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A Graph Model for the Neighborhood-connection in the Internet of Things

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사물인터넷에서 이웃-연결 그래프 모델

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Abstraction

The *neighborhood-connection* in the *Internet of Things* is described. One of problems of the internet of things is about an inactivation of some components. This paper presents a graph model formally for the neighborhood-connection for the internet of things. Also, this shows that although there are inactive components in the internet of things, the internet of things can well-operate through neighborhood-connection technique entirely.

1. Introduction

The *neighborhood-connection* in the *Internet of Things*(*IoT*) has been described by Ryu and Kim[1-3].
The most researches are about detecting, modeling reliability and measuring probability for each fault component in the internet of things[4].
This paper shows that although there are inactive components in the internet of things, the internet of things can well-operate entirely through neighborhood-connection technology. This neighborhood-connection technique is applicable to detecting and connecting proper neighbor components through context-aware of *IoT*.

2. The Graph Model for the Internet of Things

In the internet of things, every component has connection with other components. Thus, the internet of things is represented by a graph[1, 2], which is called a component graph.

A *component graph*, *G*, is a graph. Nodes and edges of the component graph are represented as components and connections among components. *G* is a *relationship* component graph if edges of *G* have the relationship among components. *G* is a *typed* component graph if the number *typ*(*i*) is for every component *c*(*i*) of *G*. The number *typ*(*i*) is a component *type* of *c*(*i*).

The Fig. 1 shows an example of general component graph with *Co-location component relationship*, *Co-work component relationship*, *Ownership component relationship* and *Social component relationship*. In the Fig. 2, rectangle boxes(1, 2, 3,...) mean typed components(devices) and circles(A, B, C,...) mean component(human), and connections mean relationships.

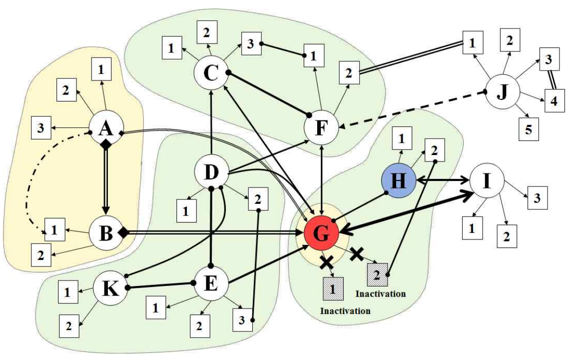

Fig. 1. General component graphs using graphs, *GG*

A component is an *activation*, *Act*, if a certain component of the internet of things is in an execution state. *Act* is isomorphic to a sub-graph of *IoT*. It means that there is a one-to-one mapping from components of *Act* into components

of *IoT*. Also, *IoT* contains *Act*.
This means that the *Act* is activating on all components in the internet of things.

A *k-inactivation*, *Ina*, in *IoT* is an inactivation of components with the number of *k* in *IoT*. All edges connected to these components can not be used. IoT^{Ina} denotes this graph with *k-inactivation*. The inactivation contains fault, un-link or unresponsive components in *IoT*.

The *IoT* is *k-neighborhood-connection*(*k-NC*) for an activation {*Act*(1), *Act*(2),........, *Act*(*n*)}, if *Act*(*i*) activates by IoT^{Ina} for every *k-inactivation* in *IoT*, when *i*=1, 2,....., *n*.

If *IoT* is *k-NC* for *Act*, then *IoT* is *j-NC* for *Act* with all *j*, where *j*=0, 2,....., *k*. In the graph *GG* of Fig. 2, the component **G** possesses two inactive devices. This component graph *GG* for *IoT* is 2-*NC*. Although the inactivation *Ina*={*c*(1), *c*(2)} for two devices of *c*(**G**) is present, this component graph *GG* can activate by GG^{Ina}.

The IoT_k is an extension of IoT_0 by detection of neighborhood related components and connections. Therefore, IoT_k is called an *optimal k-NC* of IoT_0.

3. Neighborhood-connection IoT with Optimal *k-NC*

In this section, optimal *k-NC* of the *closeness tree* of the internet of things is explained. The neighborhood-connection *IoT* is viewed as a tree[1]. The internet of things is composed as trees of different structures, and every level means different *closeness*. To compute simply *optimal k-NC* of *IoT*, the closeness tree uses two parameters. They are out-degree(*d*) of every component and level number(*L*).

The *closeness tree CTree* is the tree to be generated as detecting and connecting close-neighborhood components. The following algorithm computes an *optimal k-NC* of *CTree*.

Algorithm Computation of an *optimal k-NC* of *CTree*

1. Define a component set *C*(*L*)={*c*(0), *c*(1),........, *c*(*k*)} for each level *l* where 0≤*l*≤*L*-1. Also, define a type set *TYP*(*i*)={*typ*(0), *typ*(1),........, *typ*(*m*)} for each component in each level *l* where 0≤*l*≤*L*-1.
2. ***call*** *inactivation_detection*(*C*(*L*), *TYP*(*i*), *CTree*).
3. For any *i* (0≤*i*≤*k*), ***if*** *c*(*i*)∈IoT^{Ina}, ***call*** *neighborhood_ connection*(*C*(*L*), *TYP*(*i*), *CTree*, *G*). *G* is the component graph.

End-Algorithm

This algorithm can connect to all components and activate the internet of things, although the internet of things is some *c*(*i*)∈IoT^{Ina} for *i*=1, 2,....., *k*. This is *optimal k-NC* of *CTree*.

When *d*=1, the it is clear. And for *d*≥2, two adjacent levels contain components *C*(*L*) and *C*(*L*+*t*), *t*=0, 2,....., *m*-1, respectively. From any components set *C*(*L*), if inactive components *c*(*i*)∈IoT^{Ina} in *c*(*i*)∈*C*(*L*) is detected, any components *c*(*i*)∈*C*(*L*) can not connect to *c*(*i*)∈*C*(*L*+1) for *i*=1, 2,....., *k* between levels *L* and *L*+1.

4. Conclusions

The approach to the *k-neighborhood-connection* model in this paper is the component graphs to represent the internet of things and an activation. Also, there is an analysis of neighborhood-connection for inactive components of the internet of things.

However, this paper does not consider computing performance or time. Generally, it can be reconfigurable for an inactivation of the internet of things.

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References

[1] S. Ryu and S. Kim, "A Definition and Design of User Relationships of Internet of Things Graph," Proceedings in HCIKorea2019 Conference, Jeju, Feb. 2019.
[2] S. Ryu and S. Kim, "Method of Searching and Notification Devices to Around Unresponsive User," Proceedings of KIISE and KBS Joint Symposium, vol. 12, no. 1, pp. 139-141, 2018.
[31 S. Ryu and S. Kim, "Context-Aware Modeling with User Demand in an Internet of Things Environment," Journal of KIISE, vol. 23, no. 11, pp. 641-649, Nov. 2017.
[4] B. Yao, X. Liu, W. Zhang, X. Chen, X. Zhang, M. Yao, Z. Zhao, "Applying Graph Theory To The Internet of Things," HPCC and EUC, 2013.