Fachhochschule Nordwestschweiz
Hochschule für Architektur, Bau und Geomatik

THE UNIVERSITY OF MELBOURNE

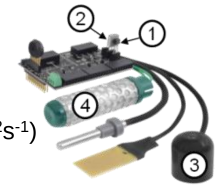
MSE | MASTER OF SCIENCE IN ENGINEERING

Improving the use of sensor network data for bushfire modeling and response

Bushfires are hazardous natural disasters that threaten people and animals. Distributed sensor networks hold the potential to capture autonomous critical diagnostic data in fire prone areas to serve analysis or monitoring applications. Such data features multidimensional characteristic: space, time, meteorological and other relevant sensor measurements. But it is difficult to see relevant information like trends, relations and behaviours in space and over time within all this data! Effective visualizations are able to assist the data interpretation and understanding and support decision-making regarding emergency services, public warning or strategic planning.

Network, Sensors & Data

The used sensor devices (nodes) consist of a board and different mounted sensors. They are set up with a capture interval of ½ hour. Each sensor has its individual measurement range:

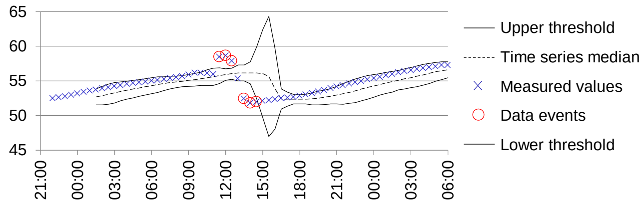


1. Air Temperature (-40 to +125°C)
2. Air Humidity (0 to +100% RH)
3. Solar Radiation (0 to +2000 μmol·m^{-2}s^{-1})
4. Soil Moisture (0 to +200 cb)

Data are sent to a router via a Wi-Fi link and passed to a web server . A web service stores the data as time stamped records in a database.

Pre-processing

Internal triggers and stored routines check the incoming records on the fly on their completeness, currentness and credibility. Further operating figures regarding data quality, data events and data importance are derived and stored as additional attributes in a quality management table.



The figure shows the data event detection for a humidity sensor, based on robust moving window statistics.

Design phase:

The goal was the development of valuable concepts, visualization designs and prototypes for several task types with regard to the sensor network data characteristics.

Be part of the experiments & test the designs:

Look for the numbers and check the following statements (solutions are printed to be read from "down under" ☹):

❶ In which direction does radiation have a spatio-temporal transition – north, south, west, east?

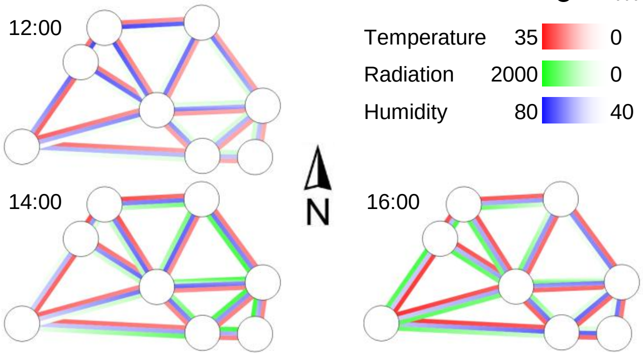
❷ What's the similar behaviour in all nodes regarding the relation between radiation and humidity?

❸ Humidity increases slowly & uniformly. True or false?

Experiment A: Simultaneous presentation of three or more continuous spatio-temporal phenomena in an animated geolocated map

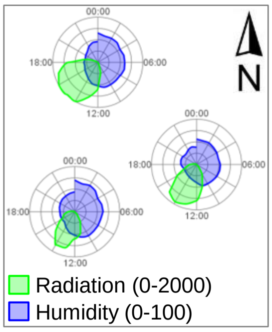
First the phenomena representation is abstracted to a triangulated irregular network (TIN), where the TIN-nodes represent the sensor devices. The edges are multiplied as much times as phenomena are present and coloured with the same base colour, according to the phenomena they belong to. Finally for each edge a saturation gradient is applied, corresponding to the sensor values, and the visualization is animated over time.

❶ West



Experiment C: Geographical small multiples

For a static map with temporal data, each node is represented with a round glyph at its geographical location: Daytime is mapped in circular, the sensor values in radial direction. Multivariate spatio-temporal behaviours can be studied comparing the glyphs in size and shape.

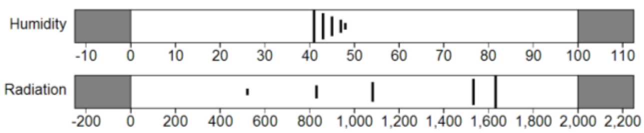


❷ Increasing radiation causes lower humidity

Experiment G: Inverting the visual encoding

Altering the visual encoding of established visualizations can lead to data representations with different advantages. E.g. reverse the mapping of a bar chart: map measurement values to a horizontal scale and timestamps to different bar sizes (meaning: the older, the smaller). This mapping allows for instance a fast acquisition of a measurement series essential characteristics.

❸ False, it's decreasing



Used visualization software: D3JS

Data-Driven Documents (D3JS) is a JavaScript library that binds data to HTML documents and uses Scalable Vector Graphics (SVG) and Cascading Style Sheets (CSS) to visualize them. It supports the manipulation of the Document Object Model (DOM) with selectors and transformations and includes animations.

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