A System for the Rapid Identification of Toxic Chemicals in HazMat Response Vehicles

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Introduction

The rapid identification of toxic chemicals is critical for saving lives in emergency situations ranging from terrorist attacks to chemical plant accidents. Hazardous Material (HazMat) specialists arrive at toxic chemical emergencies in response vehicles, and use software such as WISER (developed by the National Library of Medicine [NLM]) in those vehicles to rapidly identify the toxic chemicals. Figure 1 shows the typical context in which a laptop running WISER is used by first responders.

Figure 1. Interior view of a HazMat response vehicle showing the context in which HazMat specialists identify toxic chemicals during a chemical emergency.

Our previous research [1] has revealed that systems such as WISER have two limitations. (1) They require a large number of inputs before a chemical can be identified. This is because chemicals tend to have a high overlap of symptoms (e.g., irregular breathing) resulting in few that are discriminating. Furthermore, these systems use *Boolean Search* to look up databases, and provide little assistance for determining which symptoms are the most discriminating. (2) They have mainly text-based interfaces which require many selections to retrieve critical information (e.g., properties and classes of chemicals) necessary to make a rapid decision.

Design Method

To address the above limitations, we collaborated with an experienced first responder from a local county HazMat response team, to iteratively design an algorithm and interface appropriate for use in HazMat response vehicles. These insights were triangulated with three other HazMat specialists. We then used guidelines (e.g., provide system feedback) from the *heuristic evaluation* method [2] to implement and refine the design.

Figure 2 shows the resulting prototype called Mining And Interpretation of Diagnostic Networks (MAIDN) which tightly integrates search and visualization in a flat interface (requiring few selections), that is appropriate for use in HazMat response vehicles. The top left pane provides a

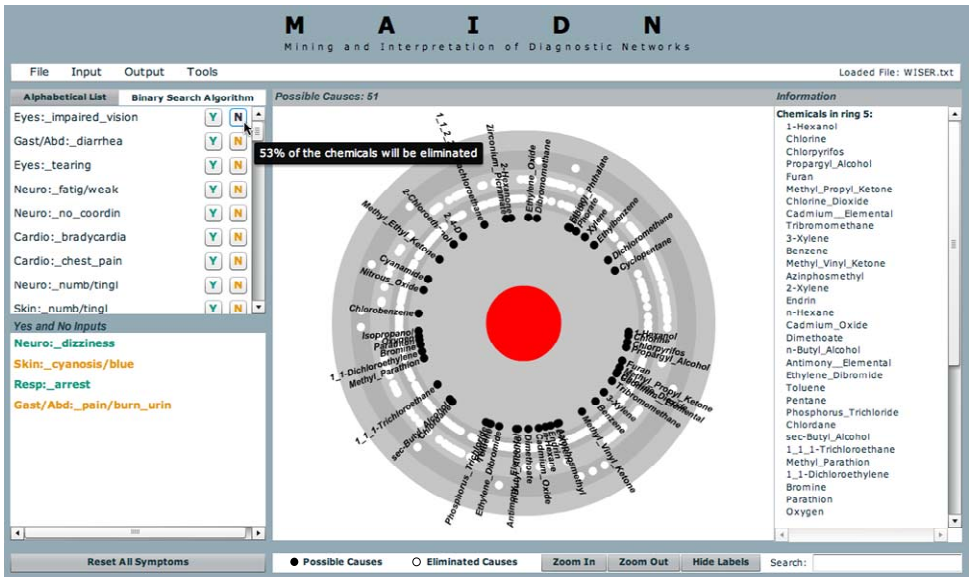

Figure 2. The MAIDN prototype integrates an algorithm which guides users to consider the most discriminating symptoms (upper left pane), and a visualization that provides "at-a-glance" how the symptom selections reduce the candidate chemicals (middle pane). Symptoms inputs can be undone by clicking in the lower left pane, and information about chemical properties and symptoms are displayed in right pane.

dynamically generated list of symptoms ranked by their ability to eliminate close to half of the remaining chemicals. For example, the top-ranked symptom (*Eyes: Impaired Vision*) in the figure will eliminate 53% of the chemicals (as shown by the pop-up box) if its no option ("N") is selected, and about the same if the ("Y") option is chosen. In the middle pane, the visualization provides "at-a-glance" the chemical nodes that are eliminated (in white) and candidate chemicals (black nodes with labels) that progressively move in smaller rings towards the inner red circle. When no more symptoms are available to distinguish between chemicals, the final candidate chemicals move into the inner red circle. The system therefore guides the user towards considering symptoms that eliminate many chemicals, and simultaneously provides visual feedback on the effects of different inputs to help make a rapid decision.

Conclusion and Future Research

A demonstration and the source code for our prototype have been provided to the WISER team at NLM. We hypothesize that our approach should improve the rapid identification of toxic chemicals during emergencies. In our future research we plan to test that hypothesis through a comprehensive user study with first responders.

References

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2. Nielsen, J. (1994). *Usability Engineering*. San Diego: Academic Press.