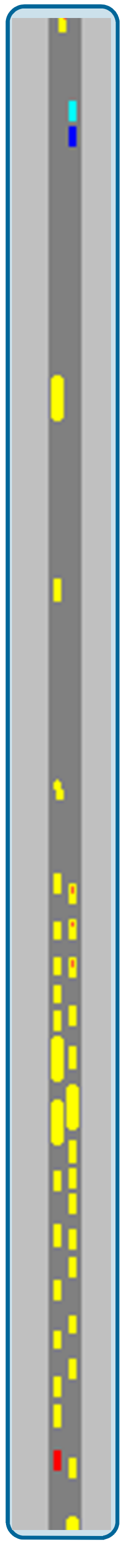
Policy Issue:

Improving traffic safety around a motorway accident site using Ambient Intelligence technologies

Welcome to this edition of the SOCIONICAL Policy Brief! The purpose of this series of policy briefs is to engage members of the policymaking community, researchers, professional services personnel as well as the general public and businesses in our work which deals with developing Complexity Science based modelling, prediction and simulation methods for large scale socio-technical systems. We focus on Ambient Intelligence (AmI) based smart environments and examine how such technology mediated environments enable, modify and control flows of information and people. The ultimate aim is to get insights into how appropriate systems might be put into place in the context of emergency and transportation scenarios in order to ensure people's safety and hassle free journeys. In each edition, we discuss one specific aspect of our ongoing research and invite you to share your views and knowledge with us.

Speed drops result in dangerous shockwaves

Vehicle breakdowns and crashes on motorways can create a sudden drop in traffic speed and make driving conditions dangerous for oncoming vehicles. It is not only the lane where the breakdown or crash happens which is affected but also the 'open' lane since the nearest vehicles in the blocked lane then try to jump into the open lane when they see their own lane blocked. These merging manoeuvres have to be timed to perfection with the driver of the manoeuvring vehicle having to quickly calculate the speeds of the vehicles on the open lane, the fluctuating size of the gap into which to manoeuvre and the optimum speed at which to squeeze into the gap. Any of these factors being inaccurately calculated could itself result in a new crash.

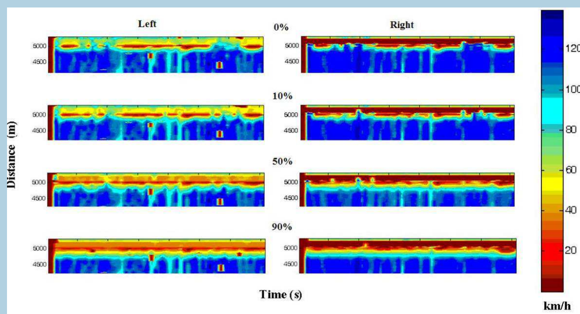


Merging into the open lane can create further sudden speed drops however and this can happen both in heavy traffic as well as light. In heavy traffic, where distances between vehicles are relatively smaller, it is easy to miscalculate the size of the confined gap into which to jump and a sudden reduction in the gap for the following vehicle already in the open lane might cause sudden braking, thereby triggering a cascading effect through the vehicles following further back. In lighter traffic on the other hand, where density is low and distances between vehicles are relatively larger, not only would the average speed be higher, there would also be greater variation in the relative speeds of the vehicles so that it is easy to miscalculate the speeds of the vehicle in front as well as that behind the gap, either of which could cause a crash. The vehicle following has to also respond quickly to the sudden change in the size of the gap triggering a sudden drop in speed that again cascades through the vehicles further behind. The greater the average speed and variation in the open lane before the manoeuvre from the blocked lane, the greater the uncertainty and magnitude of drop in the speeds subsequent to the manoeuvre. Motorway pile-ups are an example of these human calculations going wrong.

It is of course not just one vehicle that tries to manoeuvre itself from the blocked lane into the open lane. The following vehicles in the blocked lane all try to follow suit if they wish to avoid being stuck. However having a diversity of vehicles of different sizes and manoeuvrability (for example, lorries, buses and cars) on the motorway means that the oscillations in speeds between the open and blocked lane are made more complex, resulting in varying shockwaves.

Conventional speed harmonisation has limitations

Oscillating motorway speeds are a major cause for accidents and are globally damaging to efficient traffic flow. Attempts have been made to harmonise driving speeds using overhead signs before vehicles get too near to the accident site. This harmonisation should ideally enable traffic flow speeds in the two lanes to remain roughly equal to each other with the vehicles in the blocked lane having to turn only once when they reach the accident site causing the minimum disruption to the vehicles already in the open lane. Overhead signs are not always installed and when present have the obvious limitation that they are in fixed positions and since accidents can happen at varying distances from the signs, it is difficult to control the time and distance margins to allow incoming vehicles to adjust their speeds. There is also some time lost between identifying the blockage and sending instructions to the overhead sign. A more flexible system could help the traffic adapt more quickly to the new conditions.



Simulations by TUM showing the effect of AmI devices

Even 10% AmI penetration can improve traffic flow

SOCIONICAL partners have been looking into the use of AmI technologies to go beyond the state of the art in traffic management. One scenario to which this is being applied is the case of the M30 ring road in Madrid*, one of the main urban motorways in Spain, which accommodates an average flow of 300,000 vehicles a day that are directed by an Intelligent Transport System (ITS) implemented by SICE (one of the partners) to improve traffic flow and safety in the whole road network. Potential AmI technologies combine vehicle to vehicle co-operation and communication with the conventional infrastructure to allow both drivers and traffic operators to be alerted much sooner to an accident and execute the appropriate responses better. This saving in critical time, both in being alerted about the incident and in planning and executing the response has been found to be especially important in harmonising speed as evidenced by the measurements shown in the TUM simulations.

At this stage of the project, a simple simulation of motorway accidents has been carried out. In the simulation, the affected vehicle sends out wireless alerts to oncoming vehicles also equipped with the AmI device which then rebroadcast the alerts to vehicles approaching the congestion front. Preliminary results show that even a proportion as low as 10% of vehicles carrying the AmI device has a visible effect on speed harmonisation. This can be seen in the above image where the red streaks in the left column - representing the left open lane on the motorway - become progressively unbroken as the proportion of vehicles carrying the AmI devices is increased. The large red streaks in the right column indicate the traffic block in the right lane.

Motorway traffic with the addition of AmI is a particularly complex socio-technical system with a rich array of phenomena still to be explored. These will be studied in greater depth as part of ongoing SOCIONICAL work, outputs of which may be particularly useful to traffic operators and researchers.

References

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