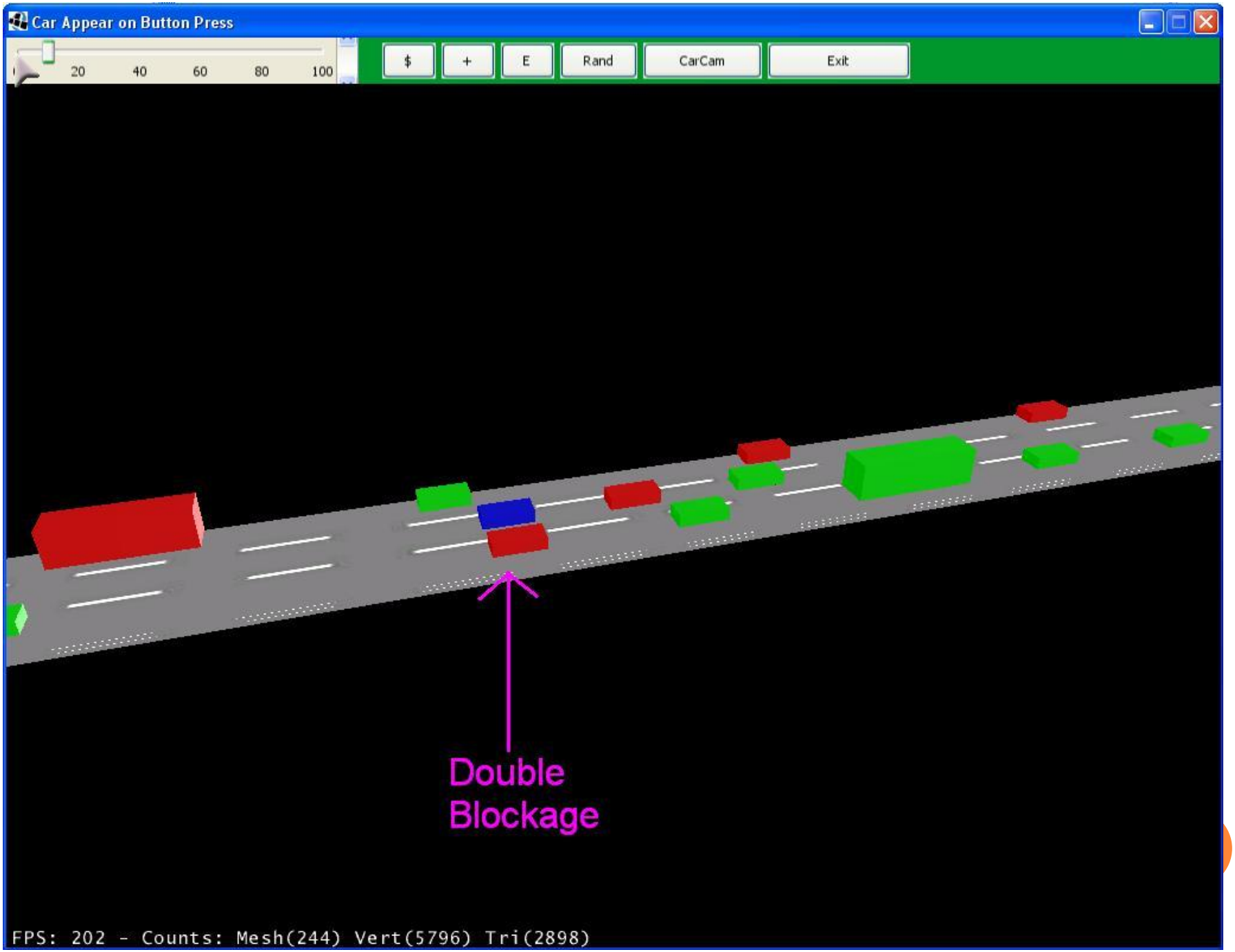


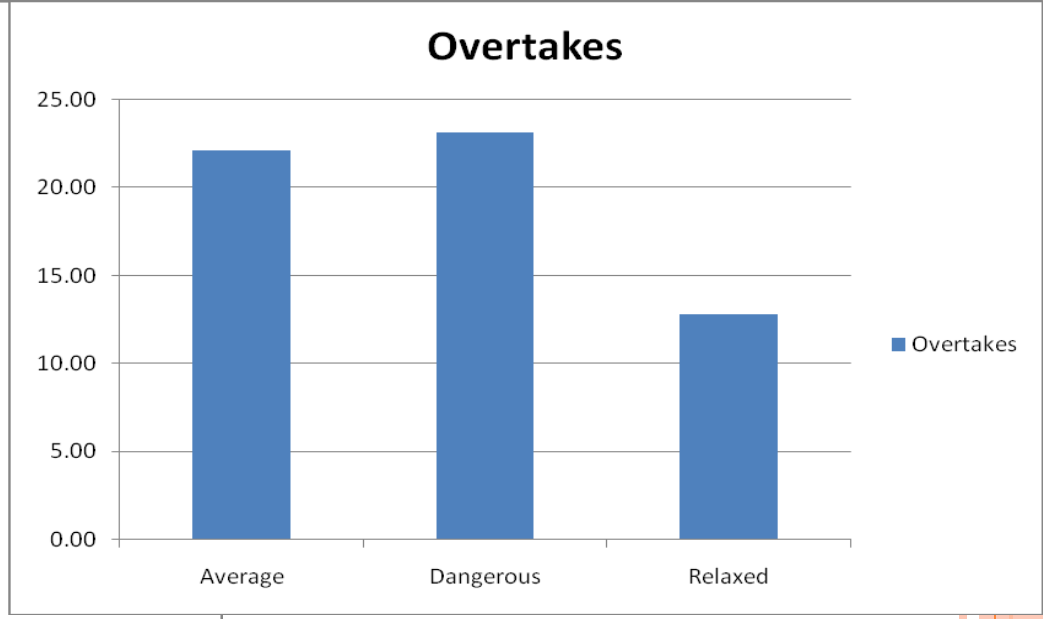
Average Lane Flow in Vehicles per Minute



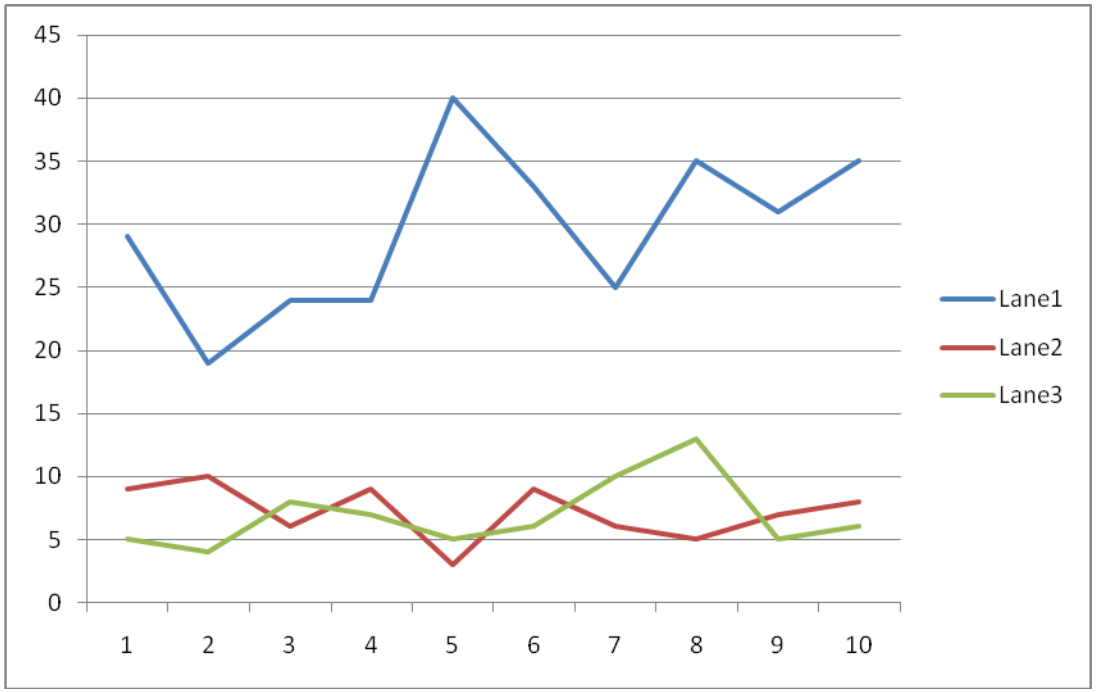
Scenario 3

- Double Lane Blockage
  - 10km Road
  - Blockage at 1km into motorway
  - Sensor every 1km
  - Vehicle Insertion rate of 100 Vehicles per minute
  - Congested road expected with traffic on stop before road block


Car Appear on Button Press
20
40
60
80
100
$
+
E
Rand
CarCam
Exit
Double
Blockage
FPS: 202 - Counts: Mesh(244) Vert(5796) Tri(2898)



Average Lane Flow in Vehicles per Minute



Conclusion

- Real-time analysis gained through immersion into the simulation helps discover information.
- Real-time observations compared to visualisation of statistical output from simulation to further assist discovery of information.
- Simulation allows many permutations of different scenarios.
- This simple simulation helps prove this ethos of information discovery through VR.

Future Work

- Enhance Simulation
  - Slip roads / Roadwork's
  - More driver types
  - Improve on immersion for VR
- Augment with data from Traffic Wales

Thanks For Listening

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- Rashid Mehmood – R.Mehmood@Swansea.ac.uk

http://www.swan.ac.uk/c2ec/