

VISUALISING MEDICAL DEVICE LOGS

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ABSTRACT

Medical device logs are currently used for incident investigation, technical support, monitoring patterns of usage and so on. This paper explores issues on visualizing device logs to discover how devices are used or misused in practice. This paper includes an analysis of logs from 58 infusion pumps of the same model. We give examples of presenting logs graphically, which makes them more prominent. Making logs visible should raise awareness of incidents that occur everyday, as well as the general value of logs.

KEYWORDS

Medical device logs, visualisation, human computer interaction

1. INTRODUCTION

Medical device logs are normally used for supporting hindsight analysis of incidents. Logging and analysing device interactions would give manufacturers insights into how devices are used in practice and how to improve their products. Moreover, keeping good logs of events would be useful for medical practitioners to learn from the mistake of other medical practitioners. To do this, investigations of incidents that did not lead to fatalities have to be carried out on a regular basis. Doing so would also ensure that the logging system works as intended.

2. CASE STUDY ANALYSIS

As a case study, we analysed logs from 58 Graseby 500 infusion pumps. The logs were plain text files and contained: the last 200 events that occurred on the pump; a cumulative frequency of the occurrences of the events over the lifespan of the pump; a summary of the durations the pump was used on battery; and a charge and pump history which contained information about the total time the pump was on, total time on battery and AC, total charge time, cumulative run time, cumulative volume infused and number of loading cycles.

Our aim in the analysis was to explore how the pumps were used to gain an understanding of how to design them better. From these logs we were able to get a view of sequences of events as well as the durations between sequences. We did this to discover any behavioural patterns which users may tend towards, especially ones which deviate from what is taught in training.

2.1. Results

We found that a few of the events were not logged in order and since the timestamp of the logs was only precise to the minute, we could not rely on the sequence of some groups of events. To analyse the logs we wrote programs which generate interactive visualisations from the logs. In the interactive matrix in Figure 1, we can click on a cell and view the durations between the sequence of events. From the sequence analysis, exactly half of all low battery alarms that occurred during infusion went on to be dead battery alarms; 17 pumps had this sequence. Closer inspection of the data showed that the duration between these two events ranged from 2 minutes to less than 1 minute

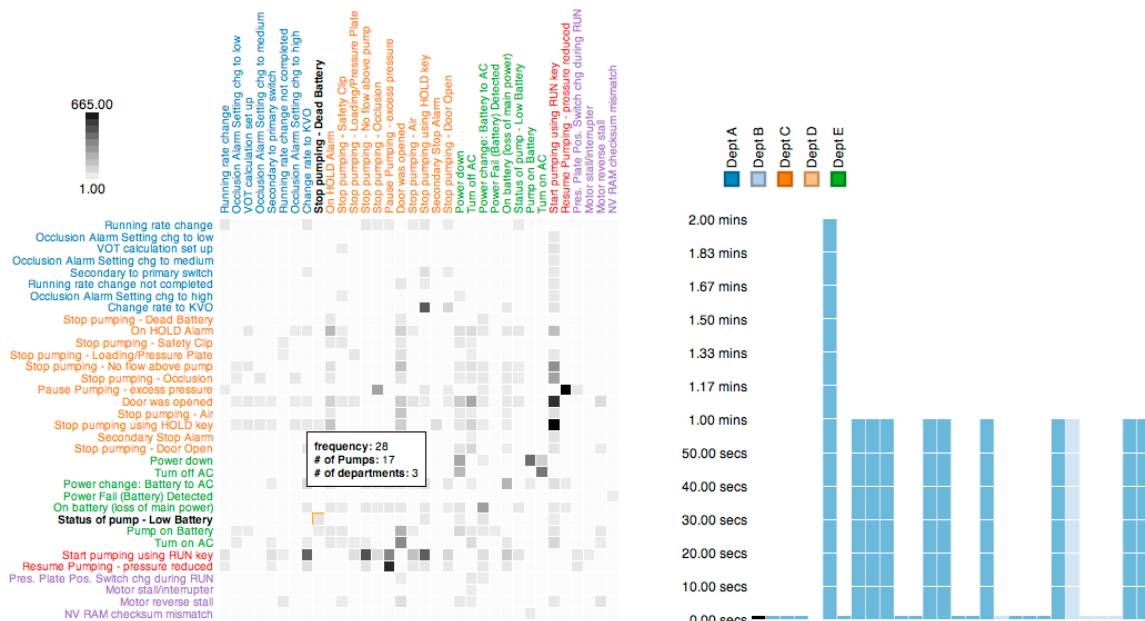


Figure 1: A screenshot of our interactive 2D matrix showing relative frequencies of sequences of events (left) and the durations between all instances of this sequence (right). Note that in the interactive visualisation (unlike this paper) the labels are legible at the default zoom level.

as shown in Figure 1. According to the manufacturers, the pump should alert the user to a low battery status approximately half an hour before the battery is fully discharged [1]. While one could say that nurses are ignoring alarms, it is also clear that the rate of depletion of the batteries should be better than two minutes. Better still, a pump could be designed such that it alerts the user if an infusion is started without enough battery life to cover the duration of the infusion.

Analysis also shows that contrary to what is being emphasised in training, infusions are being stopped by simply opening the pump door. This is a dangerous violation and unsafe practice that puts the patient at a risk of over infusion.

The visualisations presented here are specific to the log format of the Graseby 500 pump, we will have to extend (or rewrite) our programs if we want logs from different models of infusion pumps to be analysed. This poses a serious problem for hospitals because when an incident needs analysis, it costs hospitals money to get programmers to write programs which help in analysing logs and one-off programs may be unreliable.

3. CONCLUSIONS

Visualising logs can contribute much to the areas of training and assessment of end users by identifying gaps between theory and practice. It can also assist investigators in drawing conclusions more effectively, as it allows better reconstruction of the incident. Visualised logs paint a clearer picture of shortcuts, workarounds, interruption, and violation, which can feedback to the manufacturer's design process for better HCI design.

ACKNOWLEDGEMENTS

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REFERENCES

[1] Model 500 and micro 505 volumetric infusion pump : Instruction manual.