The development of an autonomous automated vehicle occupancy system for 2+ monitoring within moving road vehicles

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Where I am based – Loughborough???

Me arriving at work
Occupancy detection - applications

- High Occupancy Vehicle (HOV) or Diamond lanes
- High Occupancy Tolling (HOT)
- Congestion charging – differential occupancy based
- Road user charging
- Car parks
- Border control
- Crowd monitoring
Manual enforcement

- Efficiency ≈ 50 - 60% when well lit, good sight lines, rested & motivated
  - Ambient lighting – shadows
  - Vehicle speed
  - Tinting
  - Tiredness
  - Ethnic origin – dark skin & dark interior
  - Weather
- Cost
  - 24/7 – how do you do it at dawn and dusk?
  - Numbers of officers
- Suitable observation locations
- Safe areas to pull vehicles over
Requirements for occupancy validation

- Attended barrier
  - Pre-warn driver
  - dispute charge with toll booth operator
- Unattended barrier
  - prewarn driver
  - dispute charge with toll supervisor
  - remote contextual image (CCTV)

- Freeflow with lane separators
  - RFID tags
  - prevents crossover
  - independent systems
  - context image validation

- Open freeflow
  - RFID tags
  - spatial mapping
  - trajectory determination
  - context image validation
System features - detection

- Human skin targeting
- Animal/dummy rejection
- Ethnicity, age, gender independent
- Independent of hair loss/cosmetics
- Temperature independent
- Real-time operation
- All weather operation
- Active illumination – eye safe and invisible
- Operating range - <50m
- Maximum vehicle speed - <80mph
- Athermic/metallic windscreens
- Line of sight – if it can see, it can count
System overview

- Single pod
- Vandal resistant
- Thermal management
  - Low velocity inlets
  - Multiple inlet faces
  - High velocity outlet
  - Anti-spray paint design
  - Wiper-free
  - 5-10°C above ambient
- Post/gantry mounted
- Enclosed cabling
- Remote monitoring & control
- Completely autonomous
- Modular cartridge
  - Alignment
  - Downtime minimised

Inherently safe
CE, BS 60825 Class 3R
Positioning of occupants in vehicle

- Line of sight operation
- Driver always present!!!
  - Position swapped depending on country
  - % of LHD vs. RHD
- 1 adult passenger – front seat (except taxis)
- 2 adult passengers – 1 front, 1 rear kerb side (except taxis – 1 rear far side, 1 rear kerb side)
- 1 child
  - <1 year – rear facing in rear kerb side
  - >1 year – forward facing in rear kerb side
Systems at Loughborough University Gatehouse

- Gantry System
- Post System
Gantry camera system on Gatehouse
Night time operation, 23.00hrs – try doing that manually!!!

NO driver distraction, invisible illumination
test results – repeatability throughout the day
Repeatability studies at different speeds throughout the day

15 mph

25 mph

35 mph
Missed people because of insufficient lighting
Missed people due to turned head
Good count 2 persons - different configuration same vehicle
Issues to consider

- Enforcement applications;
  - Automatic implementations – definitions
  - Present images to enforcement officer
  - Assisting officer to undertake role
  - Officer duly able to provide enforcement task
  - Public perception of digital cameras performance – reduce offence rate – Deterrent!

- Tolling applications
  - Tarriff charged per vehicle – discount offered for 2+
  - If we can see you we can count you AND if we can count you we can give you a discount
Conclusions

- The system is a unique and complete solution to real-time vehicle occupancy monitoring.
- Capable of detecting individuals of any ethnic origin.
- Works on all vehicle types providing optical access is given.
- Capable of discriminating individuals from elaborately disguised dummies or animals.
- Provides the basis for automatic traffic occupancy determination, which can be customised for local requirements.
- ANPR, contextual imaging, triggering from simple optical make/brake reflective sensors or synchronisation of other systems are all easily integrated.
- Multiple context cameras can be used for vehicles with forward and rear facing seats.
Thank you for your interest

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