

# A User Survey on: How to Deal with Conflicts Resulting from Individual Input Devices in Context-Aware Environments?

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**Abstract.** In this paper we investigate how to deal with multiple input devices in context-aware environments. We look at how conflicts, resulting from contradictory explicit user inputs can be handled and we introduce and assess four different conflict resolution strategies in detail. These strategies are then evaluated with a questionnaire and a laboratory experiment.

## 1 Introduction

If there are multiple users in a smart environment, each one using a personal device to control and interact with it, conflict may occur. This happens when different users want to explicitly interact with the same service of a system at the same time. Typical reasons for explicit interaction are:

- The user should always have control over the system. [2]
- The user must be able to administrate the system.
- The user should be able to correct potential wrong decisions of the system.

Considering multiple user inputs it is important to remain consistency when different people with different goals interact with the same system. This shows that besides various conflict resolution techniques for implicit user interaction it is equally important to consider conflict resolution techniques for explicit user interaction. Although many researches are concentrating on implicit user interactions [1] when assessing conflict resolution. Up to now some researches [3][6] have pointed out problems with multiple explicit user interactions, but no resolution techniques were presented. In our work we introduce four different approaches for how to solve or prevent potential conflicts from multiple explicit input devices. The goal will be to find explicit interaction techniques which react on the base of social relationships in home environments.

## 2 Explicit Interaction Conflict Resolution Techniques

To remain consistency in multi-user context-aware environments it is important that only one person at a time owns the input channel. The upcoming techniques ensure that only one person can interact with the system (or service) or that at least all conflicting persons agree about the input. The first three of the four approaches are based on priority assignment; the last is a distributed one involving all users.

1) *Hierarchical* priority assignment:

At all times there is one person in control of the system.

2) *First Come First Serve (FCFS)* priority assignment:

The first person within a certain context area owns the input channel.

3) *Scheduled* priority assignment:

There is a dedicated time for every person where she owns the input channel.

4) *Technology augmented social mediation (TASM)*:

Every person involved in the conflict can actively take part in the resolution mediated through a technical device. The system reacts only on input, every conflict participant agrees with.

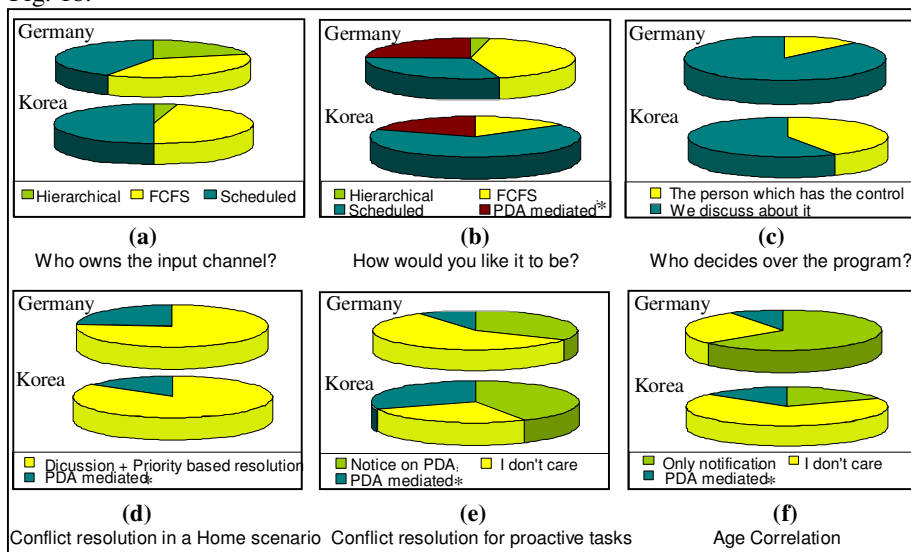
The first three approaches are simple to implement and are very effective for avoiding conflicts. Furthermore they reflect the ordinary behaviour of families at home (e.g. the first one in the living room has the remote control, similar to FCFS). The TASM works as follows: If a conflict occurs, a recommendation list of all users preferences is displayed on the user's PDAs. The users can select their choice which is displayed to the other persons, now they can decide whether to agree with this choice or to select a different item. The system only reacts on input, all conflicting persons agree with. The TASM is of most interest, when the conflicting persons can not solve the problem via a face-to-face communication (e.g. they are in different locations). In this case TASM can mediate the interests of the conflicting persons and no verbal discussion is needed. Furthermore it can help to bridge the social gap between family members to find a convenient resolution for all conflicting persons, by providing an equitable input device.

## 3 User Study and Laboratory Experiment

The goal of the user study was to find out which of the introduced resolution techniques the users may prefer and how smart homes can adopt social habits of family members. To get a first feedback in a short time we decided to carry out a questionnaire, a laboratory experiment will follow when these first results are evaluated. The questionnaire was carried out in S. Korea and Germany with 59 participants (30 Germans, 29 Koreans). It corresponded to a context-aware TV application. It was important to get information from various kinds of people, so the age ranges from 20 to 66 (average age 29), different kinds of technical skills and a wide range of occupations. First we wanted to find out how families are actually resolving conflicts regarding the TV program that occur with conventional

technologies. Furthermore we were interested in how they want such a conflict to be resolved in future systems. For analysing the data we also were interested in the dependencies of different variables, like nationality, age or gender.

In the questionnaire we detailedly described the usage of TASM considering a context-aware TV application. Because of that we could, additionally to questions about the participants TV watching habits at home, ask about new input devices like the TASM. The results show a high need to discuss about the TV content and to allocate the input channel by a priority based method; Fig. 1c, 1d. The opinions about a specific priority based approach differ, but the survey clearly indicates that a hierarchical approach is not wanted by potential users (Germany 3%, S. Korea 0%), Fig. 1b.



**Fig. 1.** Results of the user study (\*PDA Mediation is an instance of the TASM. The PDA acts as a mediator and is an equitable input device. )

Surprisingly the data shows not many distinctions between the two nationalities, but a few significant differences were observed. For Koreans it is much more important to take part in a conflict resolution even when they are not at home; 73% want to participate in any kind. In contrast to Germans, were 58% answered that they do not want to be involved. And 31% Koreans even want to solve the conflict with TASM (Germans: 9%), see Fig. 1e. Comparing Fig. 1a and 1c reveals that a hierarchical approach is more common in Germany (21%), but the decision over the TV content is based on discussion (88%). In contrast the input device allocation in Korea is alternating (FCFS 46%, Scheduled 50%), but the choice is often made by the person who has the control (42%). No inherent differences were discovered in view of the correlation between the answers and the age of the participants (>25, <=25). We only mention one further interesting issue; 51% of the younger people do not want to take part in a conflict resolution when they are not directly affected. In contrast to the older people were only 30% do not want to be involved, Fig.1f.

Assessing the correlation between the answers and the gender, one interesting tendency was observed. In three different questions the participants could choose the TASM. Averagely 24% male but only 17% of the females chose this technique. Additionally we did an experiment to take a closer look at the potential of the TASM. As an instance we integrated the PDA mediation into the ubi-UCAM 2.0 [5] and invited 12 persons (Korean) to experience this technique as an example on the TV application in the ubiHome [4]. They answered the questionnaire before and after testing the PDA mediated conflict resolution. This was chosen to see, if the experience of this new technology changes the opinion of the users. In this case we were interested in their opinion about a shared, technical assisted content decision technique. The answers for the PDA mediation tripled after the users were able to experience it (before: 8%, after: 24%), Fig. 2. This strong shift may result from the problem that it is hard to form an opinion about an input technique without experiencing it. Based on these results we will research the potential of TASM in context-aware environments.

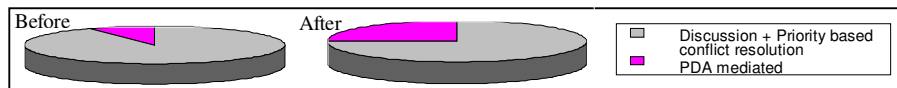


Fig. 2. How would you like to solve a conflict about the TV content?

## 4 Conclusion

In this paper we introduced four easy to implement approaches for conflict resolution. Our research shows that it is important to consider explicit user conflicts as well. When dealing with multiple input devices and multiple users it is crucial to provide means to handle such conflicts. To ensure consistency between several explicit input devices, the user's habits should be observed to build convenient input possibilities and to support the decision making process.

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