Context disambiguation based on dynamic Bayesian networks for context-aware environment in pervasive computing

Arun Paul. J
arunpaul.cse@gmail.com

Dr.B.G.Geetha
geetha@ksrct.ac.in

K.S Rangasamy College of Technology
Tiruchengode, Namakkal.

Abstract

A context is the piece of information that captures the characteristics of computing environments are often inconsistent in the dynamic and uncertain pervasive computing environments. The concurrency property defines concurrency among contextual activities which is more significant in context-aware applications and also serves as the basis for specification of many other properties. It facilitates context awareness in pervasive computing of Runtime detection of contextual properties. Existing schemes implicitly assume that context collecting devices share the same notion of time. Due to resource constraints, context collecting devices often postpone the dissemination of context data resulting in asynchrony. It detects the concurrent events in asynchronous pervasive computing environments by checking context consistency using **CADA algorithm**. It makes computing entities proactively send messages to each other, to build the happen before relation it requires which is necessary to achieve context awareness in asynchronous environments. But the problem of context ambiguity arises and message overhead occurs in such asynchronous environments. The proposed system reduces the message complexity and overcome the issues of context ambiguity problem. This efficient framework fuses data from distinct sensors, derives the underlying context state (activity), and reasons efficiently about this state in order to support context-aware services that handle ambiguity. The proposed system supports ambiguous context mediation based on **dynamic Bayesian networks** for context-aware data fusion and information theoretic reasoning to select sensor parameters leading to an optimal state estimation. It derive context and deal with context ambiguity or error in a probabilistic manner.

PERVASIVE computing creates environments that embed computation and communication in a way that organically interacts with humans to ease their daily

behavior .Contexts refer to the pieces of information that capture the characteristics of computing environments, and context awareness allows applications to dynamically adapt to the environment Context-aware applications need to detect whether contexts bear specified properties, in order to adapt their behavior. For example, an smart phone application may specify property it can be used based on user neads location of Bob is the meeting room and a presentation is going on in this room. Thus, the application will turn the phone to silent mode when holds. It is because the concurrency property is one of the most frequently specified properties Moreover, the concurrency property serves as the basis for the specification of many other properties. Refer to the examples above. Property implicitly depends on the concurrency between two contextual activities: Bob is in the meeting room and a presentation is going on in the room. Similarly it also depends on the concurrency between involved contextual activities. Thus, the concurrency property can be detected easily However, this assumption does not necessarily hold in pervasive computing scenarios, which are characterized by the intrinsic asynchrony among computing entities Specifically, context collecting devices may not have synchronized clocks and may run at different speeds. They heavily rely on wireless communications which suffer from arbitrary delay Moreover, due to resource constraints, context collecting devices usually resource-constrained sensors often postpone the dissemination of context data, also resulting in asynchrony

Related Work

The ubiquitous computing paradigm implies smart interaction of computing and communication devices with their peers and surrounding networks, often without explicit operator control. Hence, such devices need to be imbued with an inherent sentience about relevant contexts that include automatically or implicitly sensed information about the device states and the presence of the users This concept has led to various projects in smart environments . Existing work such as the Aware Home, Reactive Room ,

The work reported in provided a toolkit to enable the integration of context data into applications; however, no mechanism was proposed for sensor fusion or reasoning about contexts to deal with ambiguity. Although a mechanism is proposed in to reason about contexts, it does not provide well-defined context-aware data fusion

models nor does it address the challenges associated with context ambiguity and situation prediction. Distributed mediation of ambiguous contexts in aware environments has been used to allow the user to correct ambiguity in the sensed output.Significant efforts have also been made to develop middleware systems that can effectively support efficient context-aware applications in the presence of resource constraints, such as sensory data acquisition or information fusion . For example, DFuse the data fusion framework that facilitates dynamic transfer of different application level information into the sensor network to save power. In the adaptive middleware for context-aware applications in smart home setups, the application's quality of context (QoC) requirements are matched with the QoC attributes of the sensors with the help of a utility function. Similarly, in (QoS) requirements of the applications are matched with the QoS provided by the sensor network. Instead of looking into the network utility maximization problem with predefined utility functions, the quality of information awareframework in employs a runtime design perspective in which the wireless sensor network learns and optimizes the network utility by probing the satisfaction levels of the completed tasks. The notion of information quality in the form of application tolerance is introduced , where the loss of information or data due to resource-constrained environments are addressed by the approximation. An information-directed sensor selection approach is proposed in for a target tracking application. The work presented in used a dynamic Bayesian network (DBN)-based model to provide the information quality of sensor network applications with minimal use of resources. However, in all these schemes, the QoC requirements of the applications are assumed to be predetermined, and the applications should know both these requirements and the quality associated with each type of sensor in advance.

CONTEXT MODEL

Context-aware sensory data fusion in the face of ambiguities is a challenging research problem. The problem of distributed tracking using wireless sensor networks is formulated as an information optimization problem that quantifies several measurable information utility factors . This information-driven approach to sensor querying and data routing balances the information gain provided by each sensor with the cost associated with information

acquisition. Theselection of proper sensors with the right information at the right moment was originally introduced in, while the structure of an optimal sensor configuration constrainedby the wireless channel capacity was investigated The eliminating the simplifying assumption that all contexts are certain, we design a context-aware data fusion algorithm to mediate ambiguous contexts using dynamic Bayesian networks. Additionally,a quality of context model along with a fidelity function is proposed to satisfy the application quality requirements. collected from a network of multiple (heterogeneous) sensors are often characterized by a high degree of complexity due to the following challenges: 1) data are often acquired from
sensors of different modalities and with different degrees of uncertainty and ambiguity 2) decisions must be made quickly, and 3) the situation as well as the sensory observations evolve dynamically over time.

The paradigm of context-awareness demands systems to obtain real-world information using limited available resources in a way that is useful for the applications at hand. The derived contexts
can either be immediately used for triggering actions or representing real-life situations in which case further computation, such as data fusion techniques may be required to relate the contexts to the situations, leading to what is called situation awareness. The extended model captures the underlying description of contextrelated knowledge and attempts to incorporate various intuitions that should impact the context inference and produce better fusion results.

CONTEXT-AWARE DATA FUSION

A characteristic of a sensor-rich smart environment (e.g.,health care) is that it senses and reacts to contexts, information sensed about the environment, its occupants users and their daily activities, by providing context aware services with a goal to improve user experiences and interactions with the environment. In this section, we develope an efficient framework for sensor data fusion in a context-aware environment with the help of the underlying space-based context model. In the case of context-aware services, it is difficult to get an accurate and well-defined context that can be classified as unambiguous since the interpretation of sensed data as a context is mostly imperfect and ambiguous or noisy. To alleviate this problem, we propose a dynamic Bayesian network model.

The Dynamic Bayesian Networks provide

a coherent and unified hierarchical probabilistic framework for sensory data representation, integration, and inference. illustrates a DBN-based framework for a contextaware data fusion scheme consisting of a situation space, context states, context attributes, and a sensor fusion mediator in a network of sensors. The data fusion scheme integrates both top-down and bottom-up inference mechanisms.

The top-down inference can be used to predict the utility of a particular sensory action with respect to a goal at the top. For example, in the case of a given context state (going to the restroom), top-down inference will fuse the most relevant context attributes The bottom-up inference integrates the context attributes from a sensory action and updates each node in the network.

Problem Statement :The varible assume R to be a random variable drawn from the binary alphabet fR0;R1g with prior probabilities p0 and p1, respectively. In our case, each sensor needs to determine a sequence of context attributes for a sequence of context states fSm;t : 8t ¼ 1; 2; . . . ; Tg to determine the value of situation R. We assume that the random variables Sm;t associated with context states are i.i.d., given situation space R, with conditional distribution pSjRð:jRiÞ. The sensors send a summary Zm;t ¼ _mðSm;tÞ of their own observations to a fusion center at discrete time t, where _ is an admissible strategy (decision rule). Upon receiving the data, the fusion center produces an estimate R~ of the original situation R.

Thus, we need to find an admissible strategy for an optimal sensor-attribute mapping matrix ðD _ AÞ that minimizes the probability of estimation error Pe ¼ Pf~R 6¼ Rg.

EXPERIMENTAL STUDY

The Sun SPOT sensors for evaluating our proposed framework for context sensing and mediation.Each free-range Sun Small Programmable Object Technology contains a processor, radio, sensor board, and battery; the base-station Sun SPOT contains a processor and radio only. The Sun SPOT uses a 32-bit ARM9 microprocessor running the Squawk VM and programmed in Java, supporting the high level standard. In our context sensing and performance evaluation, we will use various built-in sensors available with the Sun SPOT sensor board.

Determination of Context Estimates

We used the Sun SPOT accelerometer sensor to measure the tilt value (in degrees) when a monitored user was in three different context states: sitting, walking, and running. From the collected samples, Similarly, we

also used the SunSPOT light sensor to measure the light level (in lumen) for different user contexts. while higher values of light intensity are likely to result when the individual is active

CONCLUSION

This system presents a framework that supports ambiguous context mediation based on dynamic Bayesian networks and information-theoretic reasoning. the proposed approach through context-aware healthcare applications in smart environments. the framework satisfies the applications' quality requirements based on a resource optimized QoC function, provides a Bayesian approach to fuse context fragments and deal with context ambiguity in a probabilistic manner, and depicts an information theoretic approach to minimize the error in the state estimation process. A SunSPOT platform based context sensing system is developed and subsequent experimental evaluation is done to perform cost/benefit analysis to engage the most efficient actions for context disambiguation in resource constrained sensor environments.

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