iTRAQ - Integrated Traffic Management and Air Quality Control using Space Services

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De Montfort University
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De Montfort University, Leicester:
> 21000 students

Key Research Groups:
- **CCI** - Centre for Computational Intelligence
- **DIGITS** – DMU’s Interdisciplinary Group in Intelligent Transport Systems

- 30 Academics, 4 Professors, 3 Readers
- About 30 PhD students
- Significant funding from a variety of sources
- Strong International reputation
- Major contributor to excellent RAE results
Other research

Current projects:
• iTRAQ (going into a demonstration / commercialisation phase)
• KTP with RingTrack, developing an embedded tracker
• AcouSense – Acoustic Sensing of Traffic Related Parameters
• Elasticity Model for Urban Traffic
• Traffic Data Analysis using CI
• Creation of a Motion Sensing Dataset
• REEMS - developing an innovative Range Extender for Electric Vehicles

Research Interests:
• Intelligent Traffic and Air Quality Management
• Acoustic Sensing
• Mobile Robotics
• Evolutionary Computing
• Control Engineering
• Intelligent and Traditional Signal Processing
• Embedded System Development
• Theory and Application of Computational Intelligence
Objective

- Automatically optimise traffic
- Automatically optimise air quality
- Inform operators, users, public, ...
  - Accurate forecasts of local traffic flow and delay
  - Accurate forecasts of local pollution levels
  - Enhanced traffic flow, delay, and air quality through using proposed strategies
- Adapt to and deal with to ever-changing traffic and air pollution conditions

Conflicting objectives
Air Quality
Air Quality
Air Quality
Traffic Monitoring
Floating Car Data (GNSS)
Architecture Overview

- Traffic data (incl. EO)
- Time
- Met data
- In-situ Air Quality
- CityScan
- EO AQ data (OMI,GOME-2)

Computational Intelligence Module

Traffic Simulator

City Plan

Demand Model

Air quality model

MACC modelled AQ

Feedback for iterative optimisation process

Optimised Traffic and Air Quality Management Strategy
Artificial Neural Networks

- **SCOOT data**:
  - Flow $f(t)$
  - Flow $f(t-1)$

- **Time stamp**:
  - Hour of Day
  - Day of Week

- **Meteorological data**:
  - Temperature
  - Cloud Coverage
  - Air Pressure
  - Amount of Rain
  - Wind Speed
  - Wind Direction

- **Adaptive Filter**
- **3 months historic data**
- **Training**

- **Forecaster**

- **Flow** $f(t+1)$
Artificial Neural Networks

Measure traffic flow at t + 1 [PCUs]

Traffic flow forecasts by FF-BP ANN with 7 HN, non-filtered [PCUs]

Traffic flow forecasts by FF-BP ANN with 7 HN, filtered [PCUs]
Region of Interest
Actual Forecast Results

Traffic Flow (veh/hr)

Air Quality NO2 (ugm-3)
Traffic Flow Prediction Results

Forecasted

Measured
Actual NRT Results (Simulation)

- a) Average over all operational hours
- b) AM peak - 8 to 9 o'clock
- c) Inter-peak – 12 to 13 o'clock
- d) PM peak – 16 to 17 o'clock
Strong increase in traffic flow
Substantial decrease in delay
While simultaneously managing air quality
Conclusions

• iTRAQ can provide:
  • Adequate and useful forecasts of traffic conditions and air quality
  • Increase in traffic flow 89% of the time (average 0.6%)
  • Reduction of delay every time (average 3%)
  • Similar levels of AQ but with shorter duration (in hourly simulations)
  • Traffic Management: Predictive rather than reactive
  • Better local management of AQ
  • A larger system that works on more junctions can enhance the traffic and AQ in a much greater way!
Future Work

• Demonstrate full implementation of system (in progress for next 2 years)

• Test system performance in operation
  – Quality of forecasts
  – Optimisation
  – Gain (how to proof this?!

• Generate a Benchmark for Optimisation community

• Integrate other services (and objectives)

• Expand this data-driven ITS approach into other domains
DIGITS – DMU’s Interdisciplinary Group in Intelligent Transport Systems

**Who we are:**
- 20 Members, 3 Professors, 2 Readers and quickly growing
- PhD and Master students
- Significant research funding from a variety of sources, incl. EU and ESA
- Gaining strong international reputation
- Researching and delivering cutting edge technologies for the transport sector

**What we do:**
- Intelligent integrated traffic management and air quality control
- Mechanical behaviour of pavement and rail track materials
- Airport and harbour environment modelling and evaluation
- Geographical information systems and data mining
- Computational intelligence
- Embedded systems and ECU design
- Telematics