行政院國家科學委員會專題研究計畫 成果報告

可快速布設無線感測網路整合軟體框架-以智慧型賣場購物環境建構為例--植基於設計樣式之快速布設 Zigbee 嵌入式軟體框架

研究成果報告(精簡版)

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計 畫 主 持 人 ： 朱延平
共 同 主 持 人 ： 石志雄

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以通訊安全及壅塞控制設計樣式為基礎的可快速佈設無線感測網路整合軟體框架-以智慧型賣場購物環境建構為例

計畫編號：NSC 99-2220-E-029-005

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主持人：朱延平

計畫參與人員：翁聖凱、陳信良、曹逸竹

執行機構：東海大學資訊工程學系

中文摘要

在諸多的802.15.4/ZigBee工業應用中，影響產品快速布設於市場之因素並非價格因素，而是多變的應用環境及設計需求，例如ZigBee需跟不同的server及感測器介接，有時甚至ZigBee本身也由不同廠家製造，如何就一設計需求快速建置軟體架構並能運作順暢為一大挑戰，也是可以提昇廠商產品流通的一大利器，若可快速將系統布設於顧客環境，並滿足其設計需求，即使其需求不斷變更，也可快速產生軟體以滿足其需求，此特色可提高顧客滿意度，增加廠商產品流通率，進而提昇獲利。目前廠商依靠不同SOHO族自行研制應用軟體以提供顧客使用，在時程上及系統軟體品質上之掌控，不是很理想，疾思解決之道，因此需要研制出一套可針對不同硬體需要及系統組合，可快速布設的嵌入式軟體架構。此架構需要有很多可重複使用的元件，可彈性重組的系統參數設定及可確保穩健品質的調校功能等。

本研究預計整合由國科會開發源碼計劃下的嵌入式軟體框架(VERTAF&VMC)及標準ZigBee元件程式庫，建構一適用於ZigBee應用之可重複布設異質跨平台嵌入式軟體框架，以視覺化設計介面及Pattern的介面，以更一步加速設計速度，本研究預計綜整加入無線通訊網路安全性及網路效能特色再與ZigBee標準ZigBee元件程式庫結合，提供ZigBee應用設計者一個快速雛形應用發展開發工具。

關鍵詞：嵌入式軟體框架、ZigBee應用樣式、設計可重複使用、ZigBee自動化程式產生。

Abstract

An automatic embedded software generation framework that can create and evolve ZigBee applications is proposed. The framework consists of two major modules, pattern extraction and code generation. Pattern extraction and development are designed to provide ZigBee application with model reuse and modification. SysML serves as a medium between pattern development and code generation. State diagrams, class diagrams and sequence diagram help describes a specific application scenario. A smart shopping cart application has been implemented using this pattern based software framework. The current location of a shopping cart has been monitored constantly by the WSN network through a signature sensing technique implemented by our lab. Both the electronic map on the

server console and the PXA255 on board embedded system find a shortest path from the current location to the target product location assigned by user on the LCD screen. This evidence proves the success of the framework process. This software framework allows user to store the whole smart shopping application scenario in the design pattern repository. Further extension of this pattern can be exercised for creating other ZigBee applications such as patient localization in a hospital environment, item retrieval in large scale storage ware house, and green power energy saving applications etc.

Keywords: Embedded Software framework, ZigBee application pattern, Design reuse, ZigBee based code generation.

1. INTRODUCTION

802.15.4/ZigBee is a new short–range wireless communication standard that possesses the possibilities of unifying various sensor, actuators, devices and asset tracking equipments. It uses battery-powered devices with low data rate and low duty cycle to provide building a cost affordable and reliable network backbone, and can be used in many applications such as industrial automation, utility metering, building control and even toys. The current version of ZigBee protocol uses the short-distance wireless communication standard of IEEE 802.15.4, and the upper layer and application layer are set up by ZigBee Alliance. The advantages of low-cost and low power consumption make it widely acceptable in both domestic and overseas markets. A research from market research company In-Stat/MDR shows the global ZigBee market will be rapidly expanding at a compound annual growth rate of 200% between 2004 and 2009 and is expected to reach 150 million units shipped in 2011. Meanwhile, the cost will be significantly reduced up to $ 10 level in accord with that predicted in [7]. Texas Instruments has announced that the unit shipment for the ZigBee chip was $ 6.5 (thousand of unit) in July 2007 [8].

While wireless sensor network drives the trend toward low-cost, in many industrial applications, it is not this factor that impacts on the rapid deployment of products on the markets but the changeable application environment and design requirements. For example, ZigBee has to interface with different servers and sensors, and sometimes even ZigBee itself are manufactured by different manufacturers. How to rapidly construct application software for different design requirements and operate smoothly are a challenge. Once a solution is found, it could as well become a useful tool to enhance final product circulation rate on the markets. In case customers' demand changes a lot, the framework can quickly deploy working software in the target environment and to meet the customer's initial requirements. This feature can improve customer satisfaction, increase the circulation rate of product, and thus enhance the profitability for customers. Currently design companies rely on human labor to develop application software for customers, on which to control the time and software quality is not a very satisfactory solution. For this reason, it is necessary to develop a set of embedded software framework for meeting the different hardware requirements, system configuration and quick software turn around time. This framework requires a lot of reusable components, system parameters setting that can be flexibly reset and adjustable functions that ensure a stable quality. This research integrates the embedded software framework (VERTAF & VMC)[13] and standard ZigBee component library under the Open

Source Foundation of the National Science Council of Taiwan to construct an embedded software framework that is suitable for generating and configuring the ZigBee applications and can be repeated deployed in heterogeneous platforms. In addition, the design accelerate the code generation with visual interface and pattern retrieval. We, in this study, expect these features can provide a rapid prototype application development for ZigBee application designers.

2. RELEVANT WORKS

Table 1 describes the relevant framework researches and products internationally as well as its characteristics, and then compares with the work terms in this study one by one in order to understand the competitiveness of our techniques.

Table 1. Relevant ZigBee frameworks

Technologies / Products	Pattern Extract	Heterogeneous interface/cross platform	Power consideration	Visual Design Assistance	Zigee standard compliance
eZeeNet	X	V	V	X	V
Texas Instrument	X	X	V	X	V
Arch Rock	X	V	V	X	V
EDALab	X	X	X	X	V
Hellicom	X	X	X	X	V
MoBIES	X	V	X	X	X
Time Weaver	X	V	X	X	X
VERTAF	X	V	X	X	X
This study	**V**	**V**	**V**	**V**	**V**

V: With this function; X: Without this function

Each product/technique has its own specialties. We compare their features using the indices such as pattern extraction, heterogeneous platform, power consideration and visual interface design and ZigBee standard compliance, etc. The most similar product lines from this table are from eZeeNet and Arch. Rock. eZeeNet is a powerful ZigBee software packages in accordance with IEEE 802.15.4 to allow the embedded wireless devices to have the self-healing capabilities and self-organizing mesh network. It supports mesh and tree network topology and specifically develops a simple use of network sensing, control, monitoring and data access code. eZeeNet provides a friendly API adjuster for the wireless sensor network and smart power management, including data exchange, the network set up, node join, etc. Arch Rock Corporation has proposed a new framework for running ZigBee application profiles such as Smart Energy and home automation over the industry-standard Internet Protocol (IP). The Compact Application Protocol (CAP) expands the scope of the ZigBee applications to any IP-enabled device, regardless of the type of wireless or wired network, to which it is connected with IEEE 802.15.4 low-power radio, preserving the resource-efficiency and compactness critical to networked devices.

By combining the pattern extraction of a ZigBee transformation engine, users are able to visualize the ZigBee application designs and modify the raw design to fit the customer demands. The pattern provides a repository that take heterogeneous platform interface issues into raw model design. These are all rare features amount many different relevant techniques.

3. PATTERN BASED ZIGBEE SOFTWARE FRAMEWORK RESEARCH METHODS

Our research methods integrate SysML, requirement modeling editor, ZigBee application design pattern, automatic code generation, and architecture model mapping, to aim at required tools for automated layout of ZigBee embedded software. The integration process is as shown in Fig. 1. The framework consists of two major modules, pattern extraction and code generation. Pattern extraction and development are designed to provide ZigBee application model reuse and

modification. SysML serves as a medium between pattern development and code generation. State diagrams and class diagrams help describes a specific application scenario. These modeling mediums are then fed into the code generation engine of Quantum platform for code synthesis and generation. ZigBee application normally interfaces with different peripheral devices such as sensors and controllers. Both automatic device API supports and library are integrated with the architecture mapping function of code gen. model. Now we introduce the content of each module and its role one by one. After integration of the tool, we use the software tools to construct a smart shopping cart application for testing the integrity of the software framework tools.

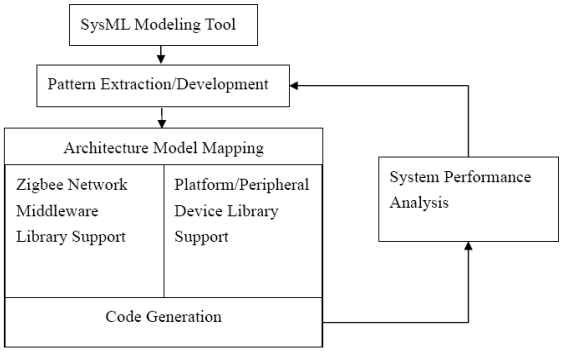

Fig. 1 Pattern based ZigBee embedded software automatic generation framework

3.1 Pattern extraction/transformation

Applying design patterns always makes the system easy to maintain, extend or resolve certain design issues [9], [10], [11]. Developers can apply a design pattern by a modeling tool to create the skeleton as represented in the brief structure of the pattern description instead of revising the original design. The question is how do we confirm that the pattern is right and the usage is correct. If the developer does not understand the purpose or usage of a pattern clearly, it may cause design errors or inconsistency.

In order to specify a pattern formally and apply a pattern by model transformation, we divide a pattern into six parts as presented in Fig. 2:

- *Pattern description*: the general description with different sections, such as motivation, consequence, etc.
- I_F: Functional Requirement Intent (FR-intent), describing what does the pattern do.
- I_N: Nonfunctional requirement Intent (NFR-intent), describing how well can this pattern contribute to quality attributes or design properties.
- S_F: FR-structure, representing the structure that can realize the IF.
- S_N: NFR-structure, representing the structural that can enhance the IN.
- *T*: Transformation specification, representing the mapping from SF to SN.

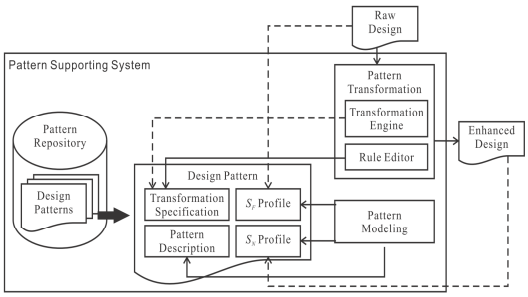

Fig. 1. The overall architecture of the approach.

Fig. 2 ZigBee Design Pattern Architecture

The pattern transformation provides pattern designers to specify pattern refinement process in formal transformation language and revise a raw design to an enhanced design automatically. As a whole, system designers can pick up a pattern which is appropriate for improving a raw design from pattern repository, and the raw design conforms to the SF of the pattern.

When developers select a pattern to apply, *T* is loaded in the transformation engine automatically. Based on *T*, a pattern is applied to the raw design which is converted to an enhanced design conforming to the S_F automatically. In general, the main components of a design pattern are intent and structure, and they should be consistent with each other as a well-designed pattern. The intent can be divided into functional requirement intent and non-functional requirement intent, we denote them by I_F and I_N, respectively.

3.2 Automatic code generation

Quantum platform(QP) is a kind of framework that is object-based and fast generates the embedded software, and the object itself uses the UML state machine in the model simulation. In accordance with the principles of program planning and the mechanisms provided by the Quantum platform, system designers can easily and quickly translate his or her construction of UML state machine system into the code of C / C + +.

Quantum can be regard as a device between application program and operating systems. The system is as shown in Fig. 3. There are mainly three layers in the Quantum Platform, which are Quantum Event Processor, Quantum architecture and the Quantum Core. Quantum Event Processor is a set of C++ class to represent the state of finite state machines and hierarchical state machine. The C++ class of these state machines can be used as dispatching events to operate. Quantum architecture provides the environment for mutually collaborative active objects (from finite state machine or hierarchical state allocations to the machine of inherited event handlers), including the events for the publication of the event queue / order event model, and other delivery mechanisms and so forth. Quantum structure must rely on an operating system. If the system does not provide any operating system, Quantum core, a core of non pre-emptive scheduling can be used.

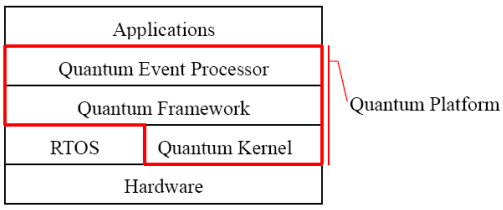

Fig. 3 Quantum framework

It realizes each SysML state machine as a QP active object by generating code that invokes the QP APIs for states, transitions, and communication events. Each active object is executed by a user-level Pthread that maps to a kernel thread in the Linux OS. Within an active object, each do method that is executed in a state, is encapsulated as a task or a task graph depending on the complexity of the method.

The requirement of UML state machines has to satisfy the run-to-completion (RTC) semantics. The effect of the RTC semantics is that whenever there is an indefinite polling of some I/O devices such as a remote controller, the polling task cannot be a QF method. The framework addresses this issue by modeling such polling tasks as an independent state machine with a single state, a self-looping transition, and a single triggering event such as data input. Such a specific state machine waits on the single event and thus there is no need to follow the RTC semantics.

3.3 Intelligent Shopping Cart Application

An intelligent shopping cart is implemented using the above framework which consists of a ZigBee localization

test grid site and an actual shopping cart equipped with a PXA255 board. The board is connected with a ZigBee sensor serving the role of communication with other reader tags. This localization grid uses 10~15 ZigBee sensors to construct rudiment of wireless localization of backbone network as is shown in Fig. 4. As is displayed in the figure there are two sub-areas. Each contains six symmetrically fixed ZigBee reference tag and one fixed reader tag in the center of the venue, represented by a square and rhombus. Fixed reader tag is responsible for connecting with all the reference tags and gateway. The fixed sensor in the center of the figure, connected with a notebook, is the gateway. When the user roam around the workplace pushing the shopping cart, the system will begin to calculate the location of the activity tag through this backbone network, and update and store it in the database of the server console. Fig. 5 shows the architecture of smart shopping cart deployment environment. There are several major modules including a location server, a reference reader module, a visual display module consisting of a PXA255 board and a ZigBee reader node and a master reader node responsible for communication to the location server. Fig. 6 further illustrate the interaction relation among different system components which is used in the code gen. for state machine interactions. Fig. 7 shows the operation scenario of the intelligent shopping cart deployment. Users first select his/her favorite dishes intended to buy in the supermarket. Then the corresponding recipe is displayed on the display panel of the PXA255 board together with different ingredients for that specific menu. In the mean time the system constantly update the current location of the shopping cart and refresh the screen for real time current position display. User then select the interested ingredient to shop for, the system then automatically displays the shortest route from the current location to the target ingredient merchandise location. There several inter-communications among different system modules. Each of the modules will be modeled as QP active objects, and the commands and data are modeled as messages to activate each of these QP objects in different timing in different sequences.

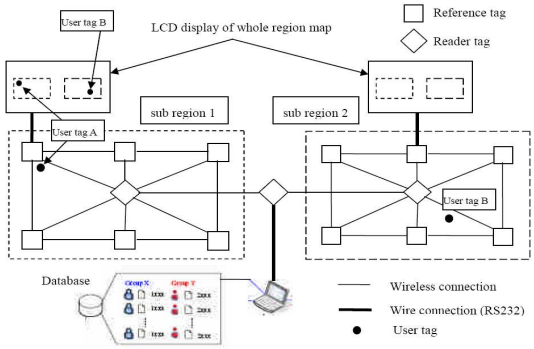

Fig. 4 ZigBee localization system deployment

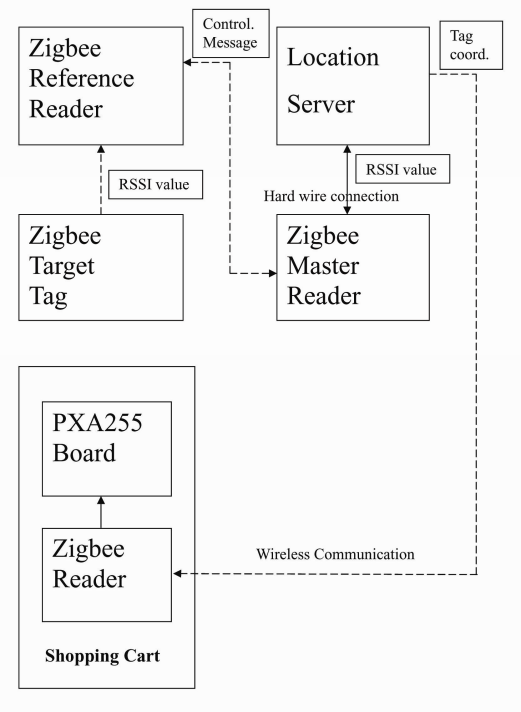

Fig.5 Localization service state diagram

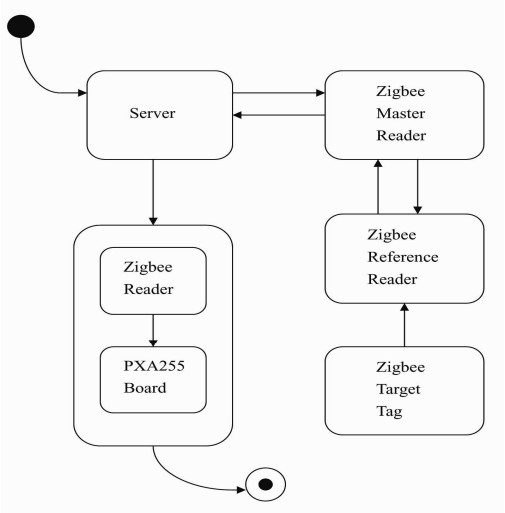

Fig. 6 Interaction diagram among different system components

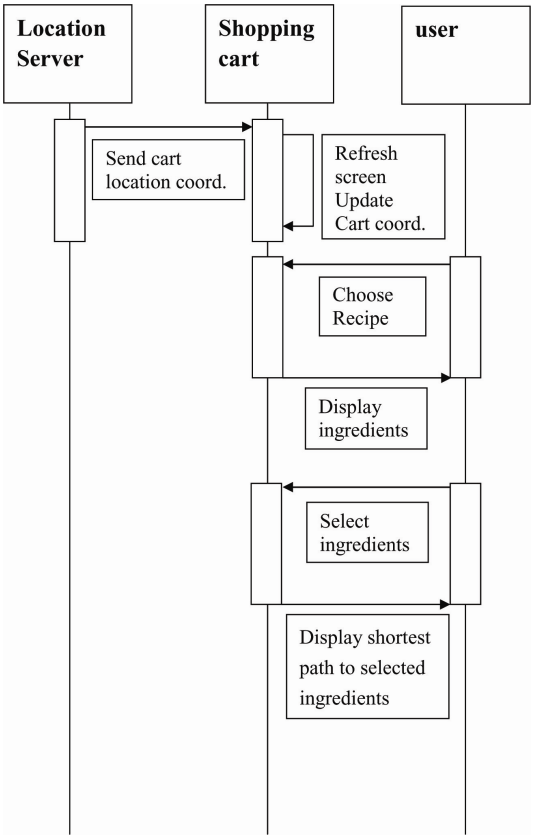

Fig. 7 Sequence diagram of system operation scenario

4. EXPERIMENTS RESULTS

Fig. 8 and 9 are the design processes of the PXA255 board module and the reference reader module. Both figures are generated using the open source tool of Papyrus. The PXA255 board is connected to a ZigBee reader node to transmit the location info. This active object is responsible for communicating with user for displaying the visual tour guide given proper instructions through touch screen actions and for communicating with the reader tag for receiving location coordinates. The reference tag is responsible for communicating with the master reader with the location server and with the ZigBee tag mounted on the roaming shopping cart. The roaming tag is constantly sending request signal to all the reference readers in the shopping site. The received RSSI signal strength values are then fed to the master reader connected to the location server. Given the hardware configuration in Fig. 4, a physical site to emulate the shopping scenario is setup as shown in Fig. 10. This site features three merchandise shelves together with four surrounding isles where user can move its shopping cart around. Fig. 11 shows an electronic map of such site. While user selects a merchandise on the electronic map on the LCD panel of a simulated shopping cart as symbolized by a wheeled chair as shown in Fig. 10. A ZigBee tag node is mounted on a PXA255 board serving as a communication platform between ZigBee sensor and user's demands. A real shopping cart will be equipped with such integration devices. The integrated board and sensor node is mounted on a shopping cart and moves around the physical site. As user gives a command that he/she is looking for a specific food product, a console server immediately find the location of the food target, and broadcast it to every node on the WSN. The current location is constantly updated by the WSN network through a finger print sensing technique[12]. Once user input the command to find the specific menu and ingredient by

touching the PXA255 display board, the system automatically find a shortest path from the current location to the target ingredient location. The process is snap shot and shown in Fig. 12. User picked pork in the lower row of the screen, and the display panel immediately display a red path from the red dot to the yellow dot where the pork zone is located. To illustrate the full functions of the whole framework of modeling and automatic code generation, we move the cart around the actual shopping field. The actual locations are then compared with the estimated locations calculated from the location server. The precision of localization has been recorded in Fig. 13. The estimation error is first re-evaluated by placing the tag back to each of the cross hairs on the black lines on the lab. floor. The deviations from the actual placements on the floor grid are then redistributed among all grid points and shown as displacement arrows sign in Fig. 13 using least square fit. The results show an acceptable average deviation error within a range of 20 cm. The proposed framework is used generate the code for serial of action and reaction between events such as user inputting food selection and server broadcasting the cart locations and PXA255 board drawing the shortest path between the source and target shopping zones.

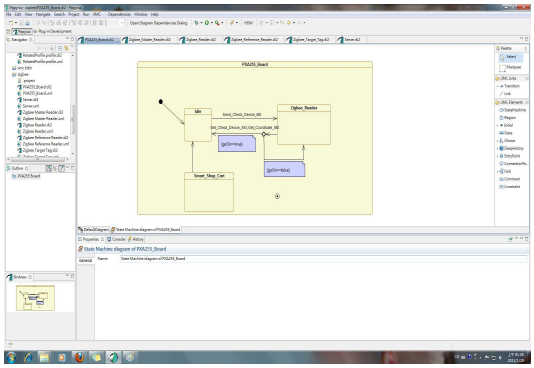

Fig. 8 State machine design process of the PXA255 board

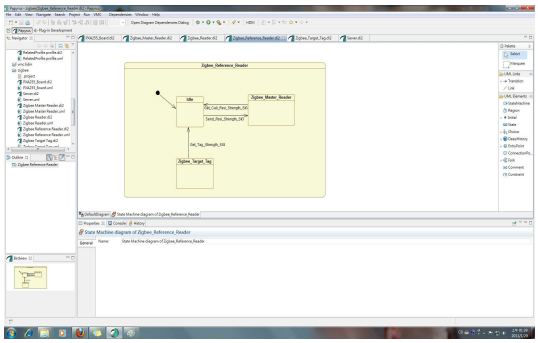

Fig. 9 State machine design process of the ZigBee reference node

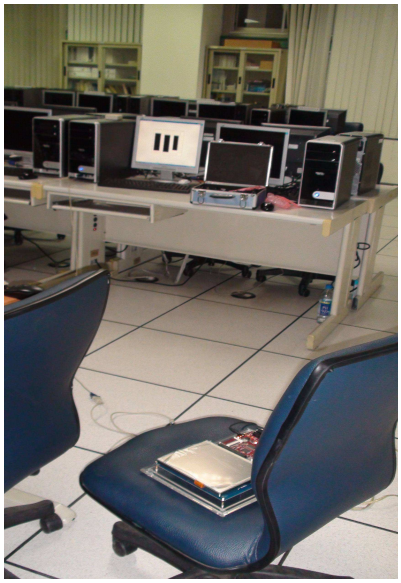

Fig. 10 Simulated shopping site, front side is a shopping cart, while far side is a server machine

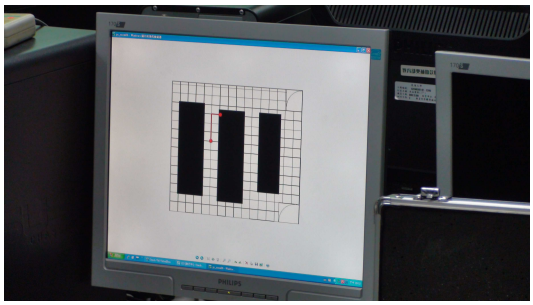

Fig. 11 Electronic map of shopping site

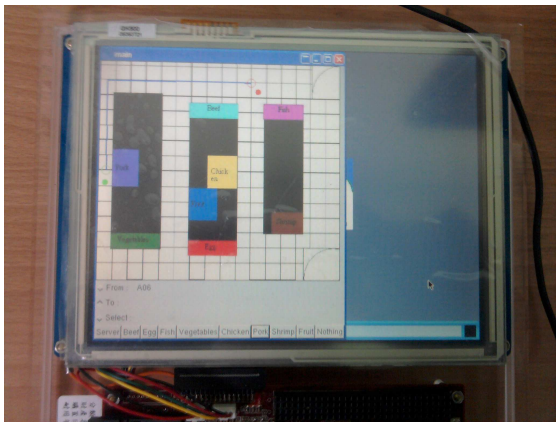

Fig. 12 Shopping cart user interface in work

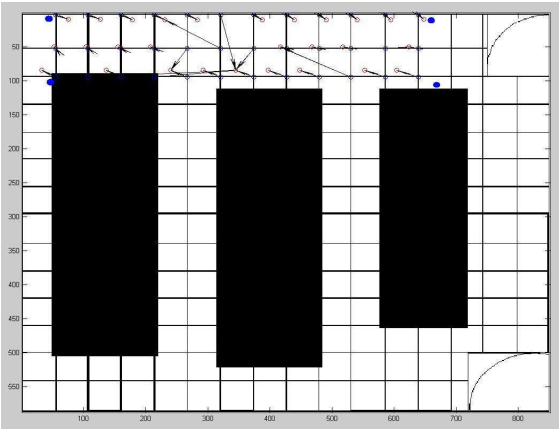

Fig. 13 Localization deviation error map at various locations of the shopping site

5. CONCLUSION

This paper proposes and implements an automatic embedded software generation framework that can create and evolve a design pattern for ZigBee applications. The design of such framework integrate SysML, requirement modeling editor, ZigBee application design pattern, automatic code generation, and architecture model mapping, to aim at required tools for automated layout of ZigBee embedded software. The framework consists of two major modules, pattern extraction and code generation. Pattern extraction and development are designed to provide ZigBee application model reuse and modification. SysML serves as a medium between pattern development and code generation. State diagrams, class diagrams and sequence diagram help describes a specific application scenario. These modeling mediums are then fed into the code generation engine of Quantum platform for code synthesis and generation. A smart shopping cart application has been implemented using the pattern based framework. The shopping cart user assigns a target food site and the system successfully broadcasts the target location to the shopping cart in motion and direct user a way to reach the target. This evidence proves the success of the framework process. This example allows user to store the whole smart shopping application scenario in the design pattern repository. Further extension of this pattern can be done for other ZigBee applications such as patient localization in a hospital environment, item retrieval in large scale storage ware house, and green energy applications, etc.

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本計畫自評

這些研究成果可以直接減少人力參與繁複ZigBee程式設計的程度，對加速嵌入式資訊家電計算速度的程度有直接的衝擊，不只具有市場之價值，同時在學理上亦可驗證設計樣式及軟工理論對商場應用之影響。此為學術上從未報導的現象。現正整理成2篇論文要投到Journal of System and Software及IEEE Transaction of SOA。

出國報告 心得報告

一、 參加會議經過

本次會議為 IEEE 學會所主辦之 2011 International Conference on Data Engineering and Internet Technology (DEIT 2011) 國際座談會，於 2011 年 3 月 15 日至 17 日在印尼塔里島舉行。DEIT 國際座談會為每年舉辦一次之資料工程研發之研討會，與會者包括了歐、美、日本、加拿大等國中數個軟體研發高度發展的企業、研究單位以及大學研究所等等。在本次的會議中，依據不同的主題，在方面共有 25 場研討會，發表超過200 篇之論文，參與本會議人數高達數百人，為國際間相當重要之資料工程研討會。本人所發表之論文"A pattern based reusable Zigbee software deployment framework"為一相當受注目的研究主題，相關研究為東海大學本研究室研究的成果，相關成果正在申請專利中，因此，在會議的過程中與相當多國際知名學者，進行深入的討論與交流。此外，在此次會議中所發表之論文均為最近最新的研究成果，在會議過程中討論相當熱烈，對於本人後續之研究方向與創新，有相當大的啟發。同時，在本會議中也激發了我許多研究，亦瞭解未來努力的方向，因此，參與本次的研討會對於本人後續在模型樣式為基礎之 ZigBee應用軟體研發之研究將有相當大的幫助。

二、與會心得

在 2011 International Conference on Data Engineering and Internet Technology (DEIT 2011)國際研討會中，許多關於模型樣式的模組設計的新觀念與突破，以及目前發展趨勢的討論均讓本人受益良多。特別是以視覺化的介面以及嵌入式源碼的研究提供了模型為基礎之ZigBee嵌入式應用軟體研發發展的新思維。目前本研究室的研究方向以ZigBee嵌入式軟體設計工具系統之架構及效能調校支援實作，與目前各國的研究方向大不相同，探究其中原因在於，目前大家大致認為多核心嵌入式軟體設計的基礎研究已經受到一定的限制，不容易有新的突破，因此，目前的研究方向大致往設計工具系統之架構及商場應用實作的方向研究，同時著重於模組樣式的研究。

不過，在ZigBee的效能提升上亦是嵌入式的一個方向，本研究室 應繼續朝向將ZigBee軟體設計自動化的方向努力，發展出一良好的圖 形化介面，如此一來，結合目前UML模組技術與本研究室的架構才能將ZigBee的效能發展到極至。對於ZigBee嵌入式軟體之研究中，最重要同時亦是最難克服的一個課題就是快速佈設軟體及整合硬體，針對整合瓶頸之不同需求，既要求其準確性、緻密性或異質性，同時亦要求其可靠性，從之前的研究結果及本次與相當多國際學者之討論，讓本人深信，以模組化及模型化各種異質整合議題及優化技巧，可以說是ZigBee嵌入式軟體快速開發相當強而有力且相當具競爭力的一種方法。近年來，許多的國家投入相當多的人力與物力在Zigbee的應用 研究上，因為這是一個學術發展及科技創新的新課題，同時也是下一 世紀國力與創新力的表現。相信在不久的將來，將本研究室的成果與國際間新思維整合，Zigbee嵌入式軟體的性能將會有新的突破。

無線感測網路(WirelessSensorNetworks，WSN)透過ZigBee技術帶出應用市場的一片天空，然而，隨著無線感測技術的進步、802.15.4/ZigBee等規格的制定，也象徵著無線感測網路已經逐漸走向標準化，吸引上下游企業相繼投入研究與產品開發，結合無線環境感知技術(WirelessContext–awareTechnology)就

變成了一個創新且具價值的資訊科技應用。因目前無線感測網路市場處於發展的初期階段，預計將從2009年開始將顯現其真正的潛力。

雖然無線感測網路有往低成本方向進行的趨勢，在諸多的工業應用中，影響產品快速佈設於市場之因素並非價格因素，而是多變的應用環境及設計需求，例如ZigBee需跟不同的server及感測器介接， 有時甚至ZigBee也需跟既有的異質有線無線網路介接，如何就一設計需求快速建置軟體架構並能運作順暢為一大挑戰，也是可以提昇國產無線感測網路產品流通的一大利器，若可快速將系統佈設於顧客環境，並滿足其設計需求，即使其需求不斷變更，也可快速產生軟體以滿足其需求，此特色可提高顧客滿意度，增加廠商產品流通率，進而提昇獲利。目前應用廠商依靠自行研制應用軟體以提供顧客使用，在 時程上及系統軟體品質上之掌控，不是很理想，疾思解決之道，因此 需要研制出一套可針對不同硬體需要及系統組合，可快速佈設的嵌入 式軟體架構。此架構需要有很多可重覆使用的元件，可彈性重組的系 統參數設定及可確保穩健品質的調校功能等。

本實驗室承蒙國科會經費支持，得以從事ZigBee嵌入式軟體開發 工具之研究，經過這一次的DEIT2011國際研討會議中，可發現在相關的研究中，本研究室的研究成果不亞於歐美重點實驗室。目前，本研究進一步要做的事，是整合本研究室的模型為基礎設計工具系統之架構及ZigBee可靠度的整合技術，經過了這次參與國際會議的經驗，若在準備充足的狀態之下參與國際會議不僅可以進行學術交流、交換研究心得、獲取新知、增進英文的表達能力，同時也能提升自我水準。在交流的過程中，如何完整表達欲傳達的訊息，如何了解提問者的問題中心，是與會過程中難得的經驗。因此，若能在行前充分準備，將會獲得最大的收穫。因此，建議所有將參與國際會議的同學們，參與國際會議前的準備工作是十分重要的，為有充分的準備才有完整的收穫。

論文被接受發表之大會證明文件

東海大學 GMail

石志雄 <shihc@go.thu.edu.tw>

DEIT 2011 P0429 Acceptance Notification

DEIT 2011 <cfp@deit2011.org> 2010年12月17日下午10:30
回覆: DEIT 2011 <cfp@deit2011.org>
收件者: shihc@go.thu.edu.tw

Dear Chihhsiong Shih

Paper ID : P0429

Paper Title : A pattern based reusable Zigbee software deployment framework

Congratulations! We are pleased to inform you that your above paper has been accepted for presentation at 2011 International Conference on Data Engineering and Internet Technology (DEIT 2011) to be held 15-17 March 2011, Bali, Indonesia. After you complete the requirements below, your paper will appear in conference proceedings and will be indexed by both EI Compendex and ISTP, as well as included in the IEEE Xplore.

In order for your paper to be included in the proceedings indexed by Ei Compendex/ISTP, it is important that you closely follow each and every instruction below, as the acceptance is conditional on your accurate and timely reactions :

1. Revise your paper, appropriately addressing the reviewer comments (at the end of this email, if any) which are intended to help you improve your paper for final publication.

2. Strictly follow the IEEE format requirements (Create IEEE PDF eXpress account by going to: www.pdf-express.org and using Conference ID: **deit11xp**); incorrectly formatted papers cannot be published or indexed. Please refer to the conference website www.irast.org/conferences/DEIT/2011/Submissions.html for detailed formatting instructions and templates. Please do a thorough spelling check, e.g., by using the spelling tool in Microsoft Word. Closely follow the instructions at the conference website (Submission page) to convert your paper to IEEE Xplore-compliant pdf file using PDF eXpress and upload your final camera-ready full paper as soon as possible, but latest by 14 January 2011. It is crucial to make sure your pdf file is IEEE Xplore-compliant using PDF eXpress. Otherwise your paper may not be included in the IEEE Xplore or indexed in EI/ISTP. Please also submit the IEEE Copyright form during your final paper submission.

3. Each paper must have 1 dedicated registration with full payment received by 14 January 2011 for the paper to be included in the proceedings (Please refer to the conference website regarding the details on registration fees. Multiple papers will require multiple registration fees.) Carefully observe the length limit of 4 pages for each paper. Extra pages beyond 4 pages will incur extra page fees. These payments must also be received by 14 January 2011 for the paper to be included in the proceedings.

4. You may pay with a credit card through the secure link provided by Paypal.com available at the conference website registration page.

If any of the above requirements are not met by the deadlines, your paper cannot be included in the conference proceedings or the conference program. Your kind cooperation will be greatly appreciated.

This notification serves as our Acceptance Letter. If you require a hardcopy of our Acceptance Letter or have any queries, please send an email to the Conference Secretariat deit2011@sgu.ac.id.

Thank you for choosing DEIT conferences to present your research results and we look forward to seeing you in Bali, Indonesia, 15-17 March 2011. We also hope that you will submit your excellent work to future DEIT conferences (further details will be announced later)

Yours sincerely,

Program Chairs, DEIT 2011

http://irast.org/conferences/DEIT/2011/

Comments from Reviewer 1 :

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1. An interesting work.
2. The authors may present some quantitative experimental results to demonstrate the performance.

Comments from Reviewer 2 :

It is a usefull job.

Comments from Reviewer 3 :

I think this paper is useful but it needs to more editions.

發表之論文摘要

A pattern based reusable Zigbee software deployment framework

Abstract—**An automatic embedded software generation framework that can create and evolve Zigbee applications is proposed. The framework consists of two major modules, pattern extraction and code generation. Pattern extraction and development are designed to provide Zigbee application with model reuse and modification. SysML serves as a medium between pattern development and code generation. State diagrams, class diagrams and sequence diagram help describes a specific application scenario. A smart shopping cart application has been implemented using this pattern based software framework. The current location of a shopping cart has been monitored constantly by the WSN network through a signature sensing technique implemented by our lab. Both the electronic map on the server console and the PXA255 on board embedded system find a shortest path from the current location to the target product location assigned by user on the LCD screen. This evidence proves the success of the framework process. This software framework allows user to store the whole smart shopping application scenario in the design pattern repository. Further extension of this pattern can be exercised for creating other Zigbee applications such as patient localization in a hospital environment, item retrieval in large scale storage ware house, and green power energy saving applications etc.**

Keywords-Embedded Software framework, Zigbee application pattern, Design reuse, Zigbee based smart shopping cart

國科會補助計畫衍生研發成果推廣資料表

日期:2011/10/29

國科會補助計畫	計畫名稱: 植基於設計樣式之快速布設Zigbee嵌入式軟體框架
	計畫主持人: 朱延平
	計畫編號: 99-2220-E-029-005- 學門領域: 自由軟體暨嵌入式系統

無研發成果推廣資料

99 年度專題研究計畫研究成果彙整表

計畫主持人：朱延平	計畫編號：99-2220-E-029-005-
計畫名稱：可快速布設無線感測網路整合軟體框架-以智慧型賣場購物環境建構為例--植基於設計樣式之快速布設 Zigbee 嵌入式軟體框架	

成果項目			量化			單位	備註（質化說明：如數個計畫共同成果、成果列為該期刊之封面故事...等）
			實際已達成數（被接受或已發表）	預期總達成數(含實際已達成數)	本計畫實際貢獻百分比		
國內	論文著作	期刊論文	0	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	0	0	100%		
		專書	0	0	100%		
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（本國籍）	碩士生	0	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		
國外	論文著作	期刊論文	1	0	100%	篇	
		研究報告/技術報告	0	0	100%		
		研討會論文	0	0	100%		
		專書	0	0	100%	章/本	
	專利	申請中件數	0	0	100%	件	
		已獲得件數	0	0	100%		
	技術移轉	件數	0	0	100%	件	
		權利金	0	0	100%	千元	
	參與計畫人力（外國籍）	碩士生	3	0	100%	人次	
		博士生	0	0	100%		
		博士後研究員	0	0	100%		
		專任助理	0	0	100%		

其他成果 (無法以量化表達之成果如辦理學術活動、獲得獎項、重要國際合作、研究成果國際影響力及其他協助產業技術發展之具體效益事項等，請以文字敘述填列。)	無

	成果項目	量化	名稱或內容性質簡述
科教處計畫加填項目	測驗工具(含質性與量性)	0	
	課程/模組	0	
	電腦及網路系統或工具	0	
	教材	0	
	舉辦之活動/競賽	0	
	研討會/工作坊	0	
	電子報、網站	0	
	計畫成果推廣之參與（閱聽）人數	0	

國科會補助專題研究計畫成果報告自評表

請就研究內容與原計畫相符程度、達成預期目標情況、研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）、是否適合在學術期刊發表或申請專利、主要發現或其他有關價值等，作一綜合評估。

1. 請就研究內容與原計畫相符程度、達成預期目標情況作一綜合評估 ■達成目標 □未達成目標（請說明，以 100 字為限） □實驗失敗 □因故實驗中斷 □其他原因 說明：
2. 研究成果在學術期刊發表或申請專利等情形： 論文：□已發表 □未發表之文稿 ■撰寫中 □無 專利：□已獲得 ■申請中 □無 技轉：□已技轉 □洽談中 ■無 其他：(以 100 字為限)
3. 請依學術成就、技術創新、社會影響等方面，評估研究成果之學術或應用價值（簡要敘述成果所代表之意義、價值、影響或進一步發展之可能性）(以 500 字為限)