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博士論文概要

論文題目

A Document based Framework for User Centric Smart Object Systems

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The emergence of awareness technologies - sensors, actuators and perception algorithms - has created novel design opportunities for everyday objects, and enabled designers to re-innovate the role of these well known everyday objects with new affordances. Attaching awareness technologies to everyday objects makes them aware of their local operational and situational context, which in turn enables them to provide better services. As users move towards the mobile and ubiquitous computing environments, and computing being pushed to operate at the periphery of human, there is a greater need for pervasive applications to leverage the services of these smart everyday objects.

This research has focused on the development of software framework for building smart object systems. The dissertation provides a theoretical foundation for smart object systems and accordingly presents a set of requirements and component abstractions for a supporting architecture. A document based framework is developed where applications' requirements and smart objects' services are objectified by structured documents. A runtime infrastructure provides the pair-wise mapping using structural type matching thus externalizing smart object management and addressing heterogeneity issues away from the applications. The framework along with an identified design process dramatically reduces the complexity of building and extending smart object systems by isolating all access issues, eliminating dedicated discovery process and API dependencies, hiding heterogeneity and providing appropriate balance between transparency and awareness.

In addition, the dissertation at hand also looked at what aspects of software architecture can manifest them as a part of the user experience. Particularly, this work exposes several issues on end user aspects both from system and human factor perspectives by slightly shifting architectural design focus onto the end users. A series of user trials are presented where the end users are actively involved in deploying, configuring and managing several smart object systems using a variety of interaction tools built as framework services. The implications of these studies illustrate the design considerations of building software architectures for human-centric smart object systems.

The dissertation has thus focused on two primary issues, i.e., an appropriate framework for building smart object systems and involving end users in the administration process of those systems, which in turn provides several design implications leading to the partial redesign of the framework. The dissertation at hand discusses these aspects and shows that the proposed document centric framework with appropriate abstractions can elegantly meet several challenges of building and extending smart objects systems in a more humane way. The framework dramatically reduces the complexity of building and extending smart object systems by isolating all access issues, eliminating dedicated discovery process and API dependencies, hiding heterogeneity and providing appropriate balance between transparency and awareness. However, while the proposed framework approaches these fundamental challenges, it has also considered end users' aspect from systems perspectives emphasizing the human centric computing paradigm. This user orientation has given a unique forma to this **work. Furthermore, the approach taken** is generic enough to be adopted in other typical distributed system applications, which is also discussed in the dissertation with suitable illustrations.

The organization of the dissertation is structured as following.

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Chapter 1 introduces the prime motivation and puts forth the primary research question of this work by illustrating the problem space and design challenges. This chapter presents the projected research contributions and formulates the structure of the thesis.

Chapter 2 provides a detail background of smart object systems, their classifications and characteristics. This chapter provides an in-depth discussion of existing works to extract the characteristics across the variety of smart object systems. This discussion forms the foundation for the development of the theoretical model of a smart object and architectural requirements for building smart object systems.

Chapter 3 introduces the design issues for building a user centric smart object system Accordingly; a theoretical system model for smart objects is presented. The chapter ends by laying out the basic design decisions of the proposed document-based framework and explains in detail the rationales behind the decisions by highlighting the limitations of existing infrastructures.

Chapter 4 presents the implementation detail of the proposed framework. Each of the components i.e., smart object wrapper, application development process and the runtime FedNet infrastructure are discussed with concrete illustrations. The chapter ends by discussing multiple end user tools built atop FedNet to engage end users in smart object system administration.

Chapter 5 provides the evaluation of the proposed framework from quantitative and qualitative aspects. The performance of the framework and quality of service issues are discussed. After that the chapter moves to the qualitative evaluation of the framework, the end user tools and the entire end user involvement process by presenting a series of user trials involving end users in building and enhancing smart object systems.

Chapter 6 puts forth few issues for further discussion including the design decisions that are considered in the current framework and bringing out a few issues for further exploration in the future. The applicability of the proposed approach in other domains, and the design implications of such human centric approach towards system research are also discussed.

Finally, Chapter 7 summarizes the research of this dissertation. This chapter presents a set of conclusions, and details some of the weaknesses of the proposed approaches. The chapter ends by outlining some potentially future research work.