

# Visualising present and past: a meter with a flexible pointer

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## ABSTRACT

Meters and gauges based on analogue pointers provide a convenient way to visualise single dimensional data streams, such as speed, voltage, altitude, or fuel level. However, often a small amount of historical information helps to understand the data at a glance, and reduces the need for constant vigilance; is the parameter relatively stable; is it increasing or decreasing? Have there been any transients in the past minute? What trends are present?

This paper describes a virtual analogue meter with a flexible pointer that shows both the instantaneous value at the tip and bends to a brief interval of history along its length. The meter has been developed in the context of monitoring the electricity grid, but has many other potential applications.

## Author Keywords

meter display, dashboard, energy monitoring, history visualisation

## ACM Classification Keywords

H5.2. Information interfaces and presentation (e.g., HCI): User Interfaces.

## General Terms

Measurement

## INTRODUCTION

Meters or gauges with analogue pointers are commonly used to display the present value of time varying quantities. The most common examples are probably those seen on the dashboard of a car (Figure 1). While the fuel and temperature values change very slowly, so that an occasional glance is all that is required to check these, car and engine speed may vary significantly over short periods of time. In these cases, a glance is sufficient to ascertain the instantaneous value of the relevant parameter, but gives no indication of how that parameter has varied since the last glance. Knowledge of the history of the parameter can be gained only by constantly watching the meter, an inadvisable activity for the driver of a motor vehicle.



**Figure 1. An example car dashboard [9]**

Virtual implementations of speedometer-like indicators are commonly used in information systems “dashboard” displays, representing the present value of quantities such as company profit or inventory levels [3, 5, 7].

There are other representations of analogue data streams which incorporate a brief history window. For example, the medical monitor display of Figure 2 is one which emulates a strip chart recorder. The instantaneous data values are represented at the right-hand edge of the plot (like the stylus of a strip chart recorder), and the data moves to the left with time (like the paper strip of a strip chart recorder), so that the display window always shows the past few seconds of data.



**Figure 2. Medical monitor showing instantaneous values and a brief history [6]**

In many cases the representation of the present value of a time varying quantity would be significantly enhanced by the provision of some immediate history, where knowing a small amount of history about the parameter would be beneficial to understanding the context of the instantaneous

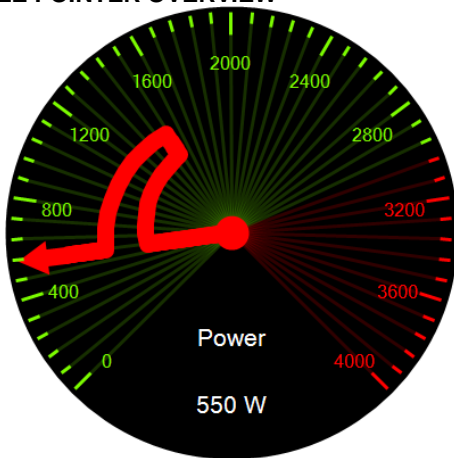
value. For example, when trying to interpret electricity usage, it is useful to know changes over the previous 10 to 50 seconds, as well as the instantaneous power consumption. If one is limited to just observing the instantaneous measurement, it is easy to miss important information such as recent peaks in demand. This is especially important for thermostatically controlled devices such as refrigerators or irons, for which the energy consumption may vary from almost zero to some significant figure over very short periods of time. In addition, a brief history can add context to values in business dashboards, enabling the identification of relationships between metrics, such as a correlation between customer returns and manufacturing defects [5].

Although a traditional line graph can show the historical information relatively easily, it demands more effort to read than a meter, and typically in the situations being described, the most recent data is more important than older data, yet a line graph allocates an equal display area for all data shown, regardless of age.

Other visualisations have the facility to display instantaneous values together with some aspect of history other than the direct history of the parameter itself. Examples include cumulative bandwidth shown on a network meter [2], minimum and maximum values, and distance travelled on a speedometer. Typically, there is a distinction between instantaneous and historical data.

This paper describes the implementation of a virtual meter visualisation that removes the distinction between instantaneous and historical data by combining the advantages of both meters and line graphs.

### FLEXIBLE POINTER OVERVIEW



**Figure 3. The flexible pointer meter showing a spike**

An example of the flexible pointer meter visualisation is shown in Figure 3. The pointer shows the instantaneous value of a parameter at the outside of the dial, in the same way as the pointer on a traditional meter. However, as the data ages, it “flows” along the pointer towards the centre of the dial while retaining the same radial

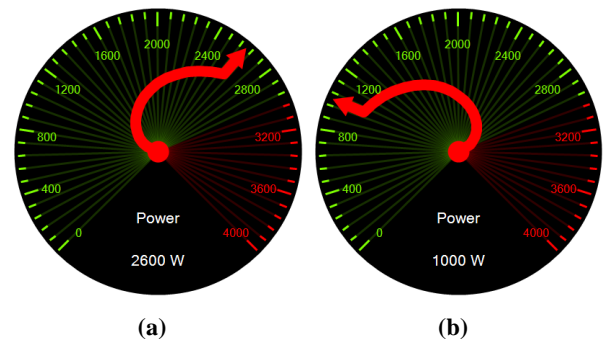
displacement. This has two effects: first, the analogy of a traditional meter is not broken – users are able to understand this part of the visualisation without explanation. Secondly, older data occupies a smaller area, and is thus of less presence, although still fully visible, leaving the dominant outer dial and larger area for the most recent data.

Users appear to have little difficulty in appreciating the radial nature of the scale for the historical data (see for example, Figure 4), although to understand the value of a parameter at some point in history, an imaginary line must be drawn from the centre of the meter, through the point of interest on the flexible pointer, and to the radial scale on the border.

For a given implementation of the visualisation, the time window represented by the pointer is fixed, and set to a figure considered appropriate to the application. Also, at present, the time scale along the pointer is linear. However, it would be possible to provide a user adjustable history window, and to explore non-linear time scales

### EXAMPLE PATTERNS

Figure 3 shows a snapshot of the power consumption of a household on a flexible pointer meter with a history of three minutes. The consumption is relatively stable (at around 550 W), but there was a brief 1500 W spike between one and two minutes ago. When visualised in real-time, the peak moves slowly towards the axis of the meter and reduces in absolute amplitude following the radial scale.



**Figure 4. A flexible pointer meter showing (a) increasing and (b) decreasing values**

Common and distinct changes in a parameter’s value produce identifiable patterns on the flexible pointer visualisation. Figure 4 shows the effect of a steady increase (a) and a steady decrease (b) in the parameter in question. A curve with a larger radius indicates a slower rate of change.

A stable (unchanging) value simply looks like a traditional meter with a straight pointer.

A sudden drop in power consumption from 1600 W to 1000 W is evident in Figure 5, suggesting that a 600 W appliance has just been switched off.

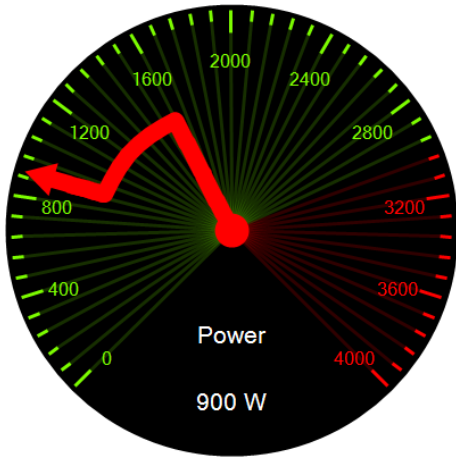


Figure 5. Sudden decrease

A fluctuating unstable parameter is shown in Figure 6. The extent of the fluctuation (maximum and minimum) is easily seen from the display.

The example shown in Figure 7 shows the actual electricity grid frequency, observed from the University of Waikato, approximately 35 seconds after the magnitude 6.3 earthquake struck the Canterbury region on 22 February, 2011. As the earthquake struck, power was disconnected over the majority of the city of Christchurch, resulting in an immediate 200 MW drop in load on the national grid [8]. As a consequence, there was a sharp increase in grid frequency caused by an excess of generation over consumption, which the electricity system took about 20 seconds to accommodate. Figure 7 also shows how time scales could be represented, by adding circles at 10-second intervals.

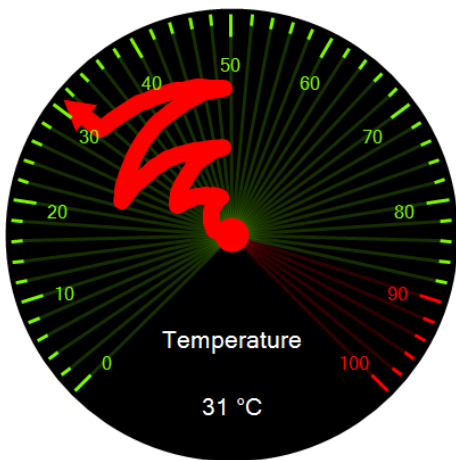


Figure 6. An unstable parameter

#### IMPLEMENTATION AND DEMONSTRATION

The visualisation, currently a working prototype, is implemented as both a C# widget, as well as a JavaScript version. A demonstration of the JavaScript version is available [4]; this shows the electrical grid frequency and

voltage of New Zealand’s North Island in real-time, as seen from the University of Waikato.

The historyCount parameter in the URL can be varied; this is the number of points retained in the history window. The meters are updated 10 times per second, so a historyCount of 50 will show five seconds of data.

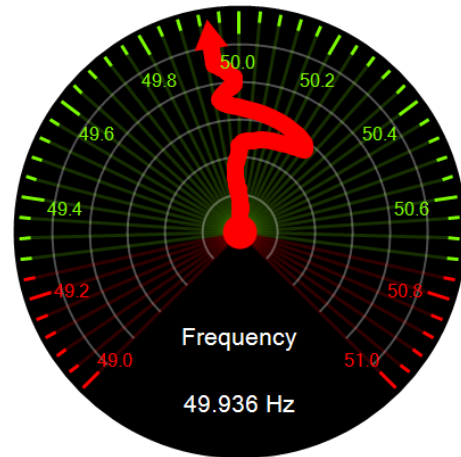


Figure 7. Grid frequency during the 2011 Christchurch earthquake, over a 1-minute timescale.

#### DISCUSSION

Traditional meters work well as peripheral awareness devices, where significant changes will draw a user’s attention. Due to the nature of the flexible meter, a significant change may not be as apparent since only the outer region of the pointer will move in response to a sudden change rather than the whole pointer. This could be addressed through other means, such as flashing the entire background of the meter when a change above a certain threshold is detected.

The prototype flexible meter is drawn with a fixed-width pointer; this may not be ideal for representing situations with sudden changes. An alternative way of drawing the pointer could be to use a rectangular-shaped pen tip, orientated tangentially to the radius of the meter. This has the effect that unchanging regions of the pointer are thicker than regions of change.

#### FUTURE WORK

The flexible pointer meter is very simple in concept, provides a small history window as well as the present value on a meter of relatively conventional appearance, and appears to be simple to understand. User studies are currently underway to establish the real usefulness of the device, and to explore various aspects of its design. For example, what is the impact of the width of the pointer? Should there be user adjustable parameters such as history window length? With wildly varying parameters, what is

the user impact of a significant increase of pointer “length”?

The visualisation has been developed in the context of the IDSLM energy load management research project [1], but clearly has potential applications in a wide range of other domains, for example showing gear changes in vehicles as in Figure 8.

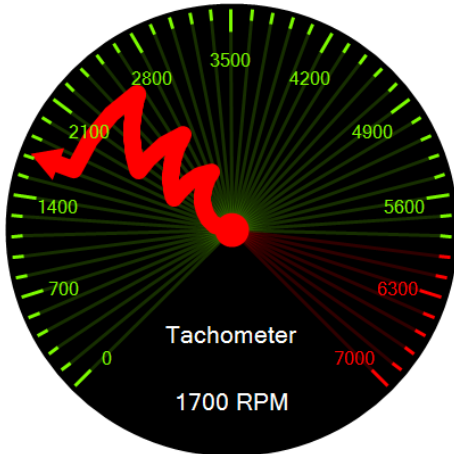


Figure 8. Tachometer showing gear changes

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