Ubiquitous Healthcare Service System with Context-awareness Capability: Design and Implementation

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ABSTRACT

The rises of the life index quality together with the medical technology improvement lead to a longer life expectancy. Thus a better health care program, especially for elderly, is needed. The common health problems facing those senior citizens are changed from acute diseases to chronic diseases, such as diabetes, hypertension, etc. Along with these changes, medical tourism is becoming the trend of the future.

In this paper, we propose a decision support systems, the Ubiquitous Context-aware Healthcare Service System (UCHS), which uses micro sensors integrate RFID to sense user's life vital signal, such as electrocardiogram (ECG/EKG), heart rate (HR), respiratory rate (RR), blood pressure (BP), blood sugar (BS), and temperature and light. The UCHS is composted of Situation-Aware Medical Tourism Service Search Subsystem (SAMTS[3]), Healthy-life Map Guiding Subsystem (HMGS), Intelligent Curative Food Decision Support Subsystem (ICFDSS), and 4D Emergency Indication and Ambulance Dispatch Subsystem (4DEIADS) to provide relevant nature medicine recommendations to its user. The UCHS built upon an integrated service platform in which medical experts' knowledge and all position and negative influence of the proposed therapy are inferred by using semantic network.

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1. Introduction

Recently medical tourism is becoming more popular, as more people realize its benefits. The main benefits of health tourism include getting the opportunity to travel to an exotic destination and reaping potentially big monetary savings (Guide, 2007). In "Industrial Manpower Package for Three-year Head-start Project of Taiwan's Economic Development Visions for 2015" (Executive Yuan, 2006), Ubiquitous Healthcare (U-Health) is meaned it has more commercial potential in Taiwan in the future. Therefore, Taiwan Medical Tourism Development Association (TMTDA) was established to research and hold relevant medical tourism activities in August 2007. However, to date, there are only a few decision support systems (DSS) to provide Nature Medicine Services (NMS) recommendation which include Medical Tourism Service (MTS), Health-life Map Service (HMS), and Curative Food Service (CFS) to reach the target "Eat, Drink, and Be Merry with Health".

Recently there have been many developments on recommendation model in other domains for the semantic web which is an opportune moment to look at the field's current state and future opportunities. For inference user's requirement to recommend, the semantic web possibly combines Service-Oriented Architecture

(SOA, includes UDDI (Universal Description, Discovery and Integration), SOAP (Simple Object Access Protocol), WSDL (Web Services Description Language)) with RDF (Resource Description Framework), DAML (DARPA Agent Markup Language), DAML-S, DAML + OIL, OWL (Web Ontology Language), OWL-S, etc. (Janssen, Lins, Schlegel, Kuhner, & Wanner, 2004; Lassila & Hendler, 2007; Zhou, Chia, & Lee, 2004).

The need for NMS recommend in semantic web is driven by three demands.

(i) To infer user's requirements by semantic engine.
(ii) To search, compare, reorganize, and integrate relevant web services to be medical tourism service according to medical domain knowledge.
(iii) To reduce query processes and time.

This paper provides an overview of the medical tourism service recommend in semantic web, combines the technical application of the SOA, OWL-S, semantic web on information system, the system gives strong auxiliary utility to support users while they have some complex problem. The designed Ubiquitous Context-aware Healthcare Service System (UCHS) is composted of Situation-Aware Medical Tourism Service Search Subsystem (SAMTS[3]), Healthy-life Map Guiding Subsystem (HMGS), Intelligent Curative Food Decision Support Subsystem (ICFDSS), and 4D Emergency

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Indication and Ambulance Dispatch Subsystem (4DEIADS) to provide relevant nature medicine recommendations to its user (Kung, Wu, Chen, & Lan, 2008; Lo, Chen, Kao, Lu, & Cheng, 2009a; Lo, Cheng, Chen, Lu, & Chen, 2009b;Lo, Cheng, & Chen, 2008a; Lo, Cheng, Chen, & Yan, 2008b; Wu, Kung, Kuo, Chen, & Tasi, 2007). Using SOA, OWL-S to build semantic web environment to infer user's requirements and search various web services which are published in UDDI through the communication networks include internet and 3G/GPRS/GSM mobile networks (Tan, Hui, & Lau, 2001; Zeng et al., 2001). In this paper, we propose the specific Medical Stemming Mechanism (MSM) and Medical Ontologies (MOs) using OWL-S combined Adaptive Medical Service Inference Module (AMSIM) which is composed of Term Frequency–Inverse Document Frequency (TF–IDF), Latent Semantic Analysis (LSA), and k-Nearest Neighbor (kNN) to reference the adaptable NMS to MUs.

The remainder of the paper is built as follows. In Chapter 2, we provide background knowledge through the description of related technologies, such as the concept of semantic web (SW), Requirement Classification Techniques, Multiple Document Summarization (MDS), and Context-aware, and the discussion about the current methods for NMS searching. In Chapter 3, we proposed the Ubiquitous Context-aware Healthcare Service System (UCHS) combined semantic inference and Context-aware technique to provide NMS. The framework which is composed of Situation-Aware Medical Tourism Service Search Subsystem (SAMTS[3]), Healthy-life Map Guiding Subsystem (HMGS), and Intelligent Curative Food Decision Support Subsystem (ICFDSS) are explained in Chapter 4–6. Finally, conclusion and the suggestions are given in Chapter 7.

2. Related works

The Designed Ubiquitous Context-aware Healthcare Service System (UCHS) is to provide (i) user's requirement inference, (ii) Nature Medicine Services (NMS) decision support, (iii) searching and inference performance. Necessary research background and relevant technology include as follows: (1) semantic web (SW), (2) requirement classification techniques, (3) Multiple Document Summarization (MDS), and (4) Context-aware.

2.1. Semantic web (SW)

To solve the problem of lacking effective service query mechanism in existing web services, a SW based technology based on web services query mechanism was proposed by Tim Berners-Lee whose proposed vision (Berners-Lee, 1989) is shown as Fig. 1.

In this paper, we focus on (1) semantic inference and (2) system performance described as follow.

2.1.1. Semantic inference

For inference user's requirement semantically, Lassila and Hendler (2007) proposed a architecture of SW applications based on RDF, with patterns in which one component uses another as a data source (via SPARQL) and acts as a data source to yet another component. However, RDF and RDF schema provide properties and syntax not completely to build ontology architecture. In this paper, we use the OWL-S which is an OWL-based Web service ontology that supplies web service providers with a core set of markup language constructs for describing the properties and capabilities of Web ser-vices in unambiguous, computer-interpretable form.

2.1.2. System performance

For efficient selection of QoS-aware web service, in Blake, Sliva, Muehlen, and Nickerson (2007), we can know the inquiry API of JUDDI has better performance than JWSDP (Java Web Services Development Pack). And there were some approaches proposed by Tian, Gramm, Ritter, and Schiller (2004) Xianjun, Gopal, Ramesh, and Whinston (2003), which used "cache" mechanism for reducing process and queries while service broker inferences QoS-aware web services. Therefore, we choose JUDDI to build UCHS with "cache" mechanism to provide SW services.

2.2. Requirement classification techniques

To date, there are various requirement classification systems which are proposed and implemented. In general, those systems consist of the following steps: (1) preprocessing, (2) constructing a set of centroid-sentences as training data for each topic category, and (3) learning classifier (Ko, Park, Seo, & Choi, 2007).

The main roles of preprocessing are (i) segmenting requirements into sentences and (ii) extracting content word (Ko et al., 2007). For Chinese, the CKIP group develops the Chinese segmentation system which includes the methods for resolving unknown words (Ma & Chen, 2003) is very useful. Although, these approaches are serviceable, they have lower power for special domain such as medical tourism in this case. For example, the sentence "皮膚有顙症" which there are four segments "皮膚(Na)", "有(V_2)", "顙(Nf)", and "症(Na)" of is a specific technicality.

In step (2), it focus on (i) generating a keyword list for each category, (ii) extracting keyword sentences, and (iii) measuring word and sentence similarities (Ko et al., 2007). For measuring similarities, there are two kinds of approaches proposed which are corpus-based semantic similarity (CBSS) and ontology-based semantic similarity (OBSS). The basic idea of CBSS is the similarity of two words w_1 and w_2 can be calculated through the two distributions $P(C \mid w_1)$ and $P(C \mid w_2)$, where C is the union of the w_1 and w_2 context features, which in the simplest form would be words that co-occur in a corpus with w_1 and w_2 (Fan & Friedman, 2007). However, CBSS can't support to semantically classify ontological concepts, but OBSS. In this paper, UCHS will apply OBSS to use the hierarchy of the ontology to calculate the distance between two concepts.

For classifier, there are many kinds of classification techniques such as k-Nearest Neighbor (kNN) (Ishii, Murai, Yamada, & Bao, 2006), clustering, and association rule. In Ishii et al. (2006), Naohiro et al. propose a new combining method which for consists of Latent Semantic Analysis (LSA) followed by the kNN the documents classification. Although, this result of combining method is the higher accuracy, the method only considers with the positive influence factors. We will consider the positive and negative influence factors to improve the inference algorithm.

2.3. Multiple Document Summarization (MDS)

Blogs increase greatly in recent years because of the rapid development of computer technology and the spread of internet. Users may get a huge amount of information through the intelligent agency from the blogs. However, it's not easy to filter the useless and repeated information for the users. To solve this problem, MMESP use the Multiple Document Summarization (MDS) to
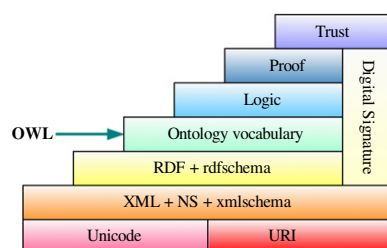

Fig. 1. Semantic Web stack (Berners-Lee, 1989).

simplify and get rid of the repeated information, so the users can save the searching time and get the important information.

UCHS is combined with MEAD which is a public domain portable multi-document summarization system based on Linux. MEAD whose process is shown as Fig. 2 is implemented by Perl programming language (Radev, Hatzivassiloglou, & McKeown, 1999).

The main procedures of MEAD are shown as follow.

(1) *Preprocess*:
The intelligent agent to retrieve the contents of the Blog using HTML format to segment the sentences in original document in order to facilitate follow-up to the weight computing (Huang & Wu, 1999; Huang, Yang, & Chu, 2001).

(2) *Feature Selection*:
In this paper, MDS is designed to consider several features to compute the weight of each sentence by words and phrases. The main three features are centrality, sentence length, and position (Liu, Yeh, Ke, & Yang, 2005; Radev, Jing, & Budzikowska, 2000; Radev, Winkel, & Topper, 2002; Yeh, 2002; Yeh, Ke, & Yang, 2002; Yeh, Ke, Yang, & Meng, 2005; Yen, 2001).

(3) *Classifier*:
The scores of every sentence are mainly computed through the weight with each feature (Kaikhah, 2004).

(4) *Reranker*:
Because by the Classifier is only carried out in accordance with score of sentence similarity calculation and sorting. It makes the problem that may exist the high similarity between sentences, especially in multi-document summarization. MEAD designs Reranker mechanism to recalculate the sentence with the syntactic similarity and set the threshold to filter out important sentences to reduce the redundancy ratio. Finally, the summary is made by extracting the sentences from original document by the compression ratio (Erkan & Radev, 2004).

(5) *Summarization*:
Summarization can retrieve and recombine words and phrases in the original document according to the order of the sentences by Reranker sorting.

(6) *Evaluation*:
HMGS is used to measure the performance of text summarization system including the effect of output results as well as users' satisfaction (Myaeng & Jang, 1999).

Fig. 2. The process of MEAD.

2.4. Context-aware

Context awareness is the important interactive system. Researchers add appropriateness and keep with user's requirement in the system. Dey et al (Dey & Abowd, 2000) defined that "context is any information that can be used to characterize the situation of an entity. An entity is a person, place or object that is considered relevant to the interaction between a user and an application, including the user and applications themselves (Dey & Abowd, 2000)". Dey et al. classify location, identity, time, and activity according to context-awareness.

In the above, context-awareness for the concept of location services of the extension service, the parameters take advantage sensors sensing user around environment. The system provides the adaptive services where users are in different environment (Dey & Abowd, 2000; Kung & Lin, 2006).

3. Ubiquitous Context-aware Healthcare Service System (UCHS)

For reaching the target "Eat, Drink, and Be Merry with Health", this paper provides an overview of the Nature Medical Service (NMS) recommend in semantic web, combines the technical application of the SOA, OWL-S, semantic web on information system, the system gives strong auxiliary utility to support users while they have some complex problem. The designed Ubiquitous Context-aware Healthcare Service System (UCHS) is composed of Situation-Aware Medical Tourism Service Search Subsystem (SAMTS[3]), Healthy-life Map Guiding Subsystem (HMGS), and Intelligent Curative Food Decision Support Subsystem (ICFDSS) to provide relevant nature medicine recommendations to its user (Kung et al., 2008; Lo et al., 2009a, 2009b; Lo et al., 2008a, 2008b; Wu et al., 2007).

3.1. Overview

The architecture of Ubiquitous Context-aware Healthcare Service System (UCHS) which is composed of SAMTS[3], HMGS, and ICFDSS enhances Mobile Users (MUs), Mobile Medical Monitor (M[3]), External Resource (ER), UDDI Registries (UDDIRs), Nature Medical Service Providers (NMSPs), and Database Server (DS) shown as Fig. 3.

MUs can utilize various terminal devices that include Personal Computer (PC), notebook, Tablet PC, Personal Digital Assistant (PDA), and smart phone to access UCHS to get adaptable NMS. Moreover, MUs will use M[3] combined micro sensors to immediately sense user's life vital signal, such as electrocardiogram (ECG/EKG), heart rate (HR), respiratory rate (RR), blood pressure (BP), blood sugar (BS), temperature, and light parameters. Those records will be transmitted and stored in DS for inference by SAMTS[3], HMGS, and ICFDSS (Kung et al., 2008; Lo et al., 2009a, 2009b; Lo et al., 2008a, 2008b; Wu et al., 2007).

The aim of semantic web is to locate services automatically based on the functionalities of web services. UDDI is helpful to discover web services with semantic web. Therefore, we use the JUDDI to build UDDI environment which provides Business Entities, Service Entities, Binding Templates, and tModels to represent the detail of business and its services.

In this paper, NMSPs which can publish the NMS to UDDIRs through heterogeneous networks are Spring Industries, Tour Industries, Curative Food Industries, Hospital Industries, etc. NMSPs will provide the order ticket service, reservation service, tourism information service, and emergency information service, etc.

MUs use mobile device to request their medical requirements to UCHS, in order to carry on the inference of NMS by SAMTS[3], HMGS, and ICFDSS. In this paper, UCHS will provide the adaptable package
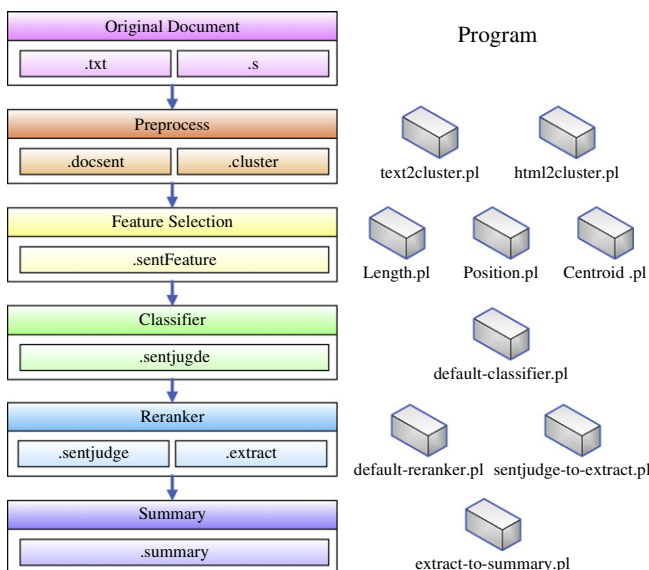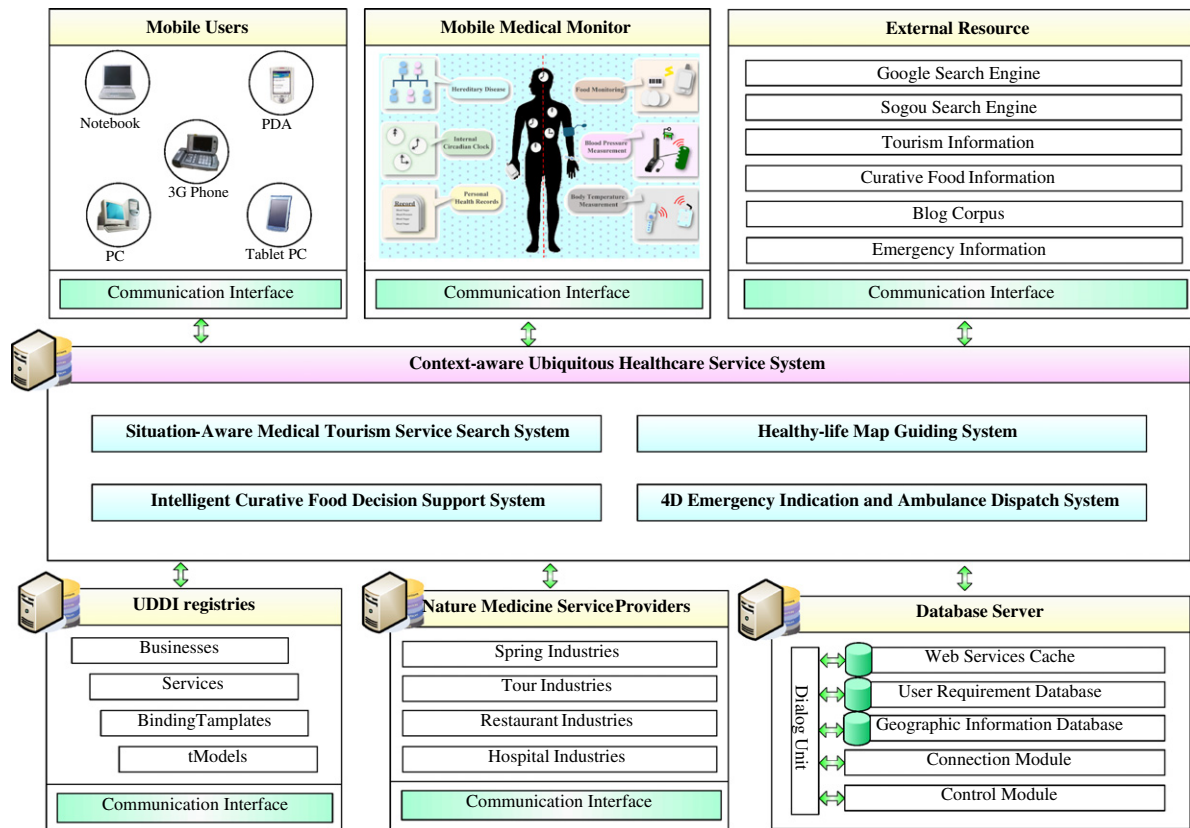
Fig. 3. The architecture of Ubiquitous Context-aware Healthcare Service System (UCHS).

tour services to reach the target "Eat, Drink, and Be Merry with Health" for MUs. First, SAMTS[3] will provide the adaptable Medical Tourism Service (MTS) by inference the MUs' medical requirement and their history health records. HMGS will provide relevant tourism information and tourist experience summary according to the adaptable MTS. Finally, ICFDSS will provide the adaptable Curative Food Service (CFS) and reservation automatically by inference the MUs' medical requirement and MTS.

3.2. Situation-Aware Medical Tourism Service Search Subsystem (SAMTS[3])

Recently medical tourism is becoming more popular, as more people realize its benefits. The main benefits of health tourism include getting the opportunity to travel to an exotic destination and reaping potentially big monetary savings (Guide, 2007). Therefore, Taiwan Medical Tourism Development Association (TMTDA) was established to research and hold relevant medical tourism activities in August 2007.

In this paper, we propose a new Medical Tourism Service (MTS) recommend system, the designed Situation-Aware Medical Tourism Service Search Subsystem (SAMTS[3]), which provides the cooperation web-based platform for all related Mobile Users (MUs) and Medical Tourism Service Providers (MTSPs) could strengthen the ability of MTS suggestion. SAMTS[3] is a five-tier system composed of the MUs, UDDI Registries (UDDIRs), MTSPs, Medical Tourism Services Server (MTSS), and Database Server (DS). Using SOA, OWL-S to build semantic web environment to infer user's medical requirements and search adaptive MTS and web services which are published in UDDI through the communication networks include internet and 3G/GPRS/GSM mobile networks. In this paper, we propose the specific Medical Tourism Stemming Mechanism (MTSM), Medical Ontology (MO), and Adaptive Medical Tourism Inference

Module (AMTIM) combined Term Frequency–Inversed Document Frequency (TF–IDF), Latent Semantic Analysis (LSA), and k-Nearest Neighbor (kNN) to reference the adaptable MTS to MUs (Lo et al., 2009b, 2008b). The detailed design and analysis of SAMTS[3] will be discussed in Chapter 4.

3.3. Healthy-life Map Guiding Subsystem (HMGS)

The rise of the quality of life index together with the improvement of economic growth lead to increase tourism requirements. Recently tourism which is becoming more popular has become a current hot topic. In addition, as people on the popularity of the concept of Healthy-life, making more and more people increasingly attach importance to good health and enjoy Healthy-life services. Healthy-life tourism services are the trend of the future.

In this paper, we propose an effective decision support system (DSS), the Healthy-life Map Guiding Subsystem (HMGS), which provides the introduction and commentaries of Healthy-Life scenic spots with relevant recommendation. HMGS is a three-tier system composed of the Clients, Multimedia Application Server (MAS), and Database Server (DS) to provide the introduction and commentaries of Healthy-Life scenic spots with relevant recommendation. HMGS is combined with an automatic text summarization technology to provide summary of commentaries. Finally, HMGS provides the adaptable tourism path in 3D web geographic information system for user reaching the Healthy-Life scenic spots (Lo et al., 2009a). The detailed design and analysis of HMGS will be discussed in Chapter 5.

3.4. Intelligent Curative Food Decision Support Subsystem (ICFDSS)

Recently curative food is becoming more popular, as more people realize its benefits. Based on the theory of Chinese medicine,

food itself is medicine. The curative food which is an ideal nutritious food can help to loss weight, increase immunity and is also good for curative effects in patients. While economy and health concept are raises, most food full on markets. How uses food to preserve people's health is a popular topic.

In this paper, we proposed and developed the "Intelligent Curative Food Decision Support Subsystem (ICFDSS)" to record efficiently user's diet. Using micro sensors integrate RFID to sense user's life vital signal, such as electrocardiogram (ECG/EKG), heart rate (HR), respiratory rate (RR), blood pressure (BP), blood sugar (BS), and treatment and light. ICFDSS provides the cooperation web-based platform for all related Mobile Users (MUs) and Curative Food Service Providers (CFSPs), could strengthen the ability of CFS suggestion. SCFSRS is a five-tier system composed of the MUs, UDDI Registries (UDDIRs), CFSPs, Curative Food Services Server (CFSS), and Database Server (DS). On the other hand, ICFDSS achieves balance diet that can provide diet exhorting and suggestion by Medical Ontology, Latent Semantic Analysis, and *k*-Nearest Neighbor, etc. (Lo et al., 2008a). The detailed design and analysis of ICFDSS will be discussed in Chapter 6.

3.5. 4D Emergency Indication and Ambulance Dispatch Subsystem (4DEIADS)

When the heavy rainfalls or typhoons occurred, many counties were unavoidable to suffer the debris-flow and flood disasters in Taiwan. Therefore, it is urgently required to obtain and inform the real-time disaster information to display the situation, and it is important for people to design an effective disaster information system to assist the disaster protection and alerting works.

To plan and design a 4D Emergency Indication and Ambulance Dispatch Subsystem (4DEIADS), which is a three-tier system composed of the mobile users, multimedia server, and disaster decision server, and the system combines mobile communication technology. 4DEIADS combines RFID technology, GPS, GIS and GPRS/3G to find out the 4D safety paths and roads in the disaster areas, and the disaster decision is packed as a reusable web services which can be used in 4DEIADS or other systems for reducing the cost and speeding up the efficiency of system development in the future. Mobile users use mobile devices with GPS to locate the longitude and latitude, and transmitting these coordinates to the GIS server. According to the longitude and latitude, the GIS will draw VR map of disaster area using GIS relevant database and show the simulated safety way to users. The 4DEIADS can draw the points on the VR map that includes all users' position and announces the best refuge and escape path. The reasoning engine of 4DEIADS is used Knapsack Problem (KP) and the Adaptive Path Algorithm (APA) which consider distance, security, traffic volume, cost, and refuges where RFID readers were installed to infer reason the 4D safety paths and escape routes (Kung et al., 2008; Wu et al., 2007).

4. Situation-Aware Medical Tourism Service Search Subsystem (SAMTS[3])

In this paper, we propose a new Medical Tourism Service (MTS) recommend system, the designed Situation-Aware Medical Tourism Service Search Subsystem (SAMTS[3]), which provides the cooperation web-based platform for all related Mobile Users (MUs) and Medical Tourism Service Providers (MTSPs), could strengthen the ability of MTS suggestion. SAMTS[3] is a five-tier system composed of the MUs, UDDI Registries (UDDIRs), MTSPs, Medical Tourism Services Server (MTSS), and Database Server (DS). Using SOA, OWL-S to build semantic web environment to infer user's medical requirements and search adaptive MTS and web services which are published in UDDI through the communication networks include internet and 3G/GPRS/GSM mobile networks. In this paper, we propose the specific Medical Tourism Stemming Mechanism (MTSM), Medical Ontology (MO), and Adaptive Medical Tourism Inference Module (AMTIM) combined Term Frequency–Inversed Document Frequency (TF–IDF), Latent Semantic Analysis (LSA), and *k*-Nearest Neighbor (kNN) to reference the adaptable MTS to MUs (Lo et al., 2009b, 2008b).

4.1. System design principles

The Situation-Aware Medical Tourism Service Search Subsystem (SAMTS[3]) provides Semantic Inference Module (SI) and Adaptive Medical Tourism Service Inference Module (AMTSIM). The SIM is combined specific Medical Tourism Stemming Mechanism (MTSM), Medical Ontology (MO), and OWL-S standard to infer and translate the original sentences to be machine readable. And the AMTSIM uses the TF–IDF, LSA, and kNN to calculate the similarity and inference the adaptive MTS.

4.1.1. Semantic Inference Module (SIM)
The Semantic Inference Module (SIM) exploits MTSM and MO to explain and to represent the data of expert's suggestions and user's requirement shown as Fig. 4.

4.1.1.1. Preprocess. Preprocess translate the different expert's suggestions and user's requirements to be the vector space model. During training time, the collection of therapy suggestions (am example is shown as Fig. 5.) as a set of documents will be represented by a word-by-document matrix A_1 and A_2, where each entry represents the occurrences of a infirmity as a word in a document, i.e. $A_1 = \{af_{in} \mid i \in I, n \in N\}$, where af_{in} is the frequency of the infirmity i in the therapy n. Let I be the number of the occurrence of all the infirmities in those therapies and N be the number of the occurrence of all the collected therapies.

Where $A_2 = \{aw_{in} \mid i \in I, n \in N\}$, where aw_{in} is the influence weight of the infirmity i in the therapy n and.

$aw_{in} = 1$, if therapy n will influence infirmity i in positively.
$aw_{in} = 0$, if therapy n won't influence infirmity i.
$aw_{in} = -1$, if therapy n will influence infirmity i in negatively.

4.1.1.2. Medical Tourism Stemming Mechanism (MTSM). To date, there are many stemming algorithms such as Brute Force Algorithms, Suffix Stripping Algorithms, Lemmatization Algorithms, etc. (Kraaij & Pohlmann, 1994). In this paper, we propose the Medical Tourism Stemming Mechanism (MTSM) based on CKIP segmentation system to process the special domain sentences referred to statistics and those algorithms. In addition to the affix-rules, a number of special conditions have to be designed to cover some specific medical tourism.

For example, there are seven segments "可(D)", "治(VC)", "輕度(A)"的(DE)", "早期(Nd)", "心血管(Na)", "系統(Na)", "疾病(Na)", and "患者(Na)" of a sentence "可治輕度的早期心血管系統疾病患者". Step 1 will remove "可(D)", "治(VC)", and "輕度(A)" orderly. And then after removing the segments "的(DE)" and "早期(Nd)" in step 2. Final, the segments "患者(Na)", "疾病(Na)", and "系統(Na)" are ordered to be removed in step 3, and the origin sentence will be replaced with the segment "心血管". The matrix A_1 and A_2 will be decreased their dimension and became as follow.

$S_1 = \{sf_{jn} \mid j \in J, n \in N\}$, where sf_{jn} is the frequency of the word j which is replaced from several infirmities i in the therapy n through stemming. And J is the number of the word j, where $J \leqslant I$.
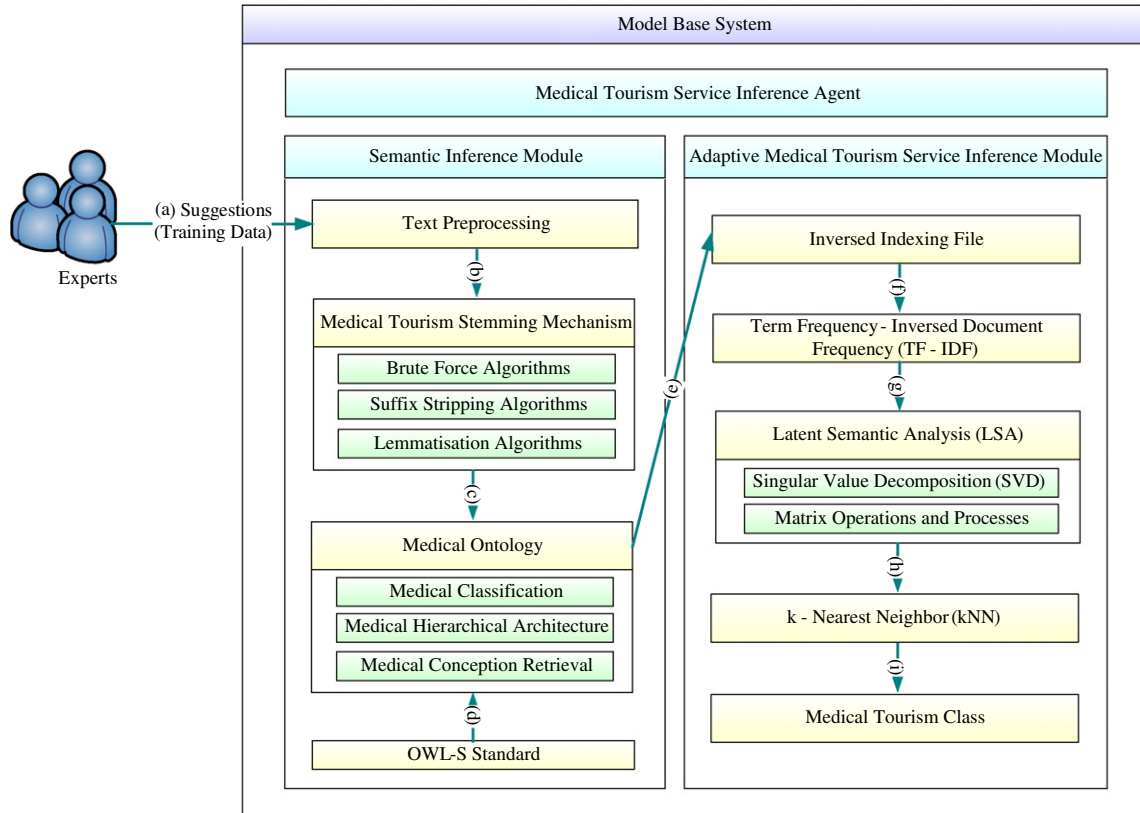
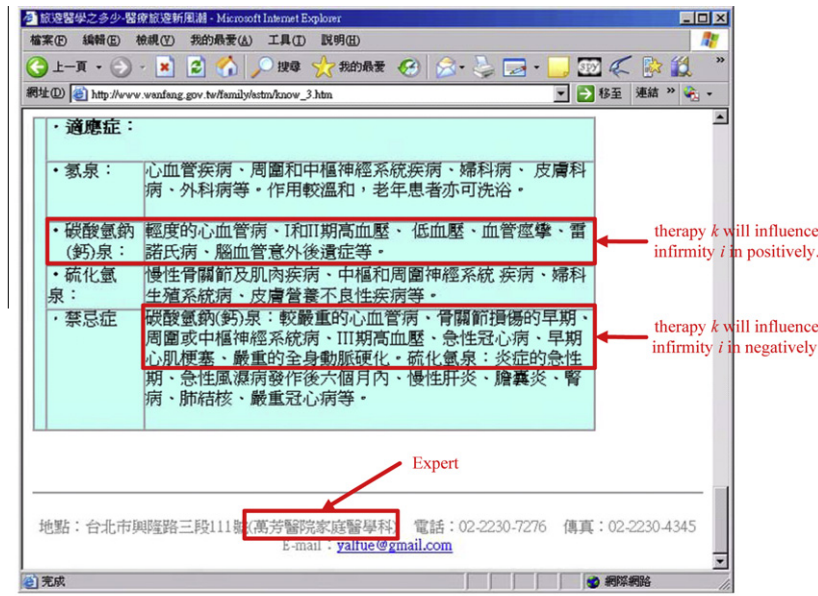**Fig. 4.** Medical tourism knowledge training process.

Fig. 5. A example of therapy suggestions from expert (Wan Fang Hospital) (WanFang, 2007).

$S_2 = \{sw_{jn} \mid j \in J, n \in N\}$, where sw_{jn} is the influence weight of the word j which is replaced from several infirmities i in the therapy n through stemming.

4.1.1.3. Medical Ontology (MO) and OWL-S Standard. The Medical Ontology (MO) focuses on medical classification, medical hierarchical architecture, and medical conception retrieval. We use the data of SOHO's Medical Directory (Sogou, 2009) to design MO which includes domain layer, category layer, concept layer, and extended

subclass layer shown as Fig. 6. The domain layer represents the domain name (such as "疾病") of MO and consists of different categories (such as ""內科", "耳鼻喉科", "外科"", and so on) defined by domain experts. Each category is made up of several concepts such as ""心臟與血管疾病", "呼吸系與胸部疾病", "消化系與腹部疾病"", and so on.

We make use of protégé_3_3_beta as the tool for editing MO. The meaning of each slot name resided in MO is defined by OWL-S standard. After building OWL-S document for interpreting
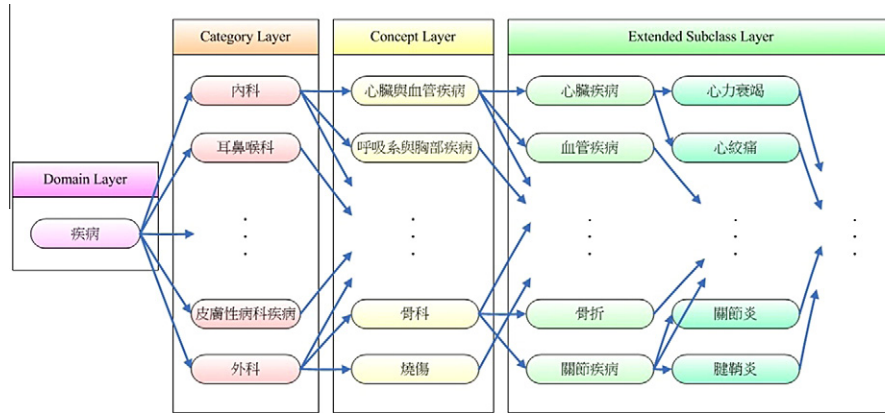
Fig. 6. The structure of Medical Ontology (MO).

the database of medical tourism service, we use the following query in OWLJessKB to tell if the input slot name is the subclass of one class in OWL-S document. For example, based on the OWL-S definition, the input slot name "心絞痛" is the subclass of ""心臟疾病", "心臟疾病"" is the subclass of "心臟與心血管疾病", and "心臟與心血管疾病" is the concept layer class in "內科", and "內科" is the category layer class in the domain layer class "疾病". Those infirmities are presented by hierarchical architecture in OWL-S document.

There are multiple layers in MO, and we can get the best through comparing the different results from getting different levels of layer in MO. In this paper, we get the concept layer in MO to retrieve medical conception to reduce the dimension of matrix. The matrix S_1 and S_2 will be decreased their dimension and became as follow.

$O_1 = \{of_{kn} | k \in K, n \in N\}$, where of_{kn} is the frequency of the concept k which is replaced from several words j in the therapy n through MO conception retrieval. And K is the number of the concepts k, where $K \leqslant J$.

$O_2 = \{ow_{kn} | k \in K, n \in N\}$, where ow_{kn} is the influence weight of the concept k which is replaced from several concepts k in the therapy n through MO conception retrieval.

4.1.2. Adaptive Medical Tourism Service Inference Module (AMTSIM)

Adaptive Medical Tourism Service Inference Module (AMTSIM) combines Term Frequency–Inversed Document Frequency (TF–IDF), Latent Semantic Analysis (LSA), and k-Nearest Neighbor (kNN) algorithm to infer adaptable MTS.

4.1.2.1. Term Frequency–Inversed Document Frequency (TF–IDF).
Salton and McGill (1986) proposed that in order to decide the importance and representation of a term in a document, the TF in this document and the frequency of this term that appears in other documents can be calculated, which is called IDF. In this paper, we will calculate the TF–IDF values of matrix O_1 into the matrix T.

$T = \{tf_{kn} | k \in K, n \in N\}$, where tf_{kn} is the TFIDF value of the concept k which is replaced from matrix O_1.

$$tf_{kn} = TFIDF(k,n) = TF(k,n) \times IDF(k) = of_{kn} \times \log\left(\frac{|N|}{DF(k)}\right),$$

where TFIDF (k,n) is the weight of concept k in the therapy n, DF (k) is the frequency of concept k in the therapy set, and $k \in K, n \in N$.

Final, we also consider the negative influence between infirmity and therapy to calculate the matrix L. Where $L = T \otimes O_2 = \{lf_{kn} = tf_{kn} \times ow_{kn} | k \in K, n \in N\}$

4.1.2.2. Latent Semantic Analysis (LSA).
We then perform Singular Value Decomposition (SVD) to L. The SVD of L is defined as $L = UZV^T$, where U is a $K \times r$ matrix of left singular vectors, Z is a $r \times r$ diagonal matrix of singular values, and V is a $r \times N$ matrix of right singular vectors. $r \leqslant \min (K,N)$ is rank of L (Yeh et al., 2005).

The process of dimension reduction is applied to Z by deleting a few entries in it, and the result of dimension reduction is a matrix Z' which is a $p \times p$ matrix. Let Z', where $p \leqslant r$, be the diagonal matrix formed from the top k singular values, and let U' and V' be the matrices produced by selecting corresponding columns from U and V. A new matrix, L', is reconstructed by multiplying three component matrixes, in the sense that it minimizes the approximation errors.

$$L' = U'Z'V'^T = \{lf'_{kn} | k \in K, n \in N\} \approx L.$$

4.1.2.3. k-Nearest Neighbor (kNN).
In this paper, a medical tourism inference model is trained by MTSM, MO, TF–IDF, and LSA through different expert's suggestions into the matrix L' for inference. When MUs input their requirement, the SIM will translate the requirement to matrix Q on concept layer by MTSM and MO, and the AMTSIM will use the matrix L' to classify the requirement into the adaptive therapy by k-Nearest Neighbor (kNN). The algorithm for the kNN is as follows:

(i) Let the user's requirement be a matrix Q on concept layer by MTSM, MO, and TF–IDF, where $Q = \{qf_k | k \in K\}$, where qf_k is the TFIDF value of the infirmity concept k, and $of(k, q)$ is the term frequency of infirmity requirement in concept k.

$$qf_k = of_{(k,q)} \times \log\left(\frac{|N|}{DF(k)}\right),$$

if user has infirmity i of concept k.

$qf_k = 0$, otherwise.

(ii) We also consider the negative influence between infirmity and therapy to calculate the similarity of the matrix Q and matrix L' as follows:

$$sim(Q, L'_n) = \frac{(\vec{Q} \bullet \vec{O_2}) \bullet \vec{L'_n}}{|\vec{Q} \times \vec{O_2}| \times |\vec{L'_n}|} = \frac{\sum_{k=1}^{K}[(qf_k \times ow_{kn}) \times lf'_{kn}]}{\sqrt{\sum_{k=1}^{K}[(qf_k \times ow_{kn})^2 \times (lf'_{kn})^2]}}$$

where $k \in K, n \in N$ and $0 \leqslant sim(Q, L'_n) \leqslant 1$

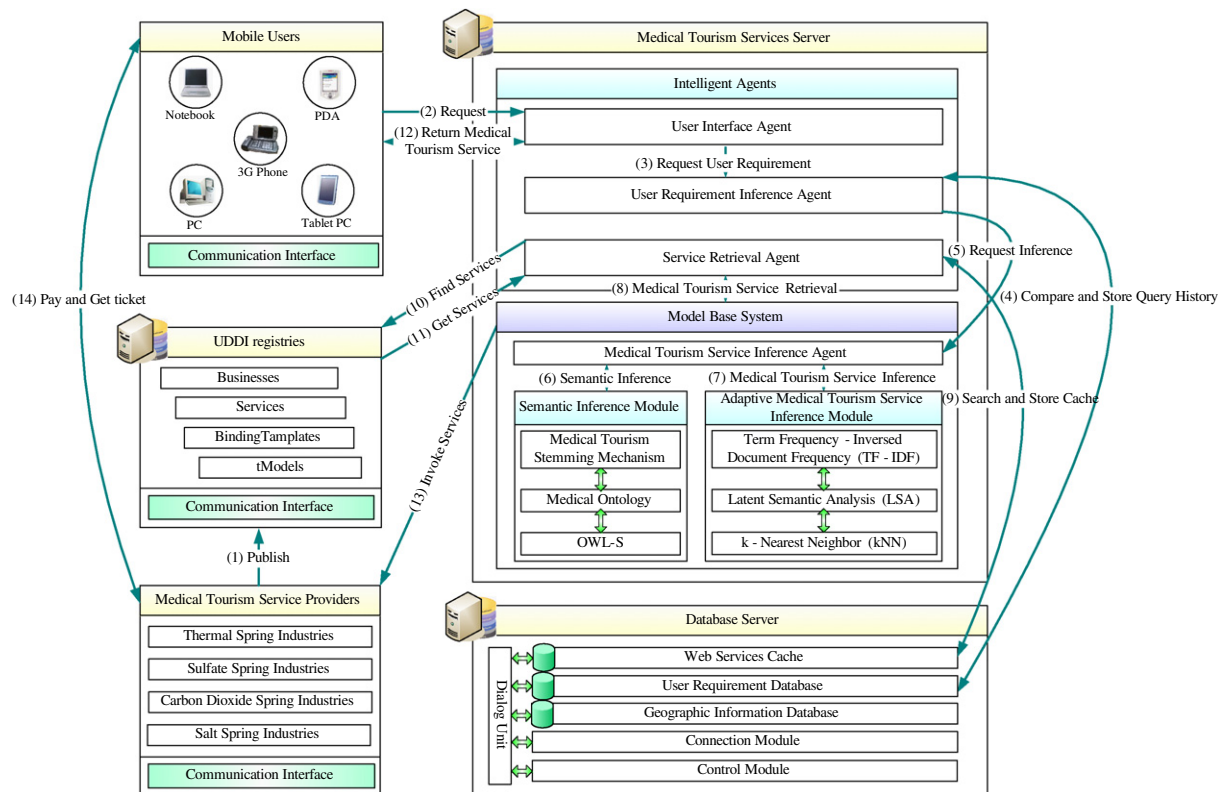(iii) The requirement matrix Q is assigned to the therapy class through kNN of Q.

Fig. 7. The architecture of Situation-Aware Medical Tourism Service Search Subsystem (SAMTS[3]).

4.2. System architecture

The Situation-Aware Medical Tourism Service Search Subsystem (SAMTS[3]) is a five-tier system, shown as Fig. 7, Mobile Users (MUs) can utilize various terminal de-vices that include PC, notebook, Tablet PC, Personal Digital Assistant (PDA), and mo-bile phone to access Medical Tourism Service Server (MTSS) through various web browsers. The UDDI Registries (UDDIRs) such as JUDDI offer UDDI standard APIs which are Inquiry API and Publication API for Medical Tourism Service Providers (MTSPs) and MTSS (as Service Requests). MTSPs are many kinds of various businesses which provide some Medical Tourism Services (MTS) to publish to UDDIRs. There are Intelligent Agents (IAs) and Model Base System (MBS) in the MTSS. There is the collecting of user's requirement information, geographical information, and web services cache in the database server. Relevant system functions design as follows.

4.2.1. Mobile Users (MUs)

Mobile users (MUs) provide the functions that include Adapt-able Medical Tourism Service (AMTS), Customized Service (CS), and Heterogeneous Networks (HN).

4.2.1.1. Adaptable Medical Tourism Service (AMTS). MUs use mobile device to request their medical requirements to SAMTS[3], in order to carry on the inference of MTS by MTSS using MBS and Semantic Inference Module (SIM). In this paper, Offering relevant adaptable MTS to users who can input difference symptoms in accordance with their situation (such as cardiopathy, inflammation, etc.), and SAMTS[3] makes MTS reservation automatically according user request. Model of MBS depend on SIM and Adaptive Medical Tourism Service Inference Module (AMTSIM) to estimate. First, the MBS has been trained by several therapies experts proposed. When MUs in-

put their requirements, the SIM will inference and translate the requirement sentences to be machine readable using stemming and ontology techniques. The AMTSIM offers Term Frequency–Inversed Document Frequency (TF–IDF), La-tent Semantic Analysis (LSA), and *k*-Nearest Neighbor (kNN) to provide adaptable MTS on different user's situation by similarity between user's requirement matrix and symptoms matrix.

4.2.1.2. Customized Service (CS). While system has user's requirements and situation to provide customized services at time, including different requirements to provide different inference by semantic search engine. MUs will be easier to get relevant MTS information for step by step.

4.2.1.3. Heterogeneous Networks (HN). MUs use in the different network protocol, so the designing of system lets the terminal device or mobile equipment can be integrated services such environments as GSM, GPRS, 3G, wired network, IEEE802.11x wireless network, etc.

4.2.2. UDDI Registries (UDDIRs)

The aim of semantic web is to locate services automatically based on the functionalities Web services provide. UDDI is helpful to discovery web services with semantic web. Therefore, we use the JUDDI to build UDDI environment which provides Business Entities, Service Entities, Binding Templates, and tModels to repre-sent the detail of business and its services. Services in JUDDI can be searched by name, by location, by business, by bindings or by tModels. However, JUDDI doesn't support any inference based on the taxonomies referred to by the tModels. Integration of semantic web and JUDDI will solve this problem. And then, Service Retrieval Agent (SRA) can retrieve the detail and relationship of those ser-vices in JUDDI by UDDI4J APIs for the semantic inference easier.

4.2.3. Medical Tourism Service Providers (MTSPs)

Medical Tourism Service Providers (MTSPs) build SOAP environment such as AXIS2 to provider some services for user invocation. After building services, MTSPs can publish the information of business, services, and binding templates to UDDIRs. For security, we can modify the AXIS2 API (such as upload.jsp) to build the hash code of service by MD5 algorithm. In this paper, MTSPs which can publish the MTS to UDDIRs through heterogeneous networks are Thermal Spring Industries, Sulfate Spring Industries, Carbon Dioxide Spring Industries, Salt Spring Industries, etc.

4.2.4. Medical Tourism Services Server (MTSS)

The Medical Tourism Services Server (MTSS) offers the relevant services of MTS semantic search, those services compose of the Intelligent Agents (IAs) and Model Base System (MBS).

4.2.4.1. Intelligent Agents (IAs).
The IAs proceed such function as collection of the materials, searching, classifying, dealing with work, etc., the work can let users get the most MTS automatically. The intelligent agent system includes User Interface Agent (UIA), User Requirement Agent (URA), and SRA.

(1) User Interface Agent (UIA) To know that user's equipment type, when the users login in and give them the proper webpage.
(2) User Requirement Inference Agent (URIA) To collect the user's requirement, such as query, operation, search history, and canned query, the information will be transmitted to the Medical Tourism Service Inference Agent (MTSIA) the DS in order to let the inference engine to analyze and recommend in advance.
(3) Service Retrieval Agent (SRA) In traditional, the semantic web combined UDDI takes a long time to do the hierarchical queries such as find_business (), find_service (), find_binding (), and find_tModel (). Therefore, we design the SRA to separate service information of huge quantity in UDDI to the Web Services Cache (WSC) in Database Server (DS), in order to save the time for accessing various UDDIRs by complex queries while MBS analyze the user's requirements. SRA which is allowed an accelerated lookup process for finding the best match for users and their requirements is powerful to reduce the UDDI query processes to pro-vide a brilliant performance in the MTS inference. When MBS return the result, SRA will recommend MTS and invoke that service after user's submission.

4.2.4.2. Model Base System (MBS).
The Model Base System (MBS) includes intelligent deduction engine that uses Data Mining technology to produce the inference. First, the MTS are established automatically by the system, and the Medical Tourism Service Inference Agent (MTSIA) will recommend information to MUs for relevant services. The MBS provides MTSIA, Semantic Inference Module (SIM), Adaptive Medical Tourism Service Inference Module (AMTSIM), and other extension modules. The SIM is combined specific Medical Tour-ism Stemming Mechanism (MTSM), Medical Ontology (MO), and OWL-S standard to infer and translate the original sentences to be machine readable. And the AMTSIM uses the TF–IDF, LSA, and kNN to calculate the similarity and inference the adaptive MTS.

First, MTSIA should be trained to find the relation between infirmities and therapies through SIM, AMTSIM, and training data from experts' suggestions shown as Fig. 3. SIM will translate each expert's suggestion to be a machine readable matrix and use MTSM, MO, and OWL-S standard to get conception matrix for inference. Second, AMTSIM will combine TF–IDF and LSA, and conception ma-

trix to increase the accuracy. Final, when MUs request, user's requirement will be sent from MTSIA to SIM, and SIM translate the medical requirement to be a conception matrix for calculating the similarity between user's requirement matrix and symptoms matrix to find the adaptive therapy by kNN.

4.2.5. Database Server (DS)

The database server includes Web Service Caches (WSC), User Requirement Database (URD), Geographic Information Database (GID), connection module, and control module. The server also offers the web services properties and user requirements to store, and it is a powerful application tool to provide information to MTSS for MTS inference.

4.3. Evaluation and case study

In this section, we report our experimental results and implement the architecture and approaches for Medical Tourism Service (MTS) as an example.

4.3.1. Evaluation

There are 46 expert's suggestions (such as therapy 1, therapy 2, ..., therapy 46) in the domain of medical tourism, and those data are collected from several web sites which are all provided by hospitals or doctors. We measure the performance of our approach in the way called k-fold cross-validation (Han & Kamber, 2006). In our experiments, training and testing are performed 46 times (i.e., k = 46). In iteration m, therapy m is selected as the test corpus, and the other therapies are collectively used to train the values for each infirmity.

In this experiment, the feasibility of applying Medical Tourism Stemming Mechanism (MTSM), Medical Ontology (MO), or Latent Semantic Analysis (LSA) to MTS requirement classification is evaluated. Tables 1 and 2 show classification index in kNN combined with MTSM, MO, or LSA.

Consider kNN first; it can be observed that it's performances of classification are 50.00%, 75.00%, 50.00%, 41.18%, and 60.00% when the classes are "Air Bath", "Thermal Spring", "Sulfate Spring", "Carbon Dioxide Spring", and "Salt Spring". The result shows that kNN algorithm combined MTSM, MO, and LSA to improve accuracy rates. Although, MO does not guarantee the obtained the most adaptable matrix always performs well for the MTS recommendations. For example, when kNN + MTSM + MO + LSA are combined, the performance of "Salt Spring" declines. In view of macro-average, there is a higher accuracy rate about 73.91% from the best combination of approaches which are kNN + MTSM + MO + LSA. Therefore, we apply kNN with MTSM, MO, and LSA in SAMTS[3].

4.3.2. A case study

The MTS reservation as one kind of web services is provided by various kinds of spring industries on the Internet. SAMTS[3] helps patients or travelers find adaptable MTS for their remedy and traveling plans. Generally, users want to find MTS reservation services through UDDI or the current matchmaking for web services. In SAMTS[3], the system will recommend adaptable MTS to MUs. The proposed method which is shown as Fig. 7 is applied to solve this problem according to the following procedures:

Step 1: Many medical tourism industries will provide their MTS reservation services on themselves SOAP site (such as AXIS2) and publish the information of those services which include company name, therapy name, location, price, etc. to UDDIRs based on JUDDI.
Step 2: When MUs inquire the SRA for the adaptable MTS through UIA, they send their requirements as a part of the request.

Table 1
Classification indexes in kNN with MTSM, MO, or LSA.

Class	kNN (%)			kNN + LSA (%)		
	kNN	kNN + MTSM	kNN + MTSM + MO	kNN + LSA	kNN + MTSM + LSA	kNN + MTSM + MO + LSA
Air Bath	50.00	50.00	50.00	75.00	75.00	75.00
Thermal Spring	75.00	75.00	75.00	75.00	75.00	75.00
Sulfate Spring	50.00	56.25	75.00	50.00	62.50	81.25
Carbon Dioxide Spring	41.18	58.82	70.59	52.94	70.59	76.47
Salt Spring	60.00	60.00	40.00	80.00	80.00	40.00

Table 2
Accuracy rate of classification indexes in kNN with MTSM, MO, or LSA.

Accuracy rate of classification	kNN (%)			kNN + LSA (%)		
	kNN	kNN + MTSM	kNN + MTSM + MO	kNN + LSA	kNN + MTSM + LSA	kNN + MTSM + MO + LSA
Micro-average	55.24	60.01	62.12	66.59	72.62	69.54
Macro-average	50.00	58.70	67.39	58.70	69.57	73.91

Step 3–4: The UIA will send the MUs' requirement to URIA. For example, MUs input their infirmities

"心臟病, 手腳冰冷, 胃腸功能障礙, 風濕症, 神經衰弱, 高血壓, 腎臟病, 過敏疾病, 慢性疾病, 酸痛, 關節炎"

in PC and PDA to request SAMTS[3] shown as Fig. 8. and Fig. 9. URIA supported the processes include lexical analysis will check and store user's information in URD for inference user's requirements.

Step 5: The URIA will get user's requirement from UIA and send it to MTSIA. When MTSIA receives the user's requirement inference result from URIA, it will control and coordinate various modules in MBS.

Step 6: The SIM will inference user's affinity information by MTSM and MO according to user's requirement from URIA. The text preprocess of SIM can segment the requirement to original word-by-document matrix which will be replaced with concept layer matrix Q by MTSM, MO, and Term Frequency–Inversed Document Frequency (TF–IDF). For example, the segment "心臟病" of this requirement will be presented the concept "心臟與血管疾病" and matrix Q is computed the TFIDF value of the concept "心臟與血管疾病".

Step 7: To search the adaptable MTS, the AMTSIM will find the adaptable MTS class by LSA and kNN. The kNN will combine the negative influence weight value to calculate the similarity between matrix Q and trained matrix L' to get the most similar class such as "Carbon Dioxide Spring". We can find the adaptable MTS class through those processes above and MTSIA will sent this message to SRA for retrieval related MTS.

Step 8–11: The SRA holds up-to-date information on offers currently available for MTS which have been requested recently. To keep offer lists up-to-date, the SRA inquires the one or more UDDIRs periodically regularly in order to check, find, and get for new offers. When SRA receives the MTS class from MTSIA, SRA will query the Web Service Cache (WSC) and Geographic Information Database (GID) to get adaptive MTS.

Step 12–13: SAMTS[3] returns the result and recommends the adaptable MTS to MUs shown as Fig. 10. and Fig. 11. If MUs agree this suggestion, SAMTS[3] will make those MTS reservation automatically.

Step 14: MUs will pay the money to get MTS reservation which are booked MTS tickets and get those tickets and bills.

4.4. Discussion

Recently there has a few medical tourism systems developed which mostly focus on location-aware service but no medical

Fig. 8. Request SAMTS[3] in PC version.

Fig. 9. Request SAMTS[3] in PDA version.

Fig. 10. Response SAMTS[3] in PC version.

Fig. 11. Response SAMTS[3] in PDA version.

tourism service recommendation in Taiwan. In this research, we proposed a Situation-Aware Medical Tourism Service Search Subsystem, which provides user's requirements inference and relative services search by semantic inference engine and find the most adaptive Medical Tourism Service. We discover the accuracy of the MTS inference is higher by combining Medical Tourism Stemming Mechanism, Medical Ontology, Term Frequency–Inversed Document Frequency, Latent Semantic Analysis, and *k*-Nearest Neighbor. Mobile users can conveniently obtain customized MTS and decision to get and use those services according to their health requirement in advance by SAMTS[3].

In the future, the MO can be modified to store more levels of medical tourism and other domain knowledge. For requirement classification, the similarity is computed by different level of MO to get adaptable medical tourism service from different industries. Otherwise, SAMTS[3] only focus now on Medical Hot Spring and can be integrated with more MTS inference for Psychotherapy, Mini Beauty Surgery, Premium Health exam, Dentistry, Ophthalmology Laser, etc.

5. Healthy-life Map Guiding Subsystem (HMGS)

Healthy-life tourism services are the trend of the future. In this paper, we propose an effective decision support system (DSS), the Healthy-life Map Guiding Subsystem (HMGS), which provides the introduction and commentaries of Healthy-Life scenic spots with relevant recommendation. HMGS is a three-tier system composed of the Clients, Multimedia Application Server (MAS), and Database Server (DS) to provide the introduction and commentaries of Healthy-Life scenic spots with relevant recommendation. HMGS is combined with an automatic text summarization technology to provide summary of commentaries. Finally, HMGS provides the adaptable tourism path in 3D web geographic information system for user reaching the Healthy-Life scenic spots (Lo et al., 2009a).

5.1. System design principles

In this paper, the design of the Healthy-life Map Guiding Subsystem (HMGS) provides functions which are Blog Content Retrieval Agent (BCRA), Multiple Document Summarization (MDS), etc.

BCRA searches the blog information from Google Blog Search and Yahoo Blog Search, and it finds the comment about the merchandise in blogs and store the Crawl and Parse into Blog Corpus. Finally, HMGS use Multiple Document Summarization technology which provides the introduction and commentaries of Healthy-Life scenic spots with relevant recommendation. Users can use the sys-

tem interface to query relevant information. Overall system processes are shown as Fig. 12.

5.1.1. Blog content retrieval agent

The Blog Content Retrieval Agent (BCRA) provides functions which are Fuzzy Search, HTML Crawler, HTML Parser, etc. The functions are shown as follows.

(1) *Fuzzy Search*:
Fuzzy search provides fuzzy computing and judge. It establishes the keywords corpus and uses the terms in corpus to search the articles in blog by Google Blog Search or Yahoo Blog Search.
(2) *HTML Crawler*:
HTML Crawler is used to create a copy of all the visited web pages for later processing by a fuzzy search. In this paper, HMGS uses the results of Google Blog Search in various Blogs and track related page link that HTML content will be saved.
(3) *HTML Parser*:
The HTML Parser analyses the HTML tag generated from HTML Crawler to get the key information. After that, it would remove the relevant special characters (such as single quotes and double quotes), and avoid attacks. Finally, we would establish Blog Corpus to get the summarization of multiple documents which is providing relevant recommendation.

5.1.2. Multiple document summarization

Healthy-life Map Guiding is combined Multiple Document Summarization technology to summarize automatically the various health-related spot blog comments in real-time and reduces the amount of information effectively. So that users can quickly browse the tourist of consumers' point of view and the past experience.

The Multiple Document Summarization uses MEAD package in our system. The relevant good comments in the Blog corpus is inputted into the MEAD modules which are (1) Preprocess, (2) Feature Selection, (3) Classifier, (4) Reranker, and (5) Summary to get text summarization automatically. The processes are shown as Fig. 13.

5.1.2.1. Preprocess.
In first step, preprocess would transfer the format of original HTML documents from blog. And then, set the documents ID and Sentence ID sequentially in order to carries on the weight of sentences in each document and the summary production.
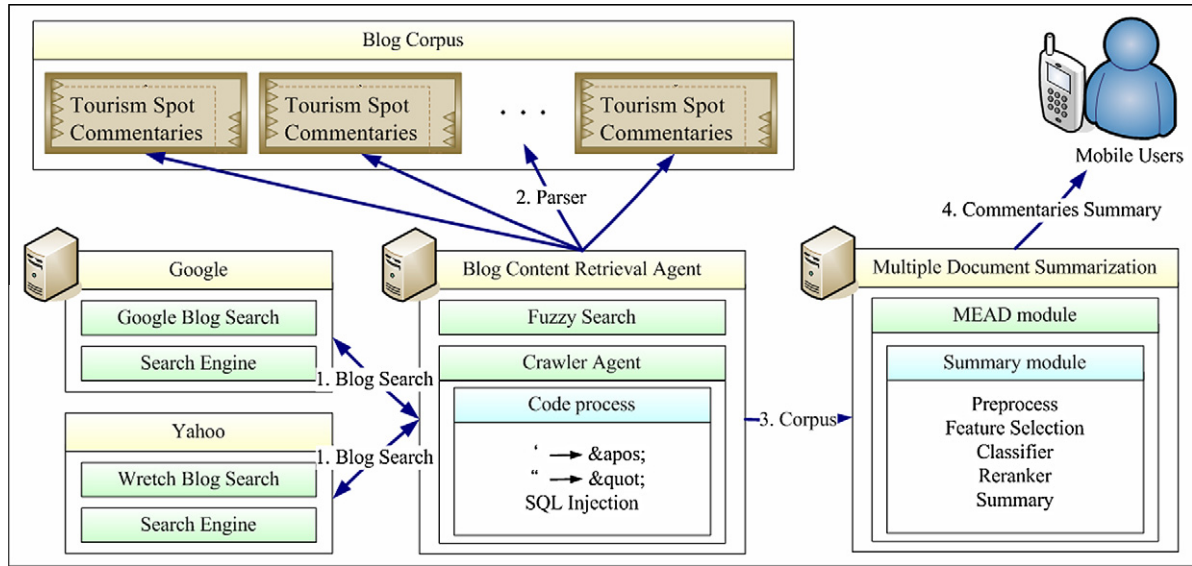
Fig. 12. The process of Healthy-life Map Guiding Subsystem (HMGS).

5.1.2.2. Feature selected. After that, HMGS uses several features which are (i) Centrality, (ii) Sentence Length, and (iii) Position to calculate the weight of each sentence.

(1) *Centrality*:

We use the Vector Space Model (VSM) to carry out the similarity calculation. The maximum cosine value represents the centroid vector of the cluster. The following expression used to calculate the value of the sentence s.

$$Score_{Centrality}(s) = \frac{|keywords\ in\ s \cap keywords\ in\ other\ sentences|}{|keywords\ in\ s \cup keywords\ in\ other\ sentences|}.$$

(2) *Sentence Length*:

If the length of the sentence is above a given threshold to be 1. Otherwise, the sentence length is 0. The following expression used to calculate the value of the sentence length.

Fig. 13. MEAD's automatic text summarization process.

$$Score_{Length}(s) = \begin{cases} 1, & Length(s) > n \\ 0, & Length(s) \leqslant n. \end{cases}$$

(3) *Position*:

Position is to give the weight by the position of the sentence in the document. For the weight is divided into 10 levels: 0–9. 0: the sentence does not belong to a summary; 1–9: the sentence belongs to a summary. The importance: 1 is weakest, and 9 is strongest. The following expression used to calculate the value of the position of the sentence in the document.

$$Score_{Position}(s) = P(s \in S | Position_i) \times \frac{Average\ of\ Position_i}{9.0}.$$

5.1.2.3. Classifier. In the third steps, we select some important features to set the different weight according to those features. We summarize those features and their weight to calculate the score of each sentence.

If Centrality weight is w1, Position weight is w2. The expression shows as follow.

$$Score_{Overall}(s) = [w_1 \times Score_{Centrality}(s) + w_2 \times Score_{Position}(s)] \\ \times Score_{Length}(s).$$

5.1.2.4. Reranker. In this step, we would judge the correlation in sentences which is decreased the redundancy. Next, we would set the threshold for filtering, and set the compression to extract.

5.1.2.5. Summery. After that, we get the extract from Reranker and map the extract to summarize from Document ID and Sentence ID in this step of preprocess. Finally, Multiple Document Summarization technology provide summary of commentaries for users.

5.2. System architecture and implementation

Healthy-life Map Guiding Subsystem (HMGS) is three-tier architecture. Fig. 14 shows that user can access the data in the Multimedia Application Server (MAS) and the Database Server (DS) via personal computer, laptop, and tablet PC. MAS provides intelligent agents, multiple document summarization, real-time
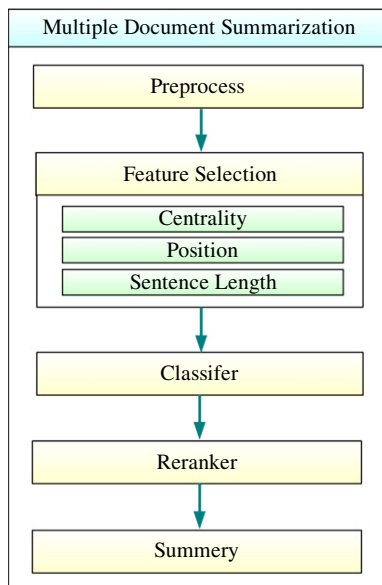
multimedia stream service and 3D web geographic information system. DS includes the blog corpus database, Healthy-Life scenic spots information, geographical information and the multimedia file database. The system functions are shown as follow.

5.2.1. Clients

The user can acquire (i) the tourist introduction of every Healthy-Life scenic spots, (ii) the relevant comment of every Healthy-Life scenic spots, and (iii) the virtually geographical guide. This paper retrieve the relevant comments from blogs via Blog Content Retrieve Agent (BCRA), and provide the scenic spots comment summaries via Multiple Document Summarization, plus the route guiding service, to help user make their tourist decision.

5.2.2. Multimedia Application Server (MAS)

Multimedia application server mainly provides intelligent agent, multiple documents summarization, real-time multimedia stream service, geographic information and virtual route guide service, etc.

5.2.2.1. Intelligent Agent (IA).
Intelligent agent does the data collection, searching, classifying, and processing. It can quickly help the user retrieve all the latest information he/she needs. This paper separates the agent function into three kinds of agent, (i) Blog Content Retrieve Agent: it provides the fuzzy searching mechanism, HTML Crawler, and HTML Parser to search and abstract the blog document; (ii) User interface agent: it distinguishes the equipment from the user side. When the user connects to the internet, it will provide the appropriate web pages; (iii) Coordinate agent: it coordinates the information transmission, avoiding the redundant access through the server and the user side.

5.2.2.2. Multiple Document Summarization (MDS).
When the MDS retrieves the comment article of the Healthy-Life scenic spot from blog content, HMGS summarize the document by using MDS. It helps user to understand the scenic spot more so that the user can decide if he/she is going to the spot. The English MDS part is done by MEAD procedure, and it use Centrality, Sentence Length, Position these three features to calculate the importance of the sentence. Finally, it yields the summarization by the adjustment of the sentence from Classifier and Reranker, as showed in

Fig. 15. The Chinese MDS is done by the agent mechanism, which was implemented by the "Lietu Search" (Lietu, 2007), as showed in Fig. 16. The user will see the final result on the web page as showed in Fig. 17.

5.2.2.3. Real-time Multimedia Stream Service (RMSS).
This paper integrates the real-time multimedia information of scenic spot in with the HMGS system, so the user can find the real-time image of the Healthy-Life scenic spot (E-Government, 2009).

5.2.2.4. Geographical information and virtually geographical guide. -
This paper presents the geographical information virtually through the Google map and Google earth API, and it also integrates the shortest path algorithm from the multimedia application server. According to the starting point and the destination set by the user, it will provide the map guide service virtually and show the route plan.

5.2.3. Database Server (DS)

The back-end database server owns the blog article database, the Healthy-Life scenic spot database, geographical information database, media file database. It integrates the information and store in the media database, and it provides the scenic spot information and reliable information about the Healthy-Life activities. It becomes an important tool of present Healthy-Life guiding service.

5.3. Discussion

This paper focuses on the integrated recommendation of tourist and Healthy-Life information, and develops Healthy–Life Map Guiding Subsystem (HMGS), which provides relevant recommendation of the Healthy-Life scenic spot and furthermore provides an integrated service platform. Also, HMGS combines the Healthy-Life scenic spot introduction and relevant comment, summarizes the information, and collaborates with the real-time image which can guide the user to the tourist spot fast and clearly. In addition, it designs the 3D virtual reality and route guiding scheme so that it can guide the user how to get to the tourist spot, and the user can watch the tourist spot from the 3D virtual reality. HMGS intends to let the user conveniently enjoy a Healthy-Life while on a trip.
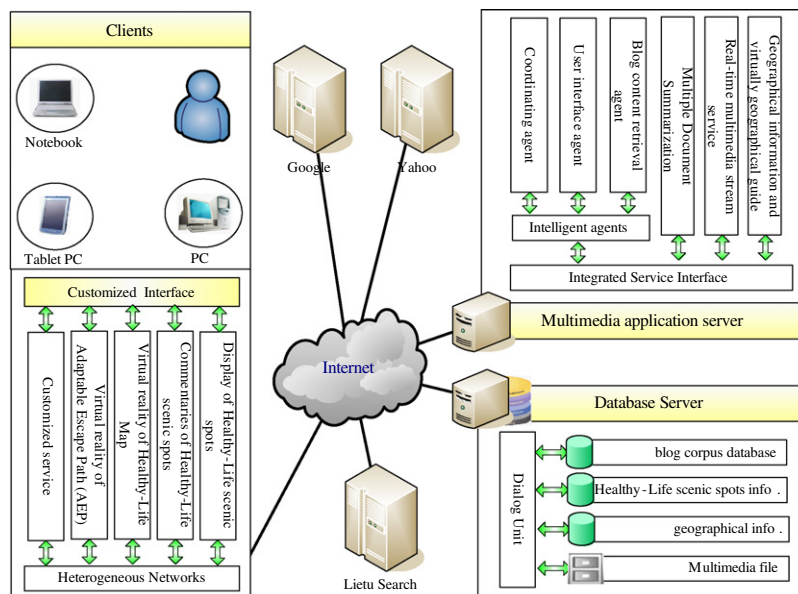

Fig. 14. The architecture of Healthy-life Map Guiding Subsystem (HMGS).
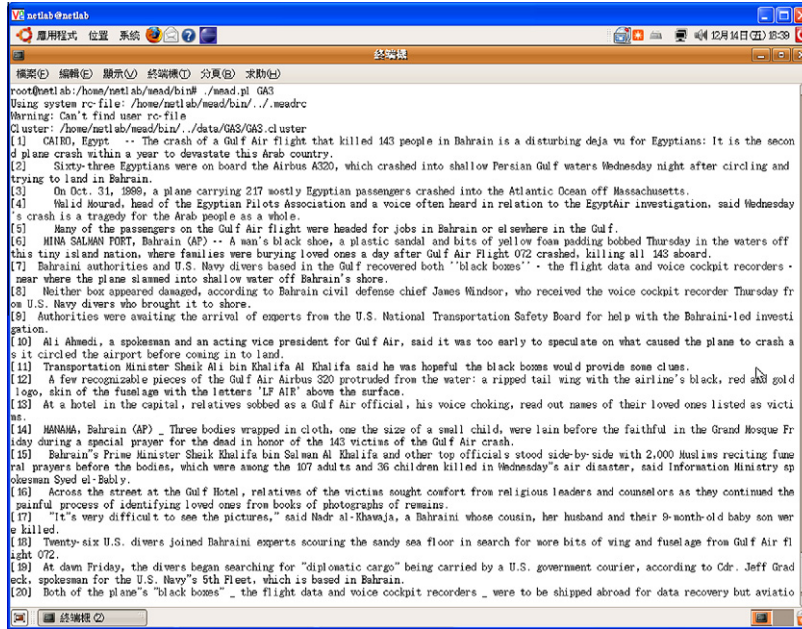
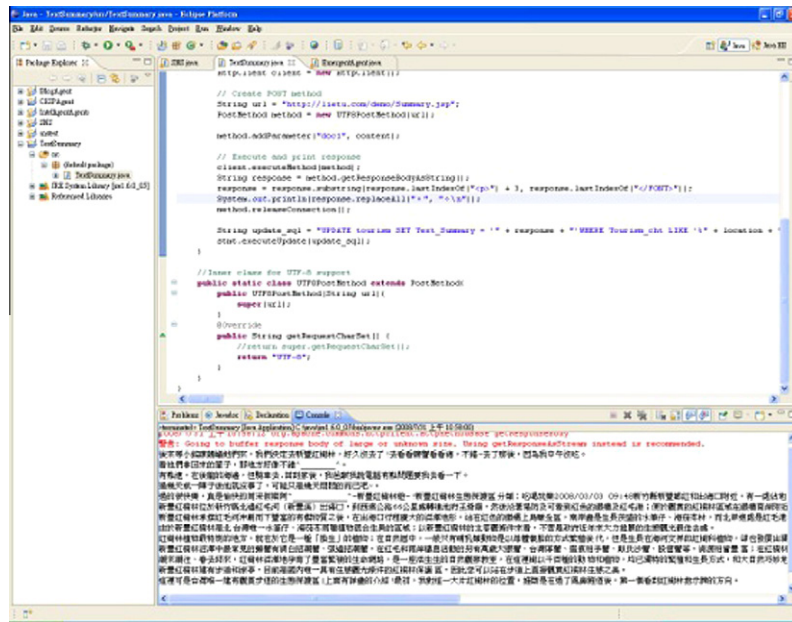Fig. 15. The implementation of MDS by MEAD.

Fig. 16. The implementation of MDS by Lietu Search.

However, HMGS only focus now on multiple document summarization technology for users' experiences. In the future, HMGS can consider with client's interest and native users' comments with Location-Based Service (LBS) to provide more precise recommendation.

6. Intelligent Curative Food Decision Support Subsystem (ICFDSS)

While economy and health concept are raises, most food full on markets. How uses food to preserve people's health is a popular topic. In this paper, we proposed and developed the "Intelligent Curative Food Decision Support Subsystem (ICFDSS)" to record efficiently user's diet. Using micro sensors integrate RFID to sense

user's life vital signal, such as electrocardiogram (ECG/EKG), heart rate (HR), respiratory rate (RR), blood pressure (BP), blood sugar (BS), and treatment and light. On the other hand, ICFDSS achieves balance diet that can provide diet exhorting and suggestion by Medical Ontology, Latent Semantic Analysis, and k-Nearest Neighbor, etc. (Lo et al., 2008a).

6.1. System design principle

First, the Curative Food Service (CFS) is established automatically by the system, and the Curative Food Service Inference Agent (CFSIA) will recommend information to MUs for relevant services. The IE provides CFSIA, Semantic Process Module (SPM), Adaptive Curative Food Service Inference Module (ACFSPM), and other
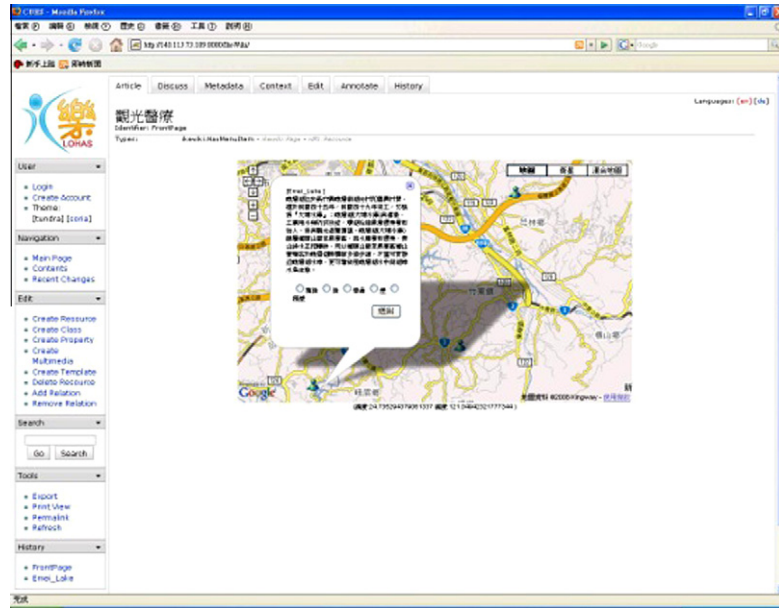
Fig. 17. The introduction and commentaries of Healthy-Life scenic spots.

extension modules. The SPM is combined specific Curative Food Stemming Mechanism (CFSM), Medical Ontology (MO), and OWL-S standard to infer and translate the original sentences to be machine readable. And the ACFSPM uses the TF–IDF, LSA, and kNN to calculate the similarity and inference the adaptive CFS.

6.1.1. Curative Food Service Inference Agent (CFSIA)

First, CFSIA should be trained to find the relationship between infirmities and therapies through SPM, ACFSPM, and training data from several experts' suggestions shown as Fig. 18.

SPM will translate each expert's suggestion to be a machine readable matrix and use CFSM, MO, and OWL-S standard to get conception matrix for inference. Second, ACFSPM will combine TF–IDF and LSA, and conception matrix to increase the accuracy. Final, when MUs request, user's requirement will be sent from CFSIA to SPM, and SPM translate the medical requirement to be a conception matrix for calculating the similarity between user's requirement matrix and symptoms matrix to find the adaptive therapy by kNN.

6.1.2. Semantic Process Module (SPM)

The Semantic Process Module (SPM) exploits CFSM and MO to explain and to represent the data of expert's suggestions and user's requirement.

(1) *Preprocess*:

Preprocess translate the different expert's suggestions and user's requirements to be the vector space model. During training time, the collection of therapy suggestions as a set of documents will be represented by a word-by-document matrix A_1 and A_2, where each entry represents the occurrences of a infirmity as a word in a document, i.e. $A_1 = \{af_{in} \mid i \in I, n \in N\}$, where af_{in} is the frequency of the infirmity i in the therapy n. Let I be the number of the occurrence of all the infirmities in those therapies and N be the number of the occurrence of all the collected therapies.
Where $A_2 = \{aw_{in} \mid i \in I, n \in N\}$, where aw_{in} is the influence weight of the infirmity i in the therapy n and
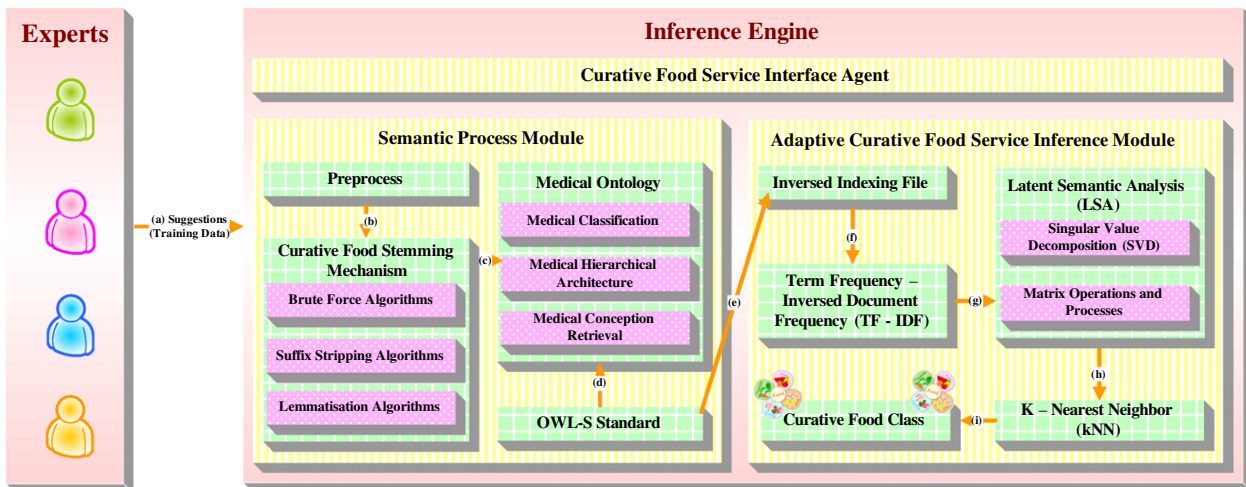$aw_{in} = 1$, if therapy n will influence infirmity i in positively.

Fig. 18. Curative food knowledge training process of IE.

$aw_{in} = 0$, if therapy n won't influence infirmity i.

$aw_{in} = -1$, if therapy n will influence infirmity i in negatively.

(2) *Curative Food Stemming Mechanism (CFSM)*:

To date, there are many stemming algorithms such as Brute Force Algorithms, Suffix Stripping Algorithms, Lemmatization Algorithms, etc. (Kraaij & Pohlmann, 1994). In this paper, we propose the Curative Food Stemming Mechanism (CFSM) based on CKIP segmentation system to process the special domain sentences referred to statistics and those algorithms. In addition to the affix-rules, a number of special conditions have to be designed to cover some specific curative food. The matrix A_1 and A_2 will be decreased their dimension and became as follow.

$S_1 = \{sf_{jn} | j \in J, n \in N\}$, where sf_{jn} is the frequency of the word j which is replaced from several infirmities i in the therapy n through stemming. And J is the number of the word j, where $J \leqslant I$.

$S_2 = \{sw_{jn} | j \in J, n \in N\}$, where sw_{jn} is the influence weight of the word j which is replaced from several infirmities i in the therapy n through stemming.

(3) *Medical Ontology (MO) and OWL-S Standard*:

The Medical Ontology (MO) focuses on medical classification, medical hierarchical architecture, and medical conception retrieval. We use the data of SOHO's Medical Directory (Sogou, 2009) to design MO which includes domain layer, category layer, concept layer, and extended subclass layer. There are multiple layers in MO, and we can get the best through comparing the different results from getting different levels of layer in MO. In this paper, we get the concept layer in MO to retrieve medical conception to reduce the dimension of matrix. The matrix S_1 and S_2 will be decreased their dimension and became as follow.

$O_1 = \{of_{kn} | k \in K, n \in N\}$, where of_{kn} is the frequency of the concept k which is replaced from several words j in the therapy n through MO conception retrieval. And K is the number of the concepts k, where $K \leqslant J$.

$O_2 = \{ow_{kn} | k \in K, n \in N\}$, where ow_{kn} is the influence weight of the concept k which is replaced from several concepts k in the therapy n through MO conception retrieval.

6.1.3. Adaptive Curative Food Service Inference Module (ACFSPM)

The Adaptive Curative Food Service Inference Module (ACFSPM) combines Term Frequency–Inversed Document Frequency (TF–IDF), Latent Semantic Analysis (LSA), and kNN algorithm to infer adaptable CFS.

(1) *Term Frequency–Inversed Document Frequency*

Salton and McGill (1986) proposed that in order to decide the importance and representation of a term in a document, the TF in this document and the frequency of this term that appears in other documents can be calculated, which is called IDF. In this paper, we will calculate the TF–IDF values of matrix O_1 into the matrix T.

$T = \{tf_{kn} | k \in K, n \in N\}$, where tf_{kn} is the TFIDF value of the concept k which is replaced from matrix O_1.

$$tf_{kn} = \text{TFIDF}(k, n) = TF(k, n) \times IDF(k) = of_{kn} \times \log\left(\frac{|N|}{DF(k)}\right),$$

where TFIDF (k, n) is the weight of concept k in the therapy n, DF (k) is the frequency of concept k in the therapy set, and $k \in K, n \in N$.

Final, we also consider the negative influence between infirmity and therapy to calculate the matrix L.

Where $L = T \otimes O_2 = \{lf_{kn} = tf_{kn} \times ow_{kn} | k \in K, n \in N\}$

(2) *Latent Semantic Analysis (LSA)*:

We then perform Singular Value Decomposition (SVD) to L. The SVD of L is defined as $L = UZV^T$, where U is a $K \times r$ matrix of left singular vectors, Z is a $r \times r$ diagonal matrix of singular values, and V is a $r \times N$ matrix of right singular vectors. $r \leqslant \min (K,N)$ is rank of L (Yeh et al., 2005).

The process of dimension reduction is applied to Z by deleting a few entries in it, and the result of dimension reduction is a matrix Z' which is a $p \times p$ matrix. Let Z', where $p \leqslant r$, be the diagonal matrix formed from the top k singular values, and let U' and V' be the matrices produced by selecting corresponding columns from U and V. A new matrix, L', is reconstructed by multiplying three component matrixes, in the sense that it minimizes the approximation errors.

$$L' = U'Z'V'^T = \{lf'_{kn} | k \in K, n \in N\} \approx L$$

(3) *k-Nearest Neighbor (kNN)*

In this paper, a curative food inference model is trained by CFSM, MO, TF–IDF, and LSA through different expert's suggestions into the matrix L' for inference. When MUs input their requirement, the SPM will translate the requirement to matrix Q on concept layer by CFSM and MO, and the ACFSPM will use the matrix L' to classify the requirement into the adaptive therapy by kNN. The algorithm for the kNN is as follows:

(i) Let the user's requirement be a matrix Q on concept layer by CFSM, MO, and TF–IDF, where $Q = \{qf_k | k \in K\}$, where qf_k is the TFIDF value of the infirmity concept k, and $of(k, q)$ is the term frequency of infirmity requirement in concept k.

$$qf_k = of_{(k,q)} \times \log\left(\frac{N|}{DF(k)}\right), \quad \text{if user has infirmity } i \text{ of concept } k.$$

$qf_k = 0$, otherwise.

(ii) We also consider the negative influence between infirmity and therapy to calculate the similarity of the matrix Q and matrix L' as follows:

$$sim(Q, L'_n) = \frac{(\vec{Q} \bullet \vec{O_2}) \bullet \vec{L'_n}}{\left|\vec{Q} \times \vec{O_2}\right| \times \left|\vec{L'_n}\right|} = \frac{\sum_{k=1}^{K} [(qf_k \times ow_{kn}) \times lf'_{kn}]}{\sqrt{\sum_{k=1}^{K} [(qf_k \times ow_{kn})^2 \times (lf'_{kn})^2]}},$$

where $k \in K$, $n \in N$ and $0 \leqslant sim(Q, L'_n) \leqslant 1$

(iii) The requirement matrix Q is assigned to the therapy class through kNN of Q.

6.2. System architecture

The Intelligent Curative Food Decision Support Subsystem (ICFDSS) is a six components system, shown as Fig. 19.

6.2.1. Mobile Medical Monitor (M^3)

Mobile Medical Monitor builds in user's home, that using micro sensors senses user's life vital signal, such as electrocardiogram (ECG/EKG), heart rate (HR), respiratory rate (RR), blood pressure (BP), blood sugar (BS), temperature, and light parameters. On the other hand, the system utilizes PDA with RFID Reader which can sense user's diet daily. The record in diet diary integrates with weight control, diet exhorting and suggestion, and to remind user to achieve balance diet.

User can wear RFID Tag wristband watch to sense body temperature. When users break away the RFID Tag wristband watch, the system can take advantage of light sensor and buzzer to remind user (Dressen, 2004; Xiao, Shen, Sun, & Cai, 2006). On the other hand, parameters of ECG/EKG, HR, RR, BP, BS, temperature, and

light can be stored in database by micro sensors. The programs can store in database and transform parameters to line charts, and then user can view vital signal parameters by mobile devices (PDA, mobile phone, tablet PC, etc.). The trend of line chart is convenient to view by user, user's family, and doctor.

6.2.2. Mobile Users (MUs)

MUs provide the functions that include Adaptable Curative Food Service (ACFS), Customized Service (CS), and Heterogeneous Networks (HN). MUs use mobile device to request their medical requirements to ICFDSS, in order to carry on the inference of CFS by CFSS using Inference Engine (IE) and Semantic Process Module (SPM).

6.2.3. UDDI Registries (UDDIRs)

The aim of semantic web is to locate services automatically based on the functionalities Web services providing. UDDI is helpful to discover web services with semantic web. Therefore, the system uses the JUDDI to build UDDI environment which provides Business Entities, Service Entities, Binding Templates, and tModels to represent the detail of business and its services.

6.2.4. Curative Food Service Providers (CFSPs)

Curative Food Service Providers (CFSPs) build SOAP environment such as AXIS2 to provide some services for user invocation. After building services, CFSPs can publish the information of business, services, and binding templates to UDDIRs.

6.2.5. Curative Food Services Server (CFSS)

The Curative Food Services Server (CFSS) offers the relevant semantic searching services of CFS, Those services compose of the IAs and IE.

6.2.5.1. Intelligent Agents (IAs). The IAs proceed such function as the materials of collection, searching, classifying, dealing with work, etc., the work can let users get the most CFS automatically. The intelligent agent system includes User Interface Agent (UIA), User Requirement Inference Agent (URIA), and Service Retrieval Agent (SRA).

(1) *User Interface Agent (UIA)* To know that user's equipment type, the users login in and give them the proper webpage.
(2) *User Requirement Inference Agent (URIA)* To collect the user's requirement, such as query, operation, searching history, and canned query, the information will be transmitted to the Curative Food Service Inference Agent (CFSIA) the ADS in order to let the inference engine to analyze and recommend in advance.
(3) *Service Retrieval Agent (SRA)* In traditional, the semantic web with UDDI takes a long time to do the hierarchical queries such as find_business (), find_service (), find_binding (), and find_tModel (). Therefore, the SRA is designed to separate service information of huge quantity in UDDI to the Web Services Cache (WSC) in Active Database Server, in order to save the time for accessing various UDDIRs by
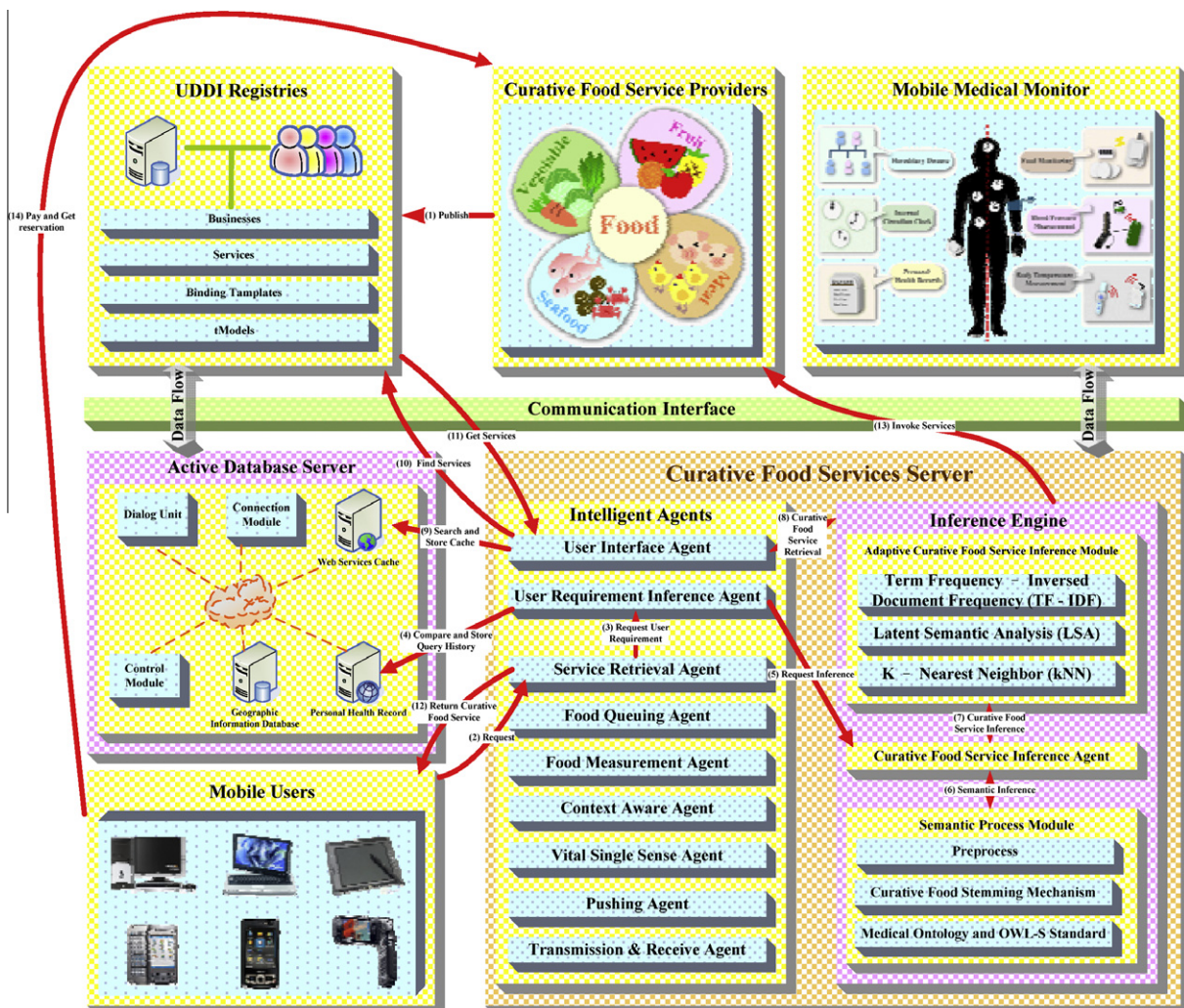

Fig. 19. The architecture of Intelligent Curative Food Decision Support Subsystem.

complex queries while IE analyze the user's requirements. SRA which is allowed an accelerated lookup process for finding the best match for users and their requirements is powerful to reduce the UDDI query processes to provide a brilliant performance in the CFS inference. When IE return the result, SRA will recommend CFS and invoke that service after user's submission.

(4) *Food Queuing Agent (FQA)*This function can combine the internal circadian clock and VS^{2}A recommending to user's food, and preventing user eating food on outside time.

(5) *Food Measurement Agent (FMA)*FMA utilizes PDA with RFID Reader which can sense and record user's diet and calorie daily.

(6) *Context Aware Agent (CA^2)*The CA^2 integrates FQA and VS^{2}A function to sense micro sensors user's temperature on waking up.

(7) *Vital Single Sense Agent (VS^{2}A)*VS^{2}A makes use of micro sensor and RFID to sense user's parameters that can stores and records by exploiting TRA.

(8) *Pushing Agent (PA)*Pushing agent can classify into two functions, one of normal condition can integrates of CA^2 and pushing messages for user's and doctor's mobile devices. Another alerting condition makes use of VS^{2}A sensor sensing over user's normal range.

(9) *Transmission & Receive Agent (TRA)*

This function can access user's parameters to store on database, such as electrocardiogram (ECG/EKG), heart rate (HR), respiratory rate (RR), blood pressure (BP), blood sugar (BS), temperature and light.

6.2.5.2. Inference Engine (IE). The Inference Engine (IE) includes intelligent deduction engine that uses Data Mining technology to produce the inference. First, the CFS is established automatically by the system, and the Curative Food Service Inference Agent (CFSIA) will recommend information to MUs for relevant services. The IE provides CFSIA, Semantic Process Module (SPM), A Adaptive Curative Food Service Inference Module (ACFSPM), and other extension modules. The SPM is combined specific Curative Food Stemming Mechanism (CFSM), Medical Ontology (MO), and OWL-S standard to infer and translate the original sentences to be machine readable. And the ACFSPM uses the TF–IDF, LSA, and kNN to calculate the similarity and inference the adaptive CFS.

First, CFSIA should be trained to find the relation between infirmities and therapies through SIM, ACFSPM, and training data from experts' suggestions shown as Fig. 18. SIM will translate each expert's suggestion to be a machine readable matrix and use CFSM, MO, and OWL-S standard to get conception matrix for inference. Second, ACFSPM will combine TF–IDF and LSA, and conception matrix to increase the accuracy. Final, when MUs request, user's requirement will be sent from CFSIA to SPM, and SPM translate the medical requirement to be a conception matrix for calculating the similarity between user's requirement matrix and symptoms matrix to find the adaptive therapy by kNN.

6.2.6. Active Database Server (ADS)

The server offers the web services properties and user requirements to store, and it is a powerful application tool to provide information to CFSS for CFS inference.

6.3. System evaluation and case study

In this section, we report our experimental results and implement the architecture and approaches for Curative Food Service (CFS) as an example.

6.3.1. Evaluation

There are 76 expert's suggestions (such as therapy 1, therapy 2, ..., therapy 76) in the domain of curative food, and those data are collected from several web sites, books, and papers which are all provided by dietitians or doctors. We measure the performance of our approach in the way called *k*-fold cross-validation (Han & Kamber, 2006). In our experiments, training and testing are performed 76 times (i.e., $k = 76$). In iteration m, therapy m is selected as the test corpus, and the other therapies are collectively used to train the values for each infirmity.

In this experiment, the feasibility of applying Curative Food Stemming Mechanism (CFSM), Medical Ontology (MO), or Latent Semantic Analysis (LSA) to CFS requirement classification is evaluated. Table 3 show classification index in kNN combined with CFSM, MO, or LSA. Firstly, we consider kNN model that can be observed performances of classification are 21.05%, 26.32%, 68.42%, and 42.11%, then the average is 39.47% when the classes are "Fruit", "Meat", "Seafood", and "Vegetable". The result shows that kNN algorithm combined CFSM, MO, and LSA to improve accuracy rates. In view of micro-average, there is a higher accuracy rate about 75.00% from the best combination approaches which are kNN + CFSM + MO + LSA. Therefore, we apply kNN with CFSM, MO, and LSA in ICFDSS.

6.3.2. Case study

In this section, we implement ICFDSS and show the results with a case study.

6.3.2.1. Context-aware. The system uses RFID implements and sensors to sense user's diet and parameters of vital single daily. The virtual case study in the below:

Firstly, when user wants to eat food that user can use PDA to connect RFID Reader which can sense user's diet contents and calorie. And the system will store and record the contents and calorie of food to database server (shown as Fig. 20).

Secondly, this paper designs a weight sensible personal basic data that can input sex, height, and body weight to compute BMI value and daily calorie (shown as Fig. 21). The weight sensible person monitors diet calorie daily, when users eat over the calorie value that will alert on the windows of notice and prevention to users. User's BMI is kept between the standard range, weight sensible person will tell users to carry on weight. Otherwise, the system will recommend users to reduce and control weight.

Table 3
Classification indexes in kNN with CFSM, MO, or LSA.

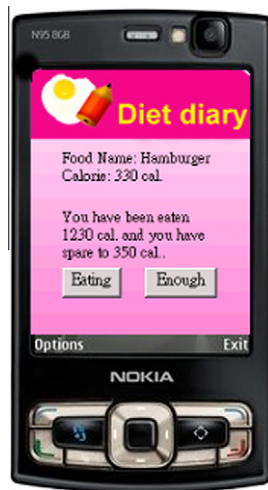| Class	kNN (%)			kNN + LSA (%)		
	kNN	kNN + CFSM	kNN + CFSM + MO	kNN + LSA	kNN + CFSM + LSA	kNN + CFSM + MO + LSA
Fruit	21.05	36.84	52.63	42.11	57.89	68.42
Meat	26.32	42.11	57.89	47.37	57.89	68.42
Seafood	68.42	63.16	73.68	57.89	68.42	73.68
Vegetable	42.11	73.68	84.21	73.68	89.47	89.47
Micro-average	39.47	53.95	67.11	55.26	68.42	75.00

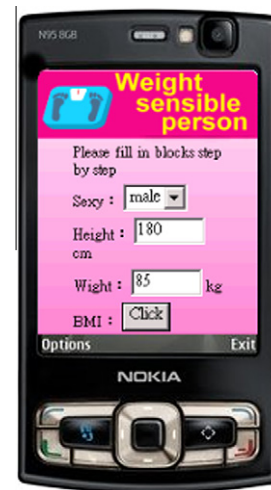**Fig. 20.** Food's name and calorie.

Fig. 21. Computing BMI value.

Thirdly, the system can query user's vital single parameter in exhort nurse function. Users can view own historical healthcare record (BP, BS, temperature, etc.) by mobile devices. ICFDSS can query and transform to line chart with parameters of ECG/EKG, HR, RR, BP, BS, temperature, and light (shown as Fig. 22).

6.3.2.2. The adaptable curative food service inference. The CFS reservation as one kind of web services is provided by various kinds of curative food industries on the internet. ICFDSS helps patients to find adaptable CFS for their remedy and eating plans. Generally, users want to find CFS reservation services through UDDI or the current matchmaking for web services. In ICFDSS, the system will recommend adaptable CFS to MUs. The proposed method is shown as Fig. 19 which is applied to solve this problem according to the following procedures:

Step 1: Many curative food industries will provide their CFS reservation services on themselves SOAP site (such as AXIS2) and publish the information of those services which include company name, therapy name, location, and price to UDDIRs based on JUDDI.

Step 2: When MUs inquire the SRA for the adaptable CFS through UIA, they send their requirements as a part of the request.

Step 3–4: The UIA will send the MUs' requirement to URIA. For example, MUs input their infirmities

"心臟病，手腳冰冷，胃腸功能障礙，風濕症，神經衰弱，高血壓，腎臟病，過敏疾病，慢性疾病，酸痛，關節炎"

in PC and PDA to request CFS, shown as Fig. 23. URIA supports the processes to include lexical analysis will check and store user's information in Personal Health Record (PHR) for inference user's requirements.

Step 5: The URIA will get user's requirement from UIA and send it to CFSIA. When CFSIA receives the user's requirement inference result from URIA, it will control and coordinate various modules in MBS.

Step 6: The SPM will inference user's affinity information by CFSM and MO according to user's requirement from URIA. The text preprocess of SPM can segment the requirement to original word-by-document matrix which will be replaced with concept layer matrix Q by CFSM, MO, and Term Frequency–Inversed Document Frequency (TF–IDF). For example, the segment

"心臟病" of this requirement will be presented the concept "心臟與血管疾病" and matrix Q is computed by the TFIDF value of the concept "心臟與血管疾病".

Step 7: To search the adaptable CFS, the ACFSIM will find the adaptable CFS class by LSA and kNN. The kNN will combine the negative influence weight value to calculate the similarity between matrix Q and trained matrix L' to get the most similar class, such as "Vegetable". We can find the adaptable CFS class through above those processes and CFSIA will sent this message to SRA for retrieval related CFS.

Step 8–11: The SRA holds up-to-date information on currently available offers for CFS which has been requested recently. To keep offer lists up-to-date, the SRA inquires the one or more UDDIRs periodically regularly in order to check, find, and get for new offers. When SRA receives the CFS class from CFSIA, it will query the Web Service Cache (WSC) and Geographic Information Database (GID) to get adaptive CFS.

Step 12–13: ICFDSS returns the results and recommends the adaptable CFS to MUs, shown as Fig. 24. If MUs agree this suggestion, ICFDSS will make the CFS reservations automatically.

Step 14: MUs will pay the money to get CFS reservations which are ordered by curative food decision system and get those bills.

6.4. Discussion

Recently the developed a few curative food recommendation services mostly focus on single infirmity considered, but they can't support to infer multiple infirmities with therapy. In this research, we propose a Intelligent Curative Food Decision Support Subsystem (ICFDSS), which provides user's requirements inference and relative services, searches by semantic inference engine and finds the most adaptive Curative Food Service (CFS). We discover the accuracy of CFS inference that is higher by combining Curative Food Stemming Mechanism, Medical Ontology, Term Frequency–Inversed Document Frequency, Latent Semantic Analysis, and *k*-Nearest Neighbor. Mobile users can conveniently obtain customized CFS and decision to use those services according to their health requirement in advance by ICFDSS.

In the future, ICFDSS can be integrated with food schedule according to MUs' diet habit and physiology state for healthiest diet. Otherwise, ICFDSS can also be combine with information
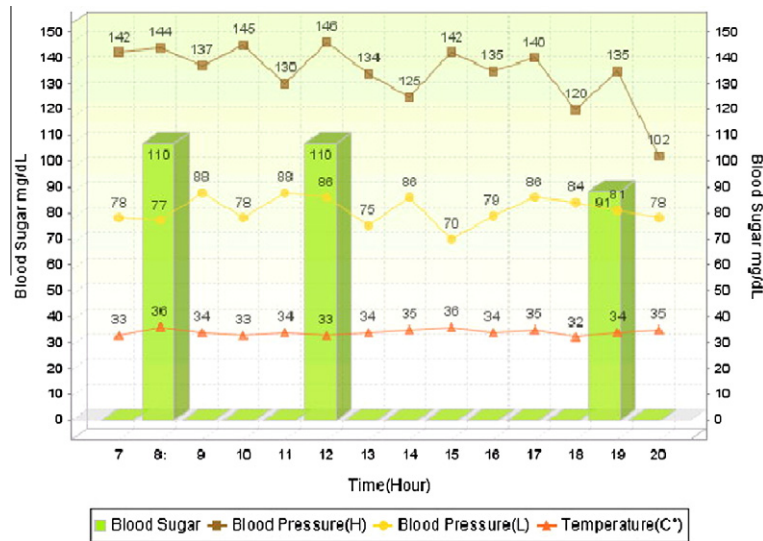
Fig. 22. Parameters of line chart.

Fig. 23. Request ICFDSS.

Fig. 24. Response ICFDSS.

appliances (such as RFID-enabled refrigerator) apply to home healthcare for CFS inference.

7. Conclusions and future work

Recently there has a few medical tourism systems developed which mostlyf ocus on location-aware service but no medical tourism service recommendation in Taiwan. In this research, we proposed a Ubiquitous Context-aware Healthcare Service System (UCHS), which provides user's requirements inference and relative services search by semantic inference engine and find the most adaptive NMS. We discover the accuracy of the NMS inference is higher by combining Medical Stemming Mechanism (MSM), Medical Ontology (MO), Term Frequency–Inversed Document Frequency (TF–IDF), Latent Semantic Analysis (LSA), and k-Nearest Neighbor (kNN). Mobile users can conveniently obtain customized NMS and decision to get and use those services reaching the target "Eat, Drink, and Be Merry with Health" in advance by UCHS.

In the future, the MO can be modified to store more levels of medical tourism and other domain knowledge for UCHS. For requirement classification, the similarity is computed by different level of MO to get adaptable NMS from different industries. Otherwise, we can analysis the market requirement with questionnaire survey and discuss about healthcare law and policy to be promoted.

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