Development of Methods for Securing Spatial Information to Protect Personal Sensitive Data While Preserving Spatial and Statistical Relationship

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Summary

Two major research topics are pursued in this project: (1) Method for securing spatial information by adding noise after acquiring spatial information; (2) Method for securing spatial information at the time of acquiring spatial information. Major results of both topics are summarized in the following.

1. Method for securing spatial information by adding noise after acquiring spatial information

A new method is developed for adding noise to the objective variable in regression analysis, which is a sensitive information as a personal information. The degree of perturbation by noise addition can be controlled by a single parameter, which eases practical application.

In the proposed method, *t*-values of regression coefficients and coefficient of determination are preserved. By applying this method to actual real estate data, numerical experiments are conducted with adding noise to the real estate price as the objective variable. The parameter value is derived such that the result of regression analysis for perturbed data is not significantly different from that using only limited portion of the data. As a result, an appropriate value of parameter is derived satisfying both a sufficient perturbation of objective variable to conceal the original value and still preserving the statistical results.

2. Method for securing spatial information at the time of acquiring spatial information

Two methods are developed to securing sensor acquired spatial data before storing them into a server. One method is to securing spatial data while transmitting through communication system. In the wireless multi-hop sensor networks, data are acquired on nodes and transmitted to sink-node, which is the boundary point with the external network. To take advantage of this particular feature of transmission to secure data, a method is devised such that data are sliced, i.e., partitioned into several parts and transmitted to the sink node while mixing the sliced data in the relay nodes. The other method is to add noise at the point of sensing the spatial data. The method of negative survey is extended so that it is applicable to continuous and correlated multi-dimensional data. In this method, noise addition operation is done in the sensor nodes, hence users who do not trust telecommunication carriers and administrative organization can participate in sensing. Hence this method enables acquiring sensitive questionnaire survey, which contributes enriching quality and sorts of spatial data.

Secret sharing scheme is a method to enable concealment calculation keeping the input information secret. A new method to reduce memory space for distributed information and to securing calculation operation. In addition, useful applications are developed for medical system and recording life-log. Traditionally, concealment multiplication requires more servers than concealment addition and subtraction. A method is developed so that multiplication can be done with the same number of servers. The new method is compared to traditional methods in terms of detailed performance.