A Safety Model for Highly Networked Home Environment

YANG Zhengguo (0910215)

School of Information Science,
Japan Advanced Institute of Science and Technology

February 6, 2012

Keywords: Home Safety, Domestic Environment Model, Dependability, Fault Tolerance, Error Avoidance, Failure Handling, Finite State Machine.

Recent years, home network with techniques of home information gathering, remote control, etc. and intelligent home devices with networking abilities has been greatly increased. And this provide home users with high automation and comfortable domestic living environment. In the other hand, this home network together with intelligent home devices and legacy home appliances make the whole home environment more complexity than ever. Especially in the viewpoint of ordinary home users, it may require them to be trained on how to use these high automation devices. So this greatly increased the probability of the occurrence of safety problems and emergency situations within the domestic environment.

This research is mainly focus on how to detect these safety problems and emergency situations, then make response to them based on the highly networked home environment with the purpose of keep home users away from safety problems and reduce property loss. And here "highly networked" means the integration of networked home appliances, data collecting devices, communication media, data storage, processing devices/equipments and necessary software that are used for collection, transmission, storage, and manipulation of information. Traditionally, safety problem detection

and reaction mechanisms like fire detection, gas detection and fall detection, etc. are only focus on a specific area, and seldom concern the relationship between one safety problem and others, and also the path of how a safety problem is formed. In our research, we proposed a system that trying to detect all home safety problems of home devices, home environment and the interaction between home user and home devices. And also the way on how to react on these safety problems.

Our proposed system is deployed in the service intermediary of the service intermediary model. In order to achieve the target, our research has been done the following things.

First, we make a classification of domestic safety problems based on material of safety problems published by professional organizations, for example fire hazard investigation published by U.S. Fire Administration, etc. and also others from the Internet. Safety problems are classified into three big categories. They are safety of home appliance, safety of indoor environment and safety of interaction between home user and home appliances. And each category has some sub-categories.

Next we abstracted a model for the domestic environment based on the interactions of different kind of entities. This domestic environment model have three layers: the architecture layer, the infrastructure layer and appliances layer. Each layer have many blocks of entities which may have the interaction with home user, technologies and intruder.

Third, we applied the concept of dependability to the domestic environment model. We defined the attributes of dependability, analyzed the threats to the dependability. And then provide means of fault tolerance, error avoidance and failure handling to obtain dependability.

For the fault tolerance, we use the concept of fault tree analysis to analyze cases of fire hazard with the purpose of finding out the basic events that contribute to the top event (fire). Based on these basic events, some rules are proposed for fault tolerance.

Fifth, in order to make a clear understanding of how one safety problem happens and how one safety problem would affect the occurrence of other safety problems. A finite state machine was proposed that based on the concept of dependability. By using this finite state machine, we can also make predictions on what safety problems would happen with the current

state and possible inputs to the machine. That is the detection of errors and failures. And also some rules are also proposed for error avoidance and failure handling.

Finally, we made our simulation and evaluation based on two cases, one is overload current (error) and another is clothes dryer fire (failure). And the implementation is based on the proposed finite state machine. The result shows that our proposed system can effectively detect and react to errors and failures within the domestic environment.