5W1H: Unified User-Centric Context

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ABSTRACT
To deploy context-aware applications, there has been a steadily increasing interest in context representation for efficient description of complex contexts in daily life. However, most ways of describing context are specific to purpose of each service or give undue value to particular information, e.g. location. In this paper, we propose unified context, describing user-centric information without dependence on purpose of any service, in terms of 5W1H (Who, What, Where, When, How, and Why). The proposed context can simply represent user's contextual information by assorting complicated information into six categories. Also, the unified context can provide several semantic structures by interpreting 5W1H-based context from the view point of sensor, user, and service. The evaluation of unified context has shown that it is useful to represent a user-centric context in the form of 5W1H. Therefore, unified context will play an important role in developing context-aware applications in ubiquitous computing environments.

Keywords
Context representation, unified user-centric context, 5W1H, ubiquitous computing

INTRODUCTION
UbiComp-enabling technologies make environments aware of a variety of situations in daily life. In such environments, there has been a steadily increasing interest in context-aware applications which appropriately react to context of users or environments near them. To deploy context-aware applications, context representation efficiently describing contextual information plays an important role in creating, interpreting and exploiting context. According to those trends, a great deal of effort has gone into context representation over the past few years in the world of ubiquitous and pervasive computing. Examples include works of Held (2002) and Strang, et al. (2004). However, most ways of describing context are specific to purpose of each service or give undue value to particular information, e.g., location.

In this paper, we propose unified context, describing user-centric contextual information without dependence on purpose of any service, in terms of 5W1H (Who, What, Where, When, How, and Why). The proposed context can simply represent user's contextual information by assorting complicated information into six categories. Also, the unified context can provide several semantic structures by interpreting 5W1H-based context from the view point of sensor, user, and service.

UNIFIED USER-CENTRIC CONTEXT
"User-centric context" refers to information that decides which services and what kind of actions will be automatically triggered according to user's requirements. Of course, various contexts such as environmental, computational and user's information can be exploited by context-aware services. However, we believe that user-centric context can be fundamental clues to be aware of user's implicit expression to trigger services with assumption that a goal of ubiquitous computing is to provide user-required services in any where at any time. As a first step to represent context for services, we focus on user-centric context. In addition, to simply represent user-centric context, we classify the context into 5W1H which is independent of the specific purpose of any service. 5W1H is a popular way to describe a fact with "Who, What, Where, When, How and Why". 5W1H that is applied to unify user-centric context depicting "a certain user (Who) is", "in a certain location (Where)", "in a certain time (When)", "paying attention to a certain object/service (What)", "representing a certain expression with physical signs (How)", or "because of a certain intention or emotion (Why)". User-centric context, in terms of 5W1H, can provide applications with basic but enough information to trigger appropriate actions.

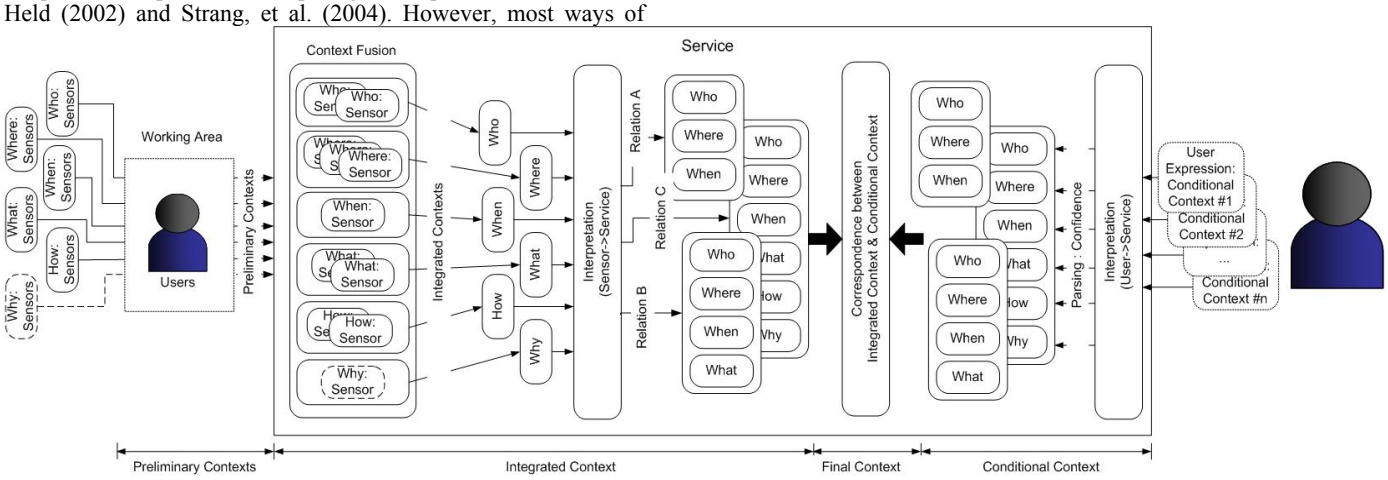

Figure 1. A context-aware process among sensor, user, and service

REPRESENTATION OF UNIFIED CONTEXT

Unified context consists of 5W1H elements and attributes describing the features of each element. Elements represent user's context in service environments. Attributes provides the meta-data related to an element or relationship with other elements. 'Who' element provides identification of a user in service environments and is a basis for interpreting a set of 5W1H. 'Where' element gives user's location information. The location shows available services surrounding a user because every sensor and service has its own active area where it affects users. 'When' element represents time when a context is available, i.e. a given context is valid only at a given time or interval. 'What' element is information of an object which a user is paying attention to. 'How' element depicts a user's expression such as behaviors or bio-signals. 'Why' element represents a mental state of the user such as intention or emotion. However, the role of 'Why' element is not to be aware of full mentality but to provide a clue to trigger a service or to get user's feedback on given services.

As shown in figure 1, unified context is classified into 'preliminary context', 'conditional context' and 'integrated context & final context according to the context-interpreting subject, i.e. a sensor, user, and service. The preliminary context from sensor's view represents factual information about a user in a service environment. The conditional context from user's view depicts contextual condition that users specify in services corresponding to their desire. From service's view, the integrated provides accurate information by means of fusing several preliminary contexts and the final context triggers a service if a correspondence between integrated contexts and conditional contexts occurs.

```
<Context Generator="ubiTV" WorkingArea="area B">
- <Final>
   -<Who>
      <Name UID="731219-xxxxx">Seiie Jang</Name>
      <Profile><Relationship Person="Woontack Woo
        priority="50">Disciple</Relationship> </Profile>
    </Who>
   -<Where>
      <Location Type="Indoor">
        <Coordinates Granularity="80cm" Origin="Door">
          <X>3</X> <Y>12</Y>  </Coordinates>
        <Symbols Reference="ubiHome">TV</Symbols>
      </Location>
    </Where>
   -<When>
      <TimeStamp Type="Symbolic">Evening</TimeStamp>
      <Interval Type="Absolute">
        <From>200504122130</From>
        <To>200504122132</To> </Interval>
    </When>
   -<What>
      <Destination Type="Object"> <DName
       Type="MultiMedia">TV</DName> </Destination>
      <Manipulation> <Function>Play</Function>
       <Parameter>Channel 9</Parameter>
       <Parameter>Volume 20</Parameter> </Manipulation>
    </What>
   -<How>
      <Activity>
        <Action>Standing</Action>
      </Activity>
    </How>
   -<Why>
      <Intention>Turn On</Intention>
    </Why>
  </Final>
</Context>
```

Figure 2. An example of unified user-centric context

Figure 2 shows an example of a final context which is generated by a context-aware service. This context means "TV (Play: channel 9, volume 20)$_{\text{What.Manipulation}}$ is triggered if Seiie Jang$_{\text{Who.Name}}$ is paying attention to TV$_{\text{What.Destination}}$ in the TV$_{\text{Where.Location.Symbol}}$ and is standing$_{\text{How.Activity.Action}}$ (for turning on TV)$_{\text{Why.Intention}}$". To generate such a final context, several contexts are processed as follows. At first, a sensor distributed in working area 'B' sends the service a preliminary context such as "Seiie Jang$_{\text{Who.Name}}$ is paying attention to TV$_{\text{What.Destination}}$ at (3,12) location$_{\text{Where.Location.Coordinates}}$ in 21:30~32$_{\text{When.Interval}}$". Another sensor in area B delivers "someone is standing$_{\text{How.Activity.Action}}$ in front of TV$_{\text{Where.Location.Symbols}}$". Of course, a user (Seiie Jang) specified the service with conditional context such as "I want to get TV(Play: channel 9, volume 20)$_{\text{What.Manipulation}}$ if Seiie Jang$_{\text{Who.Name}}$ is paying attention to TV$_{\text{What.Destination}}$ in the TV$_{\text{Where.Location.Symbols}}$ and is standing$_{\text{How.Activity.Action}}$". By fusing preliminary contexts from sensors, the service generates a set of integrated context, e.g. "Seiie Jang$_{\text{Who.Name}}$ is paying attention to TV$_{\text{What.Destination}}$ at (3,12) location$_{\text{Where.Location.Coordinates}}$ in 21:30~32$_{\text{When.Interval}}$ and is standing$_{\text{How.Activity.Action}}$ for turning on TV$_{\text{Why.Intention}}$". Then, the service compares an integrated context with conditional contexts and generates final context if a correspondence occurs.

ANALYSIS OF UNIFIED CONTEXT

We evaluate unified 5W1H-based context with above following factors.

Structure: Unified context consists of elements and attributes. An element represents user's situations and an attribute describes features of the element. In addition, all elements and attributes are labeled to reduce the ambiguity that may occur during interpreting context.

Composition/Decomposition: Unified context is classified into preliminary, integrated, final, and conditional context. This is adaptable to create, interpret, and exploit context in distributed computing environment.

Interchange: Unified context guarantees the serialization of context representation because it is based on XML. In addition, it guarantees harmonized services that share the state of operation with others by means of final context.

Unification: Unified context represents user-centric contextual information in terms of 5W1H and is interpreted according to the view point of sensor, user, and service. However, it requires formalizing sub-elements of each element of 5W1H in order to describe user's context in details.

Extensibility: Unified context guarantees extensibility of context by means of structural representation that enables an element to contain sub-elements. However, there is a restriction that all contextual information should fall into six categories.

Applicability: Unified context has been used in various context-aware sensors and services of ubiHome [1], which is a testbed for ubiComp-enabling home environment.

CONCLUSION & FUTURE WORKS

In this paper we proposed unified context, describing user-centric context without dependence on purpose of any service, in terms of 5W1H. As a result of evaluation, unified context has weakness on extensibility. To complement such a shortcoming, unified context should be extended to describe user-centric context to the physical and computing environments as future works.

REFERENCE

1. Jang, S., Shin. C., Oh. Y., and Woo, W. Introduction of 'ubiHome' Testbed. The first Korea/Japan Joint Workshop on Ubiquitous Computing & Networking Systems 2005(ubiCNS2005).