THESIS INFORMATION

Title: **An Approach to Representing Visually Multivariable Spatio-Temporal Data**

Major:	Computer Science
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Data visualization is a mapping of data onto information and/or knowledge. In that, data are represented as visual graph suitable for human visual perception in converting graph to information or knowledge. The thesis "An Approach to Representing Visually Multivariable Spatio-temporal Data" systemizes the progress converting data to knowledge corresponding to human visual perception and the process representing multivariate data of case studies to structure the framework for visualizing multivariate data. However, the visual representation of multivariate data faces big challenge due to the technical limitation of displaying environment and the biological limitation of human visual system. The thesis analyzes and divides the challenge into three research questions to constitute the framework of visualization: (1) How to represent several data variables on 2D displaying environment?; (2) How to display multivariate graph with visual features as user's expectation?; (3) How to make good the limitation of size and resolution of 2D displaying environment?

Considering the relations of data variables in cases applying visualization, the thesis proposes models of multidimensional cubes representing multivariate data. The non-spatial multidimensional cube represents non-spatial multivariate data. The 2D-spatial multidimensional cube, also called multidimensional map, represents data of objects moving on ground, and data of spatio-temporal objects. The 3D-spatial multidimensional cube represents fly data. These multidimensional cubes representing visually multivariate data enable user to answer analytical questions, including elementary questions, global questions, and relation questions. When analyzing data with relation questions in case studies, user extracted enjoyable information from non-spatial multidimensional cube representing empirically the data relating to the happening of hand-foot-mouth epidemic in Binhduong province and from multidimensional map representing empirically the data relating to the happening of dengue fever epidemic in Angiang, Soctrang, and Tiengiang provinces.

The thesis “An Approach to Representing Visually Multivariable Spatio-temporal Data”, based on empirical case studies, approaches two sides of the mapping of data onto information and/or knowledge to making up the system for visualizing multivariate data with two components, visual technique and visual perception. The component of visual technique converts data to graph by computer, meanwhile the component of visual perception converts graph to information by human. For the component of visual technique, the thesis applies the philosophy “the whole is more than the sum” to structure the visualization framework for converting a set of multivariate data to one visual graph suitable for user’s vision and demands. The framework is structured with two stages, visual mapping and visual displaying. The stage of visual mapping is affected by data characteristics in converting a set of multivariate data to one multidimensional graph. The stage of visual displaying is affected by the characteristics of user’s visual perception and demands in increasing visual features of the multidimensional graph to become visual graph.

The framework for representing multivariate data proposed by the thesis “An Approach to Representing Visually Multivariable Spatio-temporal Data” is an interactive framework of visualization. It is composed of five functions utilized as five steps of the process converting a set of multivariate data to one visual graph. Graphic tools are made up to supply users not only to interact to visual graph but also interact to all functions of visual representation to improve the visual features of graph as their expectation. The framework of visualization solved three research questions relating to the challenges in visualizing multivariable spatio-temporal data. The thesis also constituted the process integrating retinal variable as a strong solution to increase visual features of multidimensional graph. The approach to integrating retinal variable applies the Cartesian product of a generated retinal variable and planar mark classes to improve visual features, where a generated retinal variable is a subset of a basic retinal variable or subset of a product of basic retinal variables. The increase of the number of generated retinal variables formed by the product of basic retinal variables results in the significant increase of the number of planar mark classes integrated retinal variable.

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