Editorial

Foresight Project

This issue of the journal includes a further four papers originally commissioned for the UK Government’s Foresight study on Intelligent Infrastructure.

The first of these, by Miles and Walker, examines how artificial intelligence (AI) in transport may evolve over the medium-term future. It is assumed that the intelligent infrastructure of the future could have the potential for sensing, gathering, and essentially ‘knowing’ a great deal about the transport networks and systems of the future. The sheer amount of data, and the complex nature of the information processing required, will make the utilisation of AI essential. AI and the related concept of ambient intelligence (AmI) are well suited to handling the increasingly complex and varied data needed to describe the operations of transport systems and their usage.

The authors argue that AmI offers a vision in which we are surrounded by intelligent and intuitive interfaces supported by computing and networking technology, embedded in everyday objects such as homes, vehicles and roads. AmI will offer increased user friendliness, more efficient services, user empowerment, and greater support for human interactions. Miles and Walker suggest that this may impact transport systems in a number of ways, with considerable scope for AI to contribute to the development of new, intelligent modes of operation for the existing infrastructure to deal with problems of capacity, safety, reliability, efficiency and environmental pollution. AI is already deployed in many areas of transport where learning algorithms are appropriate, such as traffic management at intersections on arterial roads, travel-time predictions, and fuel-injection systems.

AI techniques are also increasingly a part of the intelligent traffic management models that analyse the behaviour and evolution of traffic. These systems do not replace human controllers, but act as intelligent assistants that cooperate in the task of defining and applying traffic control decisions. Short-term traffic prediction is important in providing real-time traveller information and route guidance. The latest integrated systems use congestion information to guide routing, both in advance of and during a journey. AI technologies will also address the need for dynamic routing, depending on information from traffic management centres and from other travellers. In combination with context-specific information and personal profiles, navigation can become more intelligent.

Automated vehicle control technology offers the benefit of ultra-fast reactions and the unwavering alertness of sensors. Combined with ever increasing intelligence and speed of data processing, this could actively support the driver.

Finally, Miles and Walker raise awareness of some of the issues associated with moving control and decision making processes away from the user, and warn that AI systems must be reliable, or will be perceived as poor substitutes for human judgement. The developers of AI must consider what happens when things go wrong, and incorporate backup systems for when the intelligence fails, for whatever reason. Also highlighted is a warning of the possibility of hacking, sabotage, vandalism, criminal misuse and other "worst case scenarios", including accidental or wilful non-compliance with operating procedures.

The second paper, by Lyons, examines the role of information in decision making for transport. A key issue for ITS-based information systems is that of user behaviour, as the use of the information provided to an individual traveller is crucial in managing demand and influencing this behaviour. The issues of how and why individuals arrive at their decisions, and the finding of ways to influence them, lie at the heart of travel behaviour, giving rise to patterns of mobility and demand upon transport systems. The effectiveness of an IIS will depend, in part, on how it assembles and disseminates relevant information to travellers. Lyons argues that the interaction between information, choice, and behaviour is a complex one that researchers are continuing to study, and that the provision of improved, context-specific information may help to influence usage and individual choice in the long-term. Nevertheless, he suggests that when considering travel options, the choice is not only about comparing their absolute merits, but also about their perceived viability. While travel information cannot change the nature of the actual travel options and their attributes, it can challenge public perceptions. Finally, the paper leaves us with a picture of how effective ITS technology can be, suggesting that technological advances and human ingenuity will lead to smart, personalised information services which may solve a number of transport problems. Some of the barriers to influencing travel choices may well be technological, but human nature, together with the relative merits and availability of travel options, also play a part in the choices individuals make.

The third paper, by Gelenbe, discusses users and services in Intelligent Networks, and reviews autonomous adaptation and complex services and their evolution as part of future intelligent infrastructure, together with the new architectures necessary for the effective management of future self-organising communications and service networks. Gelenbe presents the idea that technology and intelligent systems are of limited value if they do not pass on their benefits to human users. Intelligent networks can improve communications, and enhance our cultural environment, health, and social life. In addition, through the use of intelligent networks, users could ubiquitously and
harmoniously connect to, offer, or receive many services, including transport.

Without effective and reliable communications networks, intelligent infrastructure systems are unlikely to be allowed to manage many aspects of daily life, such as transport activities. Traditionally, communications technology has relied on centralised networks to which users can connect to access services. The Internet has begun to break down this centralised model, offering highly distributed, pervasive, communication-intensive services. He concludes that future networks will enable an intelligent dialogue between users and services, which will adapt to the needs of its users. However, achieving the level of service demanded by users will be one of the most significant challenges if these systems are to be successful.

The final Foresight paper has been contributed by Shawe-Taylor et al., and discusses the issues surrounding data mining, data fusion, and information management in future intelligent infrastructure. The authors begin with the premise that inexpensive and ubiquitous information processing increasingly allow users to obtain information about the status of the transport network, using technologies such as radio-frequency identification devices, sensor networks, and global positioning systems to collect data. Making best use of that data, and finding and exploiting patterns within it, will be essential for the effective use and management of the infrastructure. However, with the massive rise in the amount of data to be processed, computers will have to run sophisticated algorithms that act as filters between sensor systems and users, identifying potentially interesting relations and patterns. Thus the fields of data mining and data fusion are becoming crucial to the handling and distillation of this data. Data mining - finding meaningful patterns in a torrent of data - already plays a crucial role in the algorithms behind, for example, the Google search engine, and those used in bioinformatics. Data fusion and information management could create a step change in the effectiveness with which we exploit our transport infrastructure; for example, the techniques could enable increased integration of public and private transport. Resulting reductions in congestion and car occupancy could bring about significant energy savings. Pattern recognition and machine learning are seen by the authors as key techniques requiring further development to meet the challenges of information management for transport applications. The paper concludes by suggesting scenarios for intelligent traffic management that utilise these data mining and management tools to enhance the services and information choices available to the individual.

Accompanying the intelligent infrastructure papers, we have two papers that concentrate specifically on incorporating intelligence into the detection and management of incidents on major interurban routes.

The paper by Thomas and Dia looks at a number of increasingly sophisticated ways to process the real-time speed and occupancy data available from loop detectors to develop a better understanding of traffic behaviour and, specifically, to detect when an incident is occurring or has occurred that disrupts usual traffic flow. In addition to considering existing algorithms, the authors examine and develop new approaches based on neural network and fractal dimension analysis that appear to show considerable promise of improved performance.

The complimentary paper by Dia and Cottman discusses how the road infrastructure can be most intelligently used when an incident has been detected. This needs to take account of spare capacity on the secondary road network, away from the major arterials, and also expected driver behaviour and choices. The authors discuss modelling of “microscopic” driver behaviour, such as headway and lane choice, and use these models to explore how the network can best be used under a range of incident conditions. This modelling work provides a rich understanding of macroscopic traffic behaviour that can contribute to the development of robust management plans.

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