Visualising Melbourne Pedestrian Count

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***Abstract*—We present a visualisation of Melbourne pedestrian count data and a visual metaphor for representing hour-level temporal dimension in this context. The pedestrian count data is captured from sensors located around the city. A visualisation web application is implemented that incorporates a thematic map of these sensor locations with a 24-hour clocklike polygon that shows pedestrian counts at every hour, and alongside a display of daily temperature. Our visualisation allows users to analyse how the city is used by pedestrians. Moreover, the design of our visualisation was driven by the type of analysis tasks carried out by city planners. The visualisation would help city planners better understand the dynamics of pedestrian activity within the city and aid them in urban management and design policy recommendation.**

I. Introduction

Pedestrian activity is vital to urban areas and reflects the liveliness and impacts the financial prosperity of a city. It has been considered an area of fascinating research in both academia and industry. In 1994, Gehl [1] and his students spread out over the city of Melbourne and captured the characteristics of its civic life by standing at various parts of the city and counting everybody passing them for 10 minutes and afterwards, generalised the data for up to an hour. They analysed how public infrastructures affected the way people spent their time. The results of these analyses were used by the city planners to make incremental changes to the public space resulting in an increased number of people engaged in civic life. More recently, [2] examined the dynamics of merging streams of pedestrians in public spaces. Their findings show that inefficient design of merging sections for pedestrian safety inhibits the quick movement of crowd when necessary such as in emergency situations. Approximately 800,000 people visit the city of Melbourne every day and at some point constitute the pedestrian population [3]. The city of Melbourne has set up pedestrian counting sensors positioned throughout the city to provide pedestrian counts for every hour at a given location. These also provide a means to understand multiple factors of societal influences such as commercial activities, and social norms amongst others. The pedestrian count dataset contains spatio-temporal attributes.

In this work, we visualise the Melbourne pedestrian count and alongside show the daily temperature. Our visualisation includes a thematic map of Melbourne with geographic locations of sensors shown as circles whose area represents pedestrian counts and a 24-hour clocklike polygon that shows counts at every hour. A section displaying the daily maximum and minimum temperature is also present. We used a visual metaphor for representing hour-level temporal dimension - a clocklike polygon that lets users investigate how the city is used by pedestrians, given daily temperature. Event control contains a list of events that lets users analyse the count of people at the various locations without having to remember the exact date of events. An animation control lets users play the visualisation for a certain period and see how the counts change using hourly updates as frames. The idea of our visualisation was to enable city planners to better understand how the city is utilised by pedestrians, understand the effect of factors such as daily temperature and key events on pedestrian activity, and to better inform them of how to plan for the future needs of the city economically, socially and otherwise. We illustrate the design of our visualisation motivated by the typical kind of analysis tasks carried out by these city planners.

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II. City Planning Analysis Tasks

The responsibility of planning the best utilisation of land and infrastructural resources of a city is usually undertaken by city planners [4]. They are tasked with the analysis of urban data from a wide variety of sources, ranging from population characteristics to map land areas and economic activities. The results of these analyses provide insights regarding how the city is being used and are the basis for urban planning. However, many analytical tasks associated with the investigation of urban data usage require the consideration of spatio-temporal dimensions. We have identified some of these tasks that are useful to city planners and utilised them as guidelines for designing and assessing our visualisation [4]. These help them:
(T1) Visualise the count of people who passed a sensor location at certain hours of the day using our visual metaphor;
(T2) Analyse the pattern of movement of people at certain hours of the day;
(T3) Compare two or more sensor locations to see the difference in movement at different time of the day, given daily maximum and minimum temperature;
(T4) Analyse the effect of city events on pedestrian activity;
(T5) Categorise sensor locations into common themes e.g. all train station locations into profile named *station*.

III. Visualisation Design

The City of Melbourne has set up sensors for counting pedestrians across the city at hourly intervals since 2009. We collected data from 2013 to 2016 [5]. The data is meant to provide insights into how the city is being used by pedestrians. The important attributes of the pedestrian count data are date, hour, sensor ID, sensor location, geographic coordinates of sensor locations, and hourly counts. We combined this count dataset with Melbourne temperature data [6] for the same period. The temperature data contains only the daily maximum and minimum temperature values.

A web application implemented to visualise the data is shown in Fig. 1.

Design 1: For (**T1, T5**), using the geographic coordinates attributes, the sensor locations are shown on a thematic map with the area of the circles being proportional to the overall hourly counts of people. The colours of the circle represent common location categories. Locations with similar activities have been grouped together as shown in Fig. 1(e & g). Thematic maps are useful for analysing proportions over geographic areas [7]. Although analysis involving statistical proportions can be explored with diverse non-cartographic visualisations such as line charts, other tasks involving investigation of changing spatio-temporal dimensions are better shown with maps [8].

Design 2: For (**T2, T3**), When a circle is hovered over or clicked, it expands into a 24-sided clocklike polygon where each side of the polygon represents an hour. The length of each side corresponds to the hourly counts as shown in Fig. 1(f). In order to reduce occlusion, the opacity of the polygons was reduced. This makes it visible and yet transparent enough to see underlying location points. A section displays maximum and minimum temperature for the selected day. As visual metaphors have been shown to shape how information is internalised and influences how visualisations are understood [9], we adopted a clocklike visual metaphor to represent hours, informed by an object with which users already measure time.

Time Selection Control: lets the user select temporal condition in the visualisation. As shown in Fig. 1(a & c), the two controls, Date-picker and Hour combo boxes allow users to select date and hour, updating the visualisation accordingly.

Event Control: allows the user to select temporal conditions – users can select any event to visualise how pedestrian counts increase and decrease at certain times without having to remember the date of the event, shown as Fig. 1(b) **(T4)**.

Animation Control: The *Play* button in Fig. 1(c) allows the user to play the visualisation for a certain period and see how the counts change using hourly updates as frames.

IV. Discussion

A primary reason we chose a day-by-day visualisation is to show to the user in one glance the overview of hourly pedestrian counts and the effect of daily temperature on pedestrian activity without losing the context that the thematic map provides. An area for future work is to extend the application to include year-by-year and month-by-month aggregates comparison. Moreover, the clocklike visual metaphor can be applied to other datasets containing temporal dimensions where the measures can be analysed over a 24 hour period e.g. weather data such as humidity, pressure. It can also be used to visualise two related measures simultaneously e.g. using the weather data, the length of each side of the polygon would represent humidity for each hour and the colour (a colour gradient) would correspond to hourly pressure values. Although inspired by our agenda to combine an intuitive visual metaphor with other visualisation types, we recognise the inevitable compromise in this approach - a trade-off of increased cognitive load in favour of visual familiarity. The opacity of the clocklike polygons was reduced to support visual perception, yet several overlapping clocklike polygons might increase visual clutter and cognitive load to the user. We will continue and extend our research to further assess the impact of the visualisation, including the merits and demerits of the 24-hour clocklike visual metaphor.

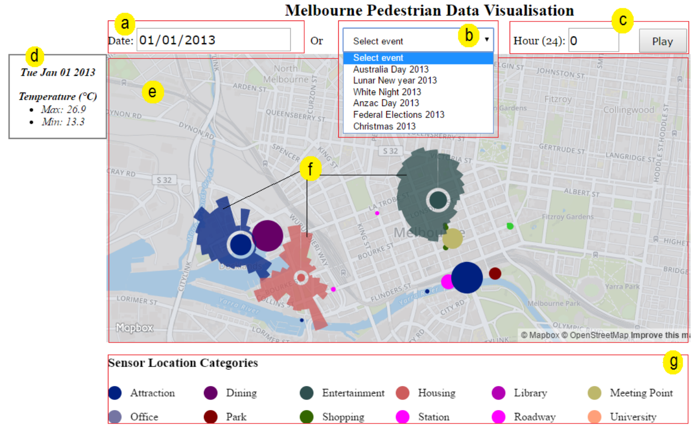

Fig. 1. The user interface with controls and legends. (a) Date selection control, (b) Event control, (c) Hour selection control and animation button, (d) Daily temperature (e) Thematic map, (f) 24-hour clocklike visual metaphor showing pedestrian count per hour, and (g) Sensor location categories legend.

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