

Display of Traffic Intent Information on Surface Moving Maps

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Abstract: To foresee and avoid potential conflicts on the ground is a major safety issue for today's airports in the face of runway incursions. Surface moving maps can support pilots' awareness by providing positional information on own-ship and other traffic. While this is surely of great help to detect potential conflicts it does not promote the human need to predict future developments, as only current status information is presented at the moment. The display of traffic intent information, e.g. a prediction of future own-ship and positions of other traffic, is a new concept that has been developed and tested for free flight operations. Now the first attempt was made to transfer this concept to surface moving maps. This paper will elaborate on why information about future developments is crucial for operators in safety-critical environments. It will further provide a short introduction on the status quo of traffic intent information research and finally present open questions on the display of intent information to be tackled by future research.

1 Increasing complexity and the need to foresee the future

The increasing complexity of cockpit automation limits the possibilities for humans to detect system failures. In the beginning, new cockpit technology has decreased the number of human errors because computers can increase system reliability to an extent where mechanical failures occur only rarely [De02]. However, the number of human-machine-interaction breakdowns has risen since then and has turned out as a major source of error. This is not at all surprising, as "the quickening tempo of technology change and the expansion of technological possibilities has largely converted the traditional shortcuts for access to a design process (task analysis, guidelines, verification and validation studies, etc.) into oversimplification fallacies that retard understanding, innovation, and, ultimately, human factors' credibility." [WD00]. Often, complex automation merely reveals tiny bits of information about the current system status with the consequence of producing a non-transparent work environment where operators are „out of the loop“, having barely information at all or holding incomplete information about the system [De02].

When the surrounding world does not match expectations “automation surprises” are the result [SW97; SW95]. This non-transparency can be increased further, when systems only display bits of status information, but fail to inform the operator about dynamic changes and future developments. For operators it is then even more difficult to assess the current system status, and almost impossible to create a profound picture of the future traffic situation. To successfully deal with complex systems such as aviation the formation of hypotheses, action planning, and deriving prognoses about the future are crucial [VS93]. When systems do not support these processes by only delivering data about current status, then the operator’s ability to influence the situation is rather limited and surprises are more likely to occur. “Predictive information, which extrapolates a [traffic] situation into the future is a critical element in any display.”[BJ00], as this helps operators achieve a solid overview of what is going to happen in the near future. It also helps creating a maximum of possibilities how to handle the future before it has arrived.

2 Traffic intent information on moving map displays

Surface Moving Maps are intended to provide enhanced positional awareness by displaying an own-ship position on a surface map of an airport. Advanced maps even present information about surrounding traffic, assigned clearances or support movement alerting e.g. crossing a runway without clearance [VU07]. However, at the moment the capability of moving maps is limited to presenting only status information – predictive information is missing.

The Cockpit Situational Display (CSD) is an advanced display that presents intent information, i.e. predictive information of own-ship and other aircraft (e.g. location, speed, direction, flight plans). These future predictions of own-ship and other traffic help pilots gather not only momentary status information, but offer a chance to track the development of the situation and get an idea of the possible future status of all aircraft at a glance. The objective is to create an overall picture of the evolving traffic situation to detect possible conflicts early. In recent times, the concept has been developed and tested for free flight/autonomous aircraft operations [BJ00; WB02].

Transferring this concept from en-route to the ground as “Surface Map Traffic Intent Display” has been initiated by the project NextGen 4DT [SP09]. Even though the overall objective stays the same, the context here is different: Traffic density on the ground is significantly higher, by which means the number of traffic information rises. Furthermore, pilot workload increases in near-ground flight phases. Therefore, the question is: How to present intent information without causing additional workload because of the requirement to look at another display? A continuous monitoring of the display is surely not an option; rather should the relevant information be displayed in an intuitive manner, where the future situation can be quickly assessed at a glance. Is a 2D representation, e.g. as overview-mode, sufficient for fulfilling that purpose? Or do we rather need a more intuitive 3D-representation coming closer to the pilots’ perspective?

A 2D-solution has been suggested recently: “The guidance cue – a magenta dot is shown on the commanded route, moving along the ATC-assigned route approximately 30 sec.

ahead – and a own-ship speed symbol in white showing own-ship position estimated in 30 seconds from present speed and acceleration (...). Similarly, trend and intent symbology may be displayed for the selected traffic.”[SP09].

3 Remaining questions on the display of traffic intent information

For the workshop at the Mensch & Computer 2009 two questions shall be addressed:

A) *Which information should be displayed:* What kind of traffic information should be displayed? Is a selection of relevant traffic necessary? Are declutter functions useful to reduce information in order to avoid information overload?

B) *How shall information be displayed:* How can intent information be displayed so that potential conflicts can be intuitively and quickly perceived? Are 2D-representations sufficient or do we need 3D to serve that purpose? How can pilot workload be kept to a minimum? How can continuous display monitoring be avoided?

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