Design Principles for Effective Information Providing

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Abstract

The paper discusses design principles for effectively providing information that offers useful services. Most information is not annotated with a description of when and where the information would be useful. Therefore, the information can be obtained only by retrieving it with keywords or following layered categories. The paper argues that adding situation-conditions to information is important. The situation-conditions include the conditions of when, where, and how the information is relevant. Therefore, it can be retrieved easily in appropriate situations. The paper discusses how to represent situation-conditions and some necessary issues to express, use and circulate the service information.

Introduction

The purpose of our work is to enable people to use information easily, anytime, anywhere, and in any situation. Most information however is not annotated with a description of when and where the information would be useful. Therefore, the information can be obtained only by retrieving it with keywords or following layered categories. Therefore one needs mechanism for creating an interaction between human and information so that the human can use information appropriately.

On the other hand, systems that provide effective information by recognizing various situations in which people usually find themselves are studied in the field of augmented reality. They support human tasks in the real world by providing such information as descriptions of objects as they are viewed, navigation help, and instructions for performing physical tasks (Feiner 1993 [1], Fitzmaurice 1993 [2], Rekimoto and Nagao 1995 [3], Hollerer 1999 [4]). Recently, lots of related research has been done in the fields of mobile computing and pervasive computing (Long et al 1996 [5], Pradhan et al. 2001 [6], Spohrer and Stein 2001 [7]). These studies have focused on awareness of real world situations, situation dependent information processing, and information display technologies. Little research, however, has been done on how to prepare situation dependent information.

In addition, there have been some efforts to provide a semantic structure of information content, such as the Semantic Web Activity (Semantic Web 2001 [8]). Their purpose is to have data on the web defined and linked in such a way that it can be used by machines for automation, integration, and reuse of data across various applications. These efforts have explored ways to add meaning to information and to define relations between different items of information, but they have not investigated ways to arrange it according to situations, that are according to when, where, and how the information is used.

For resolving this problem, we propose a concept called *Situated Information (SI)* (Naito, Takayama and Maeda 2001 [9]) which is information with attached to situation-conditions. The situation-conditions include the conditions about when, where, and how the information is used. Therefore, it can be retrieved easily in appropriate situations. Namely, when information has attached situation-conditions, the system compares a user's situations with situation-conditions in the SI. When the system finds matching situation-conditions and real situations, it's the appropriate information is provided to the user. We also created the NVML (NaVigation Markup Language) specification which is subscribed to W3C (NVML 1999 [10]) and applications to interpret it (Naito et al. 1999 [11]). This includes part of SI functions, although it is limited to location-conditions and specified navigation services.

The information dealt with here is not declarative information (knowledge) but rather service information that helps human activities. Since such information is used in a specific situation (scene), attaching situation conditions makes it easier to retrieve and utilize the information.

In this paper, we discuss various issues related to realizing SI more generally, based on our experiences in building NVML. First we will show some examples of SI and discuss representation of situations and information. Then we discuss some gadgets which must be considered when connecting situation-conditions to information. Furthermore, we present how to circulate these data. Finally we will summarize.

Situated Information

We call the information to which situation-conditions are attached SI. SI consists of a situation-conditions part and an information content part, combined into a single datum. We will show the some examples of SI in the following and discuss the situation-conditions part and the information content part respectively.

Examples of SI

The situation-conditions part is expressed by sets of conditions where the information content part is needed such as time, location, circumstance, and so on. The information content part is expressed by multimedia sources such as text, voice, audio, image, video, virtual reality data and so on.

```
<situatedInformation>
  <situations>
    <time> around noon </time>
    <location area="100m">
        <latitude> N35.39.35.9 </latitude>
        <longitude>E139.42.14.6 </longitude>
    </location>
  </situations>
  <information title=" X Restaurant">
    <text>
          Italian
          lunch service time 11:00-14:00
          …. </text>
    <voice> Today's special is clam chowder </voice>
    <image src ="menu.jpg"/>
  </information>
</situatedInformation>
```

Figure 1: Example of *Situated Information* (a).

The SI described in Figure 1 implies that *X* Restaurant's information will be useful to people who are near *X* Restaurant at some time close to noon and can be used when people come within a 100-meter radius of the position specified by the latitude and longitude (assuming that this latitude and longitude indicate the restaurant position) and it is about noon. Then the system could introduce *X* Restaurant by using text, voice, and image data.

```
<situatedInformation>
  <situations>
    <time> weekend </time>
    <location area="1km">
        <latitude> N35.39.55.3 </latitude>
        <longitude>E138.40.22.6 </longitude>
    </location>
    <property-status who="child"> sick </property-status>
  </situations>
  <information title="Y Emergency Hospital">
    <text> Pediatrics
          Surgery
          Internal medicine
          …. </text>
  </information>
</situatedInformation>
```

Figure 2: Example of *Situated Information* (b).

The SI described in Figure 2 implies that *Y* Emergency Hospital's information will be useful to people who have a sick child and are within a 1 kilometer radius of the position specified by the latitude and longitude.

```
<situatedInformation>
  <situations>
    <time> 9:00/21:00 </time>
    <location area="500m" on="route99">
        <latitude>  N35.38.12.4 </latitude>
        <longitude>E140.51.39.1 </longitude>
    </location>
    <property-status object="gas tank"> quarter </property-
status>
  </situations>
  <information title="Z Gasoline Station">
    <text> regular 1.09
          super  1.19
          premium 1.29
          …. </text>
    <image src="shell.jpg"/>
  </information>
</situatedInformation>
```

Figure 3: Example of *Situated Information* (c).

The SI described in Figure 3 implies that *Z* Gasoline Station's information will be useful to people who are within a 500 meter radius of the position specified by the latitude and longitude on route 99 and whose when car's gas tank is about one quarter full, while it is between the times of 9:00 and 21:00 (assuming that this period is when the gas station is open).

This information is useful to people who meet the situations described in SI. When the system finds matching situation-conditions and real situations, its information is provided to the people by using text, voice, and image data automatically. If this information were stored with no situation-conditions, it would be hard to find.

NVML is one of the SI containers from the viewpoint that can describe a series of location-information sets. It implies that a NVML content includes a bunch of information attached location-condition. We will show an example of SI defined by NVML in figure 4.

```
<guide>
  <point area="100m">
    <name> Tokyo Station </name>
    <latitude>  N35.40.39.0 </latitude>
    <longitude>E139.46.18.1 </longitude>
    <address>  Chiyoda-ku, Tokyo </address>
  </point>
  <info>
    <text>  Platform 1,2 : Chuo Line
          Platform 3: Keihin-Tohoku Line (Omiya)
          Platform 4: Yamanote Line (Ueno)
          …. </text>
    <voice> Tokyo station is the entrance of capital Tokyo
        and famous for Renaissance-style red brick building
          …. </voice>
```

```
        <image src ="image/tokyo-station.jpg"/>
      </info>
    </guide>
```

Figure 4: Example of *Situated Information* defined by NVML

Situation Expression

Since we are proposing attaching situation-conditions to information, we are not going to argue about the expression method of a concrete tag in this paper. However, it is important to decide about what kinds of elements should be attached as situation-conditions. Since it is also necessary to unify the situation expression in order to make a situation match, we will mention about standardization trends.

In this research we aim at treating situations which are expressed with "who", "what", "when", "where", "why", "how". This view has appeared in some research on smart environments (Shafer 2001[12], Abowd and Mynatt 2000 [13]). In addition, situation, which both changes dramatically in daily life and which can be recognized by systems, should be chosen. If an affective expression (Picard 1997[14]) can be detected easily, we just add it as a situation-condition. That which is difficult to predict such as a social situation and that which rarely changes such as user profiles and preferences, should not be described as situation-conditions. For this reason, we are going to start from location- and time-conditions and will extend to other situations later.

Concerning location-conditions, although various proposals have been made in several organizations (GML [15], POIX [16], Korkea-aho 2001 [17]), there are some activities to standardize them. In the case of time-conditions, ISO8601 (a discussion of ISO8601 has been written by Kuhn [18]) is used as the almost unified description method, but it is thought that more semantic expressions, e.g. noon, evening etc., are required in order to treat a situation effectively. For other situations, some organizations are trying to specify ontology for situations, but so far there is apparently no unified expression. We think this is because the definition of a situation (in many cases, it discusses the related term: "context") cannot be given clearly, although a trial intended to define a context is coming out [19].

Information Content Expression

Service information, such as suggestions and recommendations that help human activities, is suitable as the information content of SI.

In the above examples, information contents are expressed according to multimedia types such as text, voice, and image. This method may be visibly different from Semantic Web Activity which is planning to attach the semantics to the information. We emphasize that when searching appropriate information in a certain situation it is more effective in attaching situation-conditions rather than attaching explanatory semantic tags. Of course, we do not deny that information (i.e. the web) has become useful by annotating and linking information semantically. Rather, we think that the standard tags of information content part will be replaced with semantic tags. On the other hand, we also think it is important to express the role of information content such as "explanation", "procedure", etc.

Representation Gadget of SI

In order to create SI, we should not simply put situation-conditions and information together, but we should think about the relationship between them. Some effective relations are realized in the NVML specification (NVML 1999 [10]).

Timing

It may be convenient if information is offered before or after the specified situation. For example, in route navigation systems, when a user is given information about a turning point, such as "turn left at the next corner where there is a gasoline station," the system gives information a few minutes before the turning point. This information is more useful than information given at the turning point. In NVML, we realize this using a "delay" attribute.

In order to offer information in a certain situation in advance, one must be able to predict the situation. In the case of moving entities, it is possible to predict arriving at the place by setting the route in advance or detecting speed and direction.

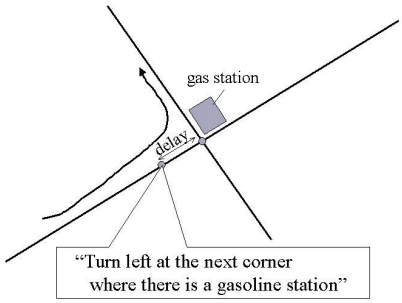

Figure 5: Timing Adjustment

Repeat

A user will often meet the same situation. In some cases, a user wants to use the same information at the same situation, repeatedly. In other cases, when a user looks at certain information once, the user does not want look at the same information again, even if the same situation happens. Therefore it is convenient if the user can specify the number of times to show. In NVML we realize that using a "times" attribute. For example, a user often repeatedly enters and leaves the same location. Then if the "times" attribute sets the value "1" as number of outputs, the location-dependent information is shown only once, when the user first enters the location.

Granularity

In order to create effective SI, we should attach situation-conditions which are easy to extract. Since it is difficult to find a match if situation-conditions are too finely described, technologies for summarizing situation-conditions are required. For example, considering time, when all of 11:55, 12:00, and 12:05 will be summarized as "around noon", it becomes easier to match them. Considering location, three locations of the following:

<latitude> N42.47.41.625 </latitude>
<longitude> E140.44.44.593 </longitude>
<latitude> N42.47.37.5 </latitude>
<longitude> E140.43.41.25 </longitude>
<latitude> N42.47.34.375 </latitude>
<longitude> E140.43.38.5 </longitude>

will be summarized as follows using range expression

<location>

<latitude> N42.47.37.5 </latitude>
<longitude> E140.43.41.25 </longitude>

<radius> 100m </radius>
</location>.

Link

In order to collect SI efficiently using robot type search engine, the link needs to be mutually shared on SI. Since SI is defined through XML, connections between SIs are realized by XLink (XLink 2001 [20]). With XLink, the linking function of HTML and not only the function of the same fundamental hyperlink but the function of an extended link can be used. It becomes possible to relate two or more resources via one link which is not included inside by the extended link. What one should be careful of here is making links among situations. When linked by the situations, information resources required in a certain situation can be extracted one after another according to the related situation.

Behavior Based Information

In some cases, it is important what information is extracted when considering a series of situations rather than considering the information on a certain momentary situation. It depends on which actions have been performed until then or which action will be performed from now on. For example, if one needs to show some information near a certain building at a part of a course which introduces history, one should explain the historical significance of the building. But if one's purpose is only navigation to the destination, information like "turn right at the building" is suitable for that location because the building is only a navigation aid.

In NVML, the set of SIs with a "navi" tag is distinguished as what is meant as a series of information. On the other hand, whatever is surrounded with a "guide" tag shall always extract effective information about the location, without being conscious of the sequence of events.

Circulation of SI

In this section, we explain how SI circulates through from a producing process to a providing process. It also argues about the issues which must be considered in each process.

Information Producing Process

The information providers disclose information about their home ground on the web with situation-conditions where the information will work well. For instance, weather companies release weather information and road administrators release road information. That is, information is scattered on the web. In the case of an in-house system, it will be published on an intra-net. They do not have to worry about where information is stored and categorizing information for someone who uses it. This suits the idea of the web in that anyone can create information and make it public easily.

It is expected that the person who dispatches information attaches the situation-conditions, but we should not count on only this. In order to circulate SIs rapidly and effectively, we need to produce them automatically by using an autonomous learning mechanism. When a person in a given situation asks for information, that information can be assumed to be useful in that situation. The system thus attaches the situation-conditions to the information and makes SI in real time, gathers the SIs from many sources, investigates in which situation the information is used most, and formally adopts as the information's condition, the condition in which it is used most. Maes et al. developed a system that uses an interface agent to assist in the decision of which action to take or suggest in the current situation (Maes and Kozierok 1993 [21]). The agent can learn by observing the user's actions and imitating them, receiving the user's feedback when it takes wrong actions, and being trained by the user on the basis of hypothetical examples. Though this system is used in desktop computer applications such as meeting scheduling and e-mail, the learning method can also be used to attach situation-conditions in the real world.

Some manual work, however, is necessary for making SI because it cannot yet be obtained on a fully automatic basis. We therefore developed a suite of tools called NVML Editor that can be used to attach location-conditions to information easily (Naito et al. 1999 [11]).

Information Gathering Process

In the information gathering process, SIs are collected by using a robot type search engine which is used in many search sites. We can consider two types of SI collection servers. One is the server which collects as many SIs as it can. It might be used in a common server like a portal site.

The other is the server which collects SI according to the situation of entities that use the SI. It might work like a personal agent.

In the latter type, the collection timing of SI will be adjustable according to the ratio of changing of the entity's situation. This implies that when a situation changes quickly, SI related to the situation is collected frequently and when a situation does not change rapidly, it is not necessary to collect information as frequently. Actual changes of situation depend on each situation (*i.e.* time, location, and other situations) and the entity *per se*. Location-conditions which are fixed to a certain location will not change, but time-conditions constantly change. SI which has only location-conditions is collected only once by an object which is fixed to a certain location, but moving people will collect this kind of SI continuously according to their movement.

Information Providing Process

In this section, we consider how SI can be used in common activities, considering cases of mobile computing and ubiquitous computing separately.

In mobile computing, a terminal device communicates with an SI collection server and sends information to a user. There are several types of implementations using SI. One is the type in which the device sends situations detected by sensors one by one and the server matches the situations with the situation-conditions of SI stored in a database or on the web. Another is the type in which the device downloads a set of SIs in advance and matches the situations by itself. In this case, at first a user selects some category through the mobile appliance. Then the server makes packaged SI according to the genre or area and sends it to the appliance. Once the appliance downloads packaged SI and the system finds appropriate information from the packaged SI in the mobile appliance, the information is shown to the user without accessing the server. The user is not given unnecessary information because the user selects the genre or area in advance when requesting packaged SI. Figure 6 shows this interaction image.

In ubiquitous computing, the environment itself becomes intelligent. Very small computational devices (i.e., ubiquitous computers) are embedded and integrated into the environment smoothly and almost transparently. These devices are aware of their physical surroundings and of when a person enters those surroundings. The computer then can give that person situation-dependent information. The devices embedded in the environment such as a street signs, traffic signals and bus stops thus must search for suitable SIs and download them if they are to be able to give the user up to date information. The device can easily search for suitable information which fits the device's location (situation) if situation-conditions are attached to the information.

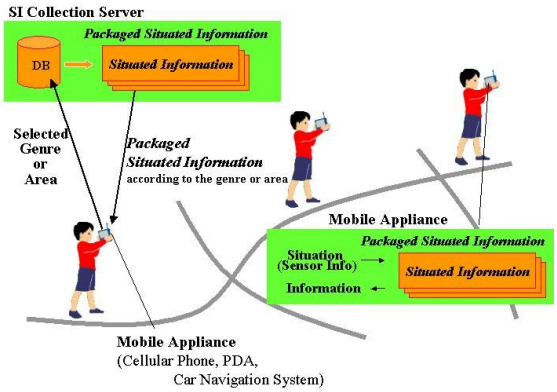

Figure 6. Interaction Image in Mobile Computing

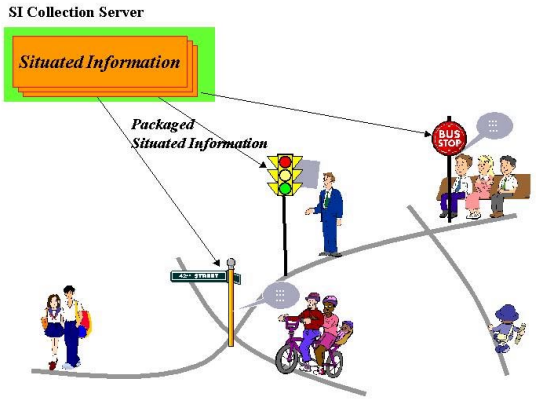

Figure 7. Interaction Image in Ubiquitous Computing

Information Displaying Process

The system compares situations which a user inputs with situation-conditions in SI. When the system finds those situations to be the same, information from SI is provided to the user. If the situation is measurable by the sensors, the information can be provided automatically.

In NVML, an information content part is described according to the form, such as text, voice, and image. Thus a terminal device can select the form according to its ability. For example, in the case of a cellular phone in which the display size is small, information is given by using text and voice. If the display has enough space, information is given by using image also.

Two or more SIs may match in a certain situation. In this case, it is also very important to take into consideration how a user is provided with these multiple SIs. We consider adjusting the interaction level with the user. The following are possibility for interaction with a user.

- All the information which fits situation-conditions can be shown, and a user pick one.
- Information to be shown is narrowed down and some chosen automatically.
- One piece of information considered to be the best for a user is chosen and shown.

These interaction levels should be adjusted manually by the user or automatically by the system.

Conclusion

In this paper, we discuss design principles for effectively providing information. Most information is not annotated with a description of when and where the information would be useful. Therefore, the information can be obtained only by retrieving it with keywords or following layered categories. We argued that adding situation-conditions is important. The situation-conditions include the conditions of when, where, and how the information is used. Therefore, it can be retrieved easily in appropriate situations. We also discuss how to represent a situation-conditions part and an information content part. In addition, as other necessary issues to create SI, we show some representation gadgets and how to circulate SIs.

On the other hand, we have already realized NVML specification and applications which is one of the SI containers from the location viewpoint, although the NVML specification specializes in navigation applications and focuses on location as a situation-condition.

We hope the issues addressed in this paper will stimulate discussion about the necessity of situation-conditions and believe our experiences contribute to constructing general SI.

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