Design and Implementation of an Ontology-Based Psychiatric Disorder Detection System

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Abstract: In this paper, we combine a decision tree algorithm with Protégé, to construct an ontology-based meridian method that serves as an example psychiatric disorder inference and a knowledge-sharing platform. This method may effectively detect a psychiatric disorder by pinpointing an association between the meridian system and modern medicine; it may also help to build a fuller picture of expert knowledge by constructing domain and task ontologies. This system provides the general public an understanding of the issues involved, while allowing experts to participate and be totally aware of satisfying the requirements therein. Moreover, the system will help eliminate information disparity between patients and physicians.

Key Words: Ontology, Psychiatric disorder, Domain ontology, Task ontology, Ontology-based system

1 Introduction

Because of excessive social competition, stress has become a part of modern-day life; it occurs in all areas of our daily lives—at home, at work, and in social life. Daily stress is not always harmful; left unchecked, however, it can pose a threat to our physical and mental health. Stress can become dangerous, because it can trigger a variety of psychiatric disorders and lead to life-threatening illnesses such as heart disease and cancer. A psychiatric disorder is an abnormal mental condition or a disorder expressing symptoms that causes significant distress and/or dysfunction [23]. In fact, one can suffer from a psychiatric disorder and be completely unaware of it. Therefore, to manage public welfare, it is critically important to have an effective approach for detecting psychiatric disorders.

In this study, we aim to present a novel system for detecting a psychiatric disorder, by addressing the following problems and difficulties. First of all, detecting a psychiatric disorder is a difficult task, given that psychiatric disorders are related to the human mind, brain, and spirit. The symptoms are recessive, potential, and difficult to discover; moreover, they cannot be detected by objective diagnostic indices, such as blood pressure (BP), glutamyl pyrabic transaminase (GOT), glulamic pyruvic transaminase (GDT), and the like. The methods used to detect a psychiatric disorder usually include clinical diagnoses and perception questionnaires, such as the diagnostic and statistical manual of mental disorders (DSM)[1]. Unfortunately, there remain problems due to a lack of objective criteria for clinical diagnoses; for example, the outcomes of perception questionnaires are easily affected by users' degrees of education or personal perception.

Second, there is a lack of connection between the meridian system and modern medicine. The meridian system is a distribution network throughout the body that supplies vital energy to every part of the body; it is closely linked to the physiological functions and balance of health in humans. Furthermore, knowledge of the meridian system allows Chinese doctors to determine disorder symptoms, further diagnose illness, and determine original causes. For these reasons, it is possible to utilize knowledge of the Chinese meridian system to learn more about the symptom patterns of psychiatric disorders. However, in previous and current research into the application of meridian theory, there has been no combination study conducted into the use of the traditional Chinese medicine concept of meridians in assisting modern medicine in diagnosing mental illnesses.

Third, there is still no constructive tool for sharing and visualizing clinical knowledge for detecting psychiatric disorders. Both modern medicine and traditional Chinese medicine lack appropriate tools vis-à-vis clinical diagnoses. This shortcoming leads to an unavailability of tools for handing down clinical diagnosis experiences, including dynamic diagnoses and static background knowledge. This unavailability of experience-based knowledge impedes progress in medical science.

Finally, the problems inherent in psychiatric disorder detection arise from their intrinsic complexity. Impact indices are interrelated and examinations are subjective. The impact indices complement each other, and each index cannot be treated as a distinct unit. In other words, any detector cannot determine one or some indices and arbitrarily treat them as anchors.

This study looks to present a novel approach that incorporates ontology and a decision-tree algorithm; moreover, the proposed method utilizes meridian science as found in traditional Chinese medicine, and psychiatric disorders collectively serve as an example for which we can develop a complete framework and a practical diagnostic system.

Within the context of diagnosing psychiatric disorders, meridian science is employed to assess the human mental situation and derive objective meridian values to compensate for the insufficiency of diagnostic indices in modern medicine for detecting psychiatric disorders. Knowledge of meridians is embedded in and serves as the foundation of an ontology-based system. An ontology-based approach is employed to imitate the role of a psychologist in detecting a psychiatric disorder; the system enables the user to interact with the system in detecting psychiatric disorders, resulting in a series of mental analyses that are made according to the meridian values. In addition, the ontology can help in visualizing dynamic diagnostic knowledge, including inference rules and static domain knowledge (e.g., components and relationships). Furthermore, the ontological tree structure can help one revise, share, and apply existing knowledge.

From an analytical perspective, the decision-tree algorithm allows for the effective classification and generation of decision rules. This study employs a decision-tree algorithm that employs the meridians as the criteria of a psychiatric disorder, as well as combinations of clinical diagnoses and DSM judgments as outcomes, to classify and generate decision rules comprehensively. The input data needs to translate the meridian values and the levels of psychiatric disorder into a coherent rule of meridian diagnosis for detecting psychiatric disorders.

The integration of meridian science, an ontology-based approach, and a decision-tree algorithm ensures a sound approach to overcoming the difficulties encountered in detecting psychiatric disorders.

2 Related Work

This section discusses the techniques used in this research and provides an overview of the relevant fields.

2.1 Meridian Science

The meridians, as described by traditional Chinese medicine, have been variously translated as the “Jing-Mai,” “Channel,” or “Vessel”; they represent the connections among various parts of the human body during embryonic development [8]. According to traditional Chinese medicine, meridians are defined as channels used in the flow of vital energy [14]. As shown in Figure 1, there are a total of 12 unique energy channels. On each side of the body, there are 12 meridians, which are denoted as “L_n” or “R_n” (the position of R_n being the opposite of L_n). Half of the meridians, which course along the upper extremities, are known as the “hand meridians”; the other half, which travel to the lower extremities, are known as the “foot meridians.”

The meridians can be viewed simply as imaginary lines on the body surface that consist of nerve endings that ultimately connect to the neuronal chains on the master homunculus through multiple synapses [14]. Furthermore, in the embryo, the meridian system is likely to have preceded all the other physiological systems, including the nervous, circulatory, and immune systems [3]. Consequently, the meridians overlap and interact with every life system of the human body. In this study, we look to employ meridian science to map the genetic foundation of all disorders and find meridian patterns, ultimately to detect psychiatric disorders.

In addition, specific equipment, MEAD[2], was adopted to measure the meridians in our study and derive objective measurements. In traditional Chinese medicine, diagnoses are made by a doctor who employs a palpation examination, which involves pressing the skin, hands, feet, chest, abdomen, and other areas to check for pathological changes; he or she then makes a diagnosis based on sensory perceptions. In fact, MEAD equipment is designed to imitate the hands of the doctor and gather concrete, meridian-based statistics. MEAD can translate abstract perceptions into concrete statistics and facilitate both analyses and inductions of meridian patterns. The MEAD interface is shown in Figure 2.

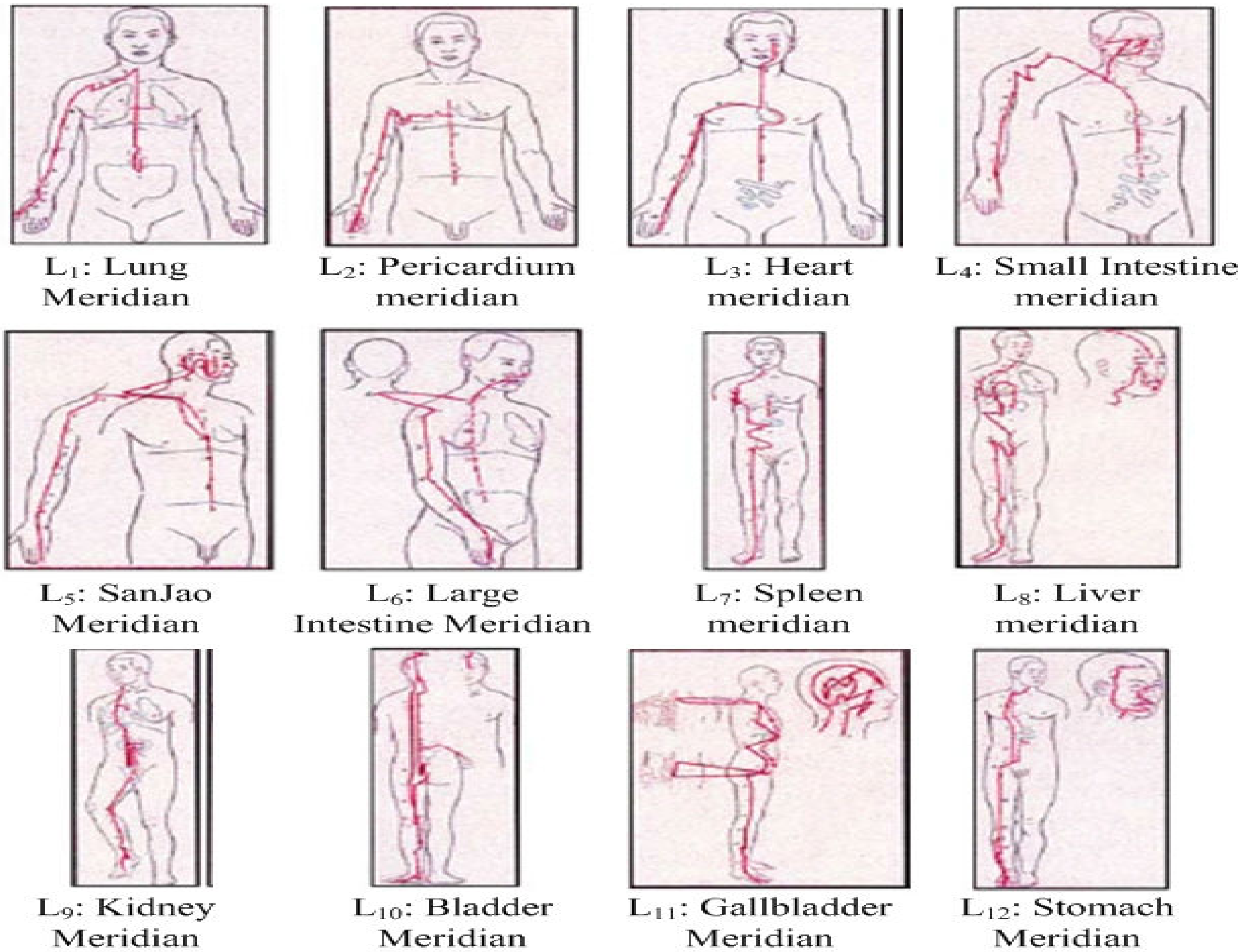
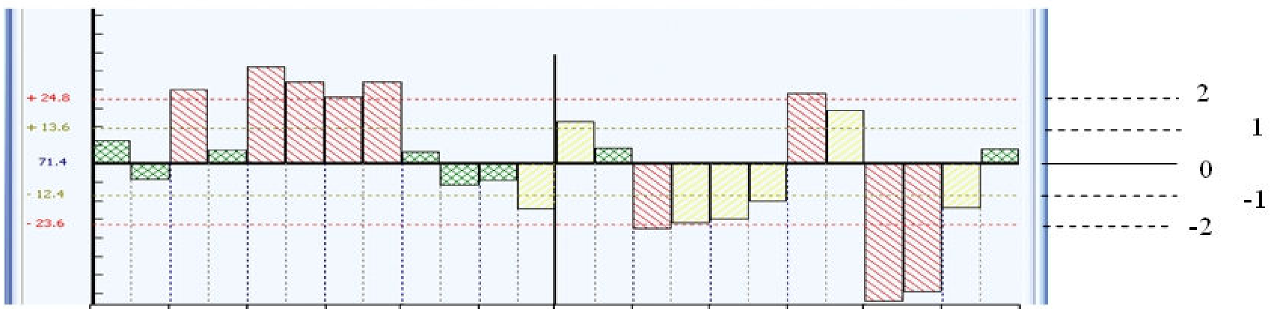


Fig. 1 The 12 meridians [14]



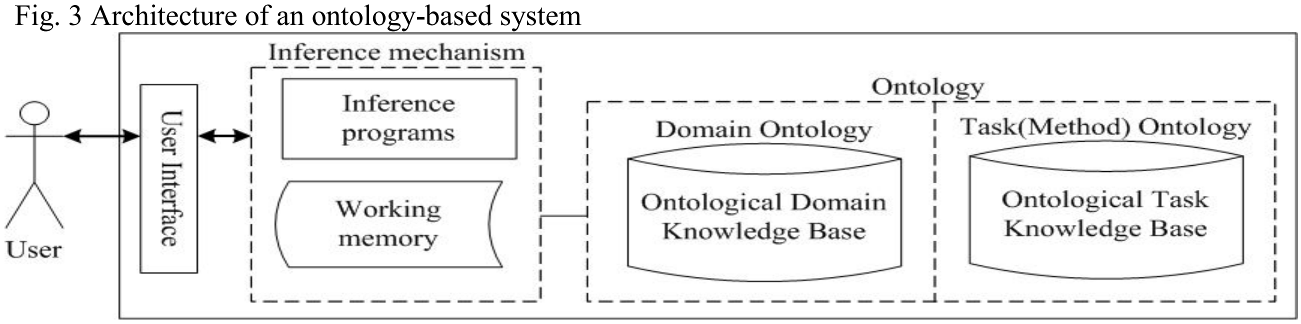
L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12
0	2	2	2	0	0	1	-2	-1	2	-2	-1
R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12
0	0	2	2	0	-1	0	-1	-1	1	-2	0

Fig. 2 The MEAD interface

2.2 Ontology-Based Information System

A discussion of ontology is needed, to achieve a deeper understanding of any ontology-based system. The word "ontology" is derived from philosophy, where it refers to a systematic explanation of being. In the computer science community, ontology becomes an important issue. There are many definitions about what ontology is; one of the most quoted is Guber's definition of it as "an explicit specification of a conceptualization" [15]. Apparently, ontology provides the means for explicitly describing the conceptualization behind the knowledge of a knowledge base [11]. For example, Natalya and Deborah [20] clarify the properties of ontology as sharing domain knowledge and making it explicit, reusing domain knowledge, separating domain knowledge from operation knowledge, and analyzing domain knowledge. In addition, ontology is referred to as a methodology that specifies distinct concepts. A literature review reveals that ontology can be successfully applied to natural language [9][13], knowledge-sharing [5][22], and knowledge technology [4][7][12][13]. Ontology can be divided into two fields, namely, domain ontology and task ontology. As mentioned earlier, ontology is employed to embody knowledge within a tree structure. However, knowledge contains not only dynamic knowledge—such as the inference procedure of a diagnosis—but also static knowledge, such as meridian components and their relationship to a psychiatric disorder. Therefore, ontology utilizes domain ontology to describe static knowledge, while it utilizes task ontology to describe dynamic knowledge. Ontology in a specific area can be completely embodied by correlating the domain ontology with the task ontology, so that dynamic and static knowledge interact. For instance, dynamic knowledge—such as knowing that when the value of the lung meridian is > 2, the person is suffering from a certain disorder—is catalogued into the task ontology; meanwhile, static knowledge—such as what the lung meridian is and its relationship to the other meridians—is catalogued into the domain ontology.

Fig. 3 Architecture of an ontology-based system



Returning to the subject, an ontology-based system refers to a system in which the inference mechanism and ontology are embedded (Figure 3). In this study, we use the inference mechanism to analyze the user's meridian values and then apply ontology to express and share the clinical knowledge of meridian diagnosis, ultimately to detect a psychiatric disorder.

Therefore, domain knowledge—which is necessary for detecting a psychiatric disorder—can be obtained and conveyed as shareable knowledge. In addition, since ontology manifests knowledge by way of the tree structure, we can use the structure to generate rule-based inferences, which are embedded in an ontology-based system. Accordingly, an ontology-based system not only allows us to share and explicate knowledge, but it can also facilitate the selection of meridian knowledge. An ontology-based system is also flexible and easy-to-use in maintaining components and relationships for future requirements.

2.3 Decision-Tree Induction

One of the most common classification methods is the use of a decision tree, which builds a tree structure and performs classifications of given data [7][18]. The decision tree used here is a model generated by a classification and regression tree (CART) and a chi-squared automatic induction. As shown in Figure 4, a decision tree consisting of nodes and branches represents a collection of rules, with each terminal node corresponding to a specific decision rule and each branch denoting a specific threshold value. This approach may be used directly for predictive or descriptive purposes, or it can be applied to knowledge acquisition in an ontology-based system. A literature review indicates that the decision tree can be used successfully in medical science [4][10].

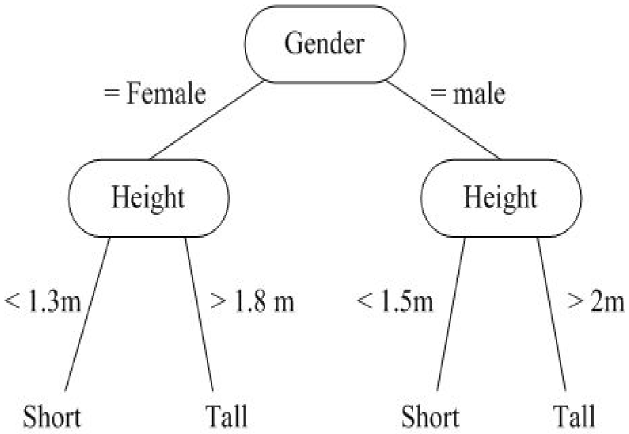


Fig. 4 Exemplary decision tree for height assessment

There are four constraints to follow in advance of using a decision tree [19]:

(1) Since the decision tree requires discrete space and is applicable only with regards to category attributes, numeric attributes must be made discrete in advance.

(2) The decision tree is easily affected by missing data and it cannot fix its own branches. Therefore, the dataset must be preprocessed, to screen for any incomplete records.

(3) The decision tree is a learning algorithm that uses training data; sometimes data noise will cause over-fitting problems. Pruning weightless criteria is an available strategy in avoiding this problem and achieving better performance.

(4) The interrelationships among the criteria must be ignored while the tree is being built.

Because the decision tree is powerful in classification and prediction, it is very suitable for this study in generating diagnostic rules. In this study, we use a decision tree to generate the dynamic knowledge of task ontology, to determine psychiatric disorder problems in multi-meridian situations. For clarity, a flow chart for generating decision rules is shown as Figure 5.

2.4 The Knowledge-Storage Platform: Protégé

This sub-section provides a general description of the knowledge-storage platform called Protégé. In this study, we use Protégé in ontology-building. Protégé was developed by the Stanford Medical Informatics (SMI) department at Stanford University, and it is a free, stand-alone, and open-source platform that provides a suite of tools to construct domain models and knowledge-based applications comprising ontologies. As shown in Figure 6, the core of Protégé is its knowledge model, and any programmatic interaction with the objects that reside within, such as classes, instances, slots, and the like. Also, Protégé can be extended by using a Java-based application programming interface (Protégé knowledge model API) with the other applications. In addition, the slot and tab plug-in are designed to customize the user interface, and the multi-storage format (Default, RDF, OWL, and the like) is designed to support different requirements. On the basis of recent studies, Protégé is capable of and effective in constructing and presenting a large body of knowledge. Furthermore, it is usually utilized in medical science, to enable the management of multiple ontologies [1][16].

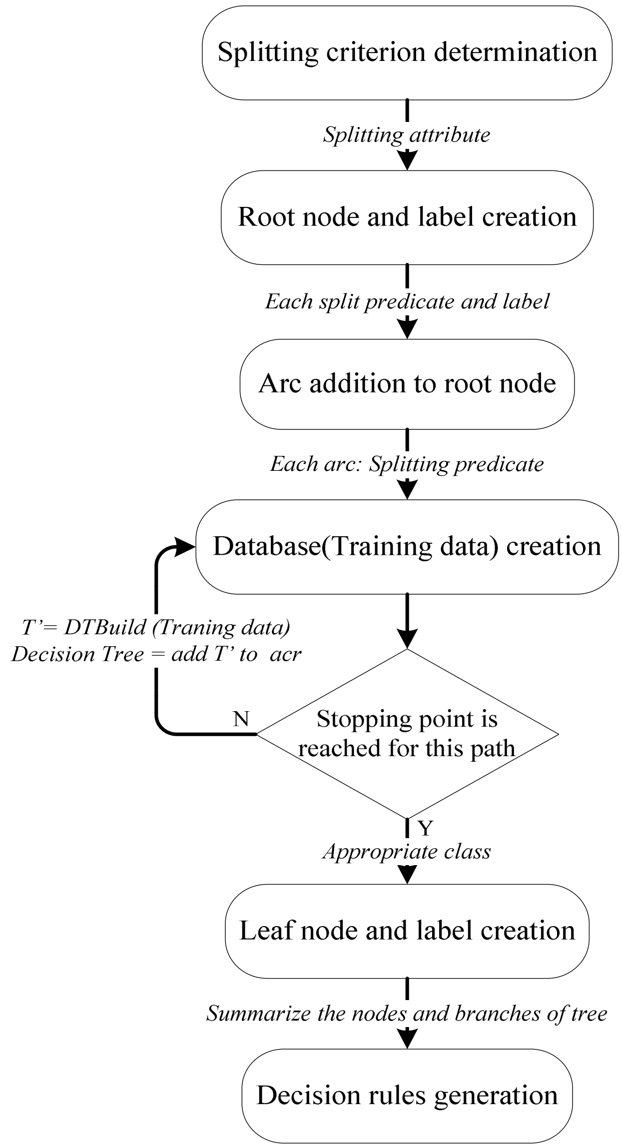


Fig. 5 Flow chart of decision-rule generation

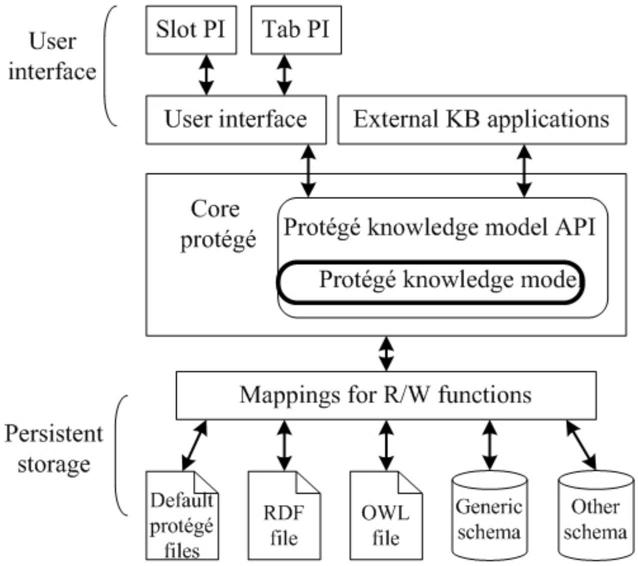


Fig. 6 Protégé architecture [6]

3 The Proposed System

This section presents an ontology-based system that is embedded with meridian knowledge that serves as the system foundation and employs the decision-tree algorithm as the inference rules generator. The architecture of the proposed system is illustrated in Figure 7. First, we apply the ontology as the method for modeling domain knowledge, integrating the inference mechanism, constructing the ontology-based system, substituting for the role of the psychologist, and detecting the psychiatric disorder.

The system will interact with users, select the required meridians, and provide an accurate diagnosis, along with further descriptions of the characteristics of the specific meridian used to detect psychiatric disorders. Within this system, we apply the decision-tree algorithm to facilitate the formation of the task ontology. The mechanism of the decision-tree algorithm inducts training data regarding meridians and classes into the inference rules, which become the task ontology of the ontology-based system. Also, the mechanism of the decision-tree algorithm will renew and expand the training dataset, replacing the inference rules while the decision tree is modified and thus promoting the accuracy of the system.

In addition, we will introduce our system in terms of data input. As shown in Figure 7, there are two inputs for this system. One of them comes from the back end of the system; the other comes from the front end of the system. The input from the back end of the system is case history data of patients and the training data for the decision-tree algorithm. The back end input comprises the meridian values and the psychiatric disorder diagnosis, which is a combination of the clinical diagnosis and DSM-based judgment. As shown in Table 1, there are 24 fields for the meridian values, denoted as F_1 to F_{12} and L_1 to L_{12}; one field for the psychiatric disorder diagnosis is denoted as "DSM," and one field for the level of psychiatric disorder diagnosis is denoted as "DSM output."

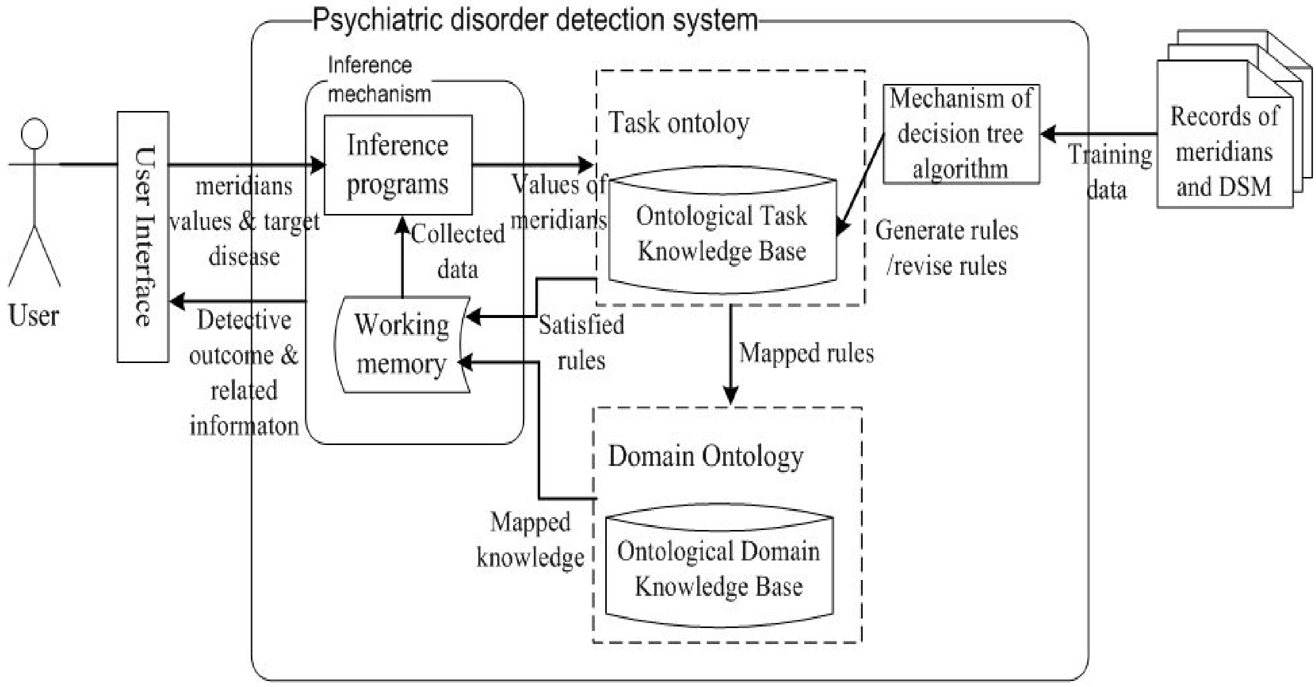


Fig. 7 Architecture of ontology-based psychiatric disorder detection system

Table 1 Schematic of training data for a psychiatric disorder

L1	*R1*	*L2*	*R2*	*L3*	*R3*	*L4*	*R4*	⋯	*L12*	*DSM*	*DSM output*
– 2.0	– 2.0	2.0	0.0	–1.0	0.0	0.0	– 2.0	⋯	– 2.0	15	Slight
1.0	2.0	0.0	2.0	–2.0	0.0	2.0	2.0	⋯	2.0	4	Normal
– 2.0	– 1.0	2.0	2.0	–2.0	– 2.0	– 1.0	1.0	⋯	1.0	11	Slight
2.0	0.0	2.0	0.0	–1.0	1.0	– 1.0	– 1.0	⋯	– 1.0	23	Serious

These 24 meridian fields are treated as the input criteria of the decision-tree algorithm, and the DSM output is treated as the output classes of the decision-tree algorithm, in order to induct and generate the decision tree of psychiatric disorders (Figure 8) and formulate coherent rules (Table 2) for the task ontology. On the other hand, the input from the front end of the system is the 24 meridian values of the user, which are obtained by the MEAD equipment discussed in section 2.1; the schema equals the criteria part of the training data. The front end input will interact with the inference mechanism and find the satisfied rules, in order to infer whether or not the user is suffering from a psychiatric disorder.

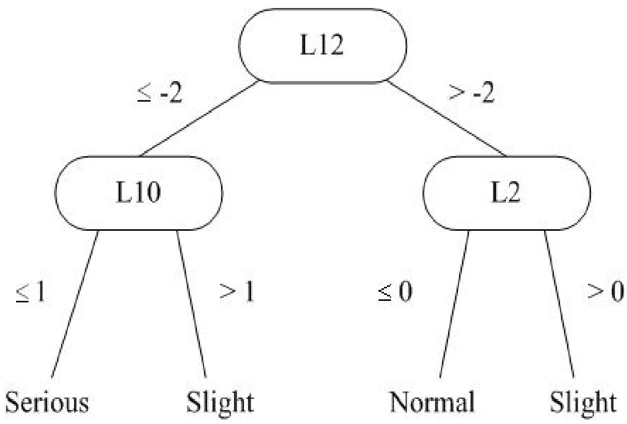


Fig. 8 Simple case of a psychiatric disorder decision tree

Table 2 Coherent rules of a simple case

Serial number	*Decision rules*	*Level of disorder*
1	L12 ≤ –2 && L10 ≤ 1	Serious
2	L12 ≤ –2 && L10 > 1	Slight
3	L12 > –2 && L2 ≤ 0	Normal
4	L12 > –2 && L2 > 0	Slight

3.1 Ontology-Based System Design

As mentioned earlier, within the context of detecting psychiatric disorders, an ontology-based approach is employed to imitate the role of the psychologist in executing the processes therein. The ontology-based system enables users to interact with the system for disorder detection in producing a diagnosis and further descriptions that correspond to the properties of a user's meridians. Two tasks are needed to design an ontology-based detection system: the formulation of domain ontology and the design of a task ontology. Also, the Java-based ontology editor, Protégé, was adopted to develop our system. In our proposed ontology-based system, the flow chart of the process used to detect a psychiatric disorder is shown in Figure 9.

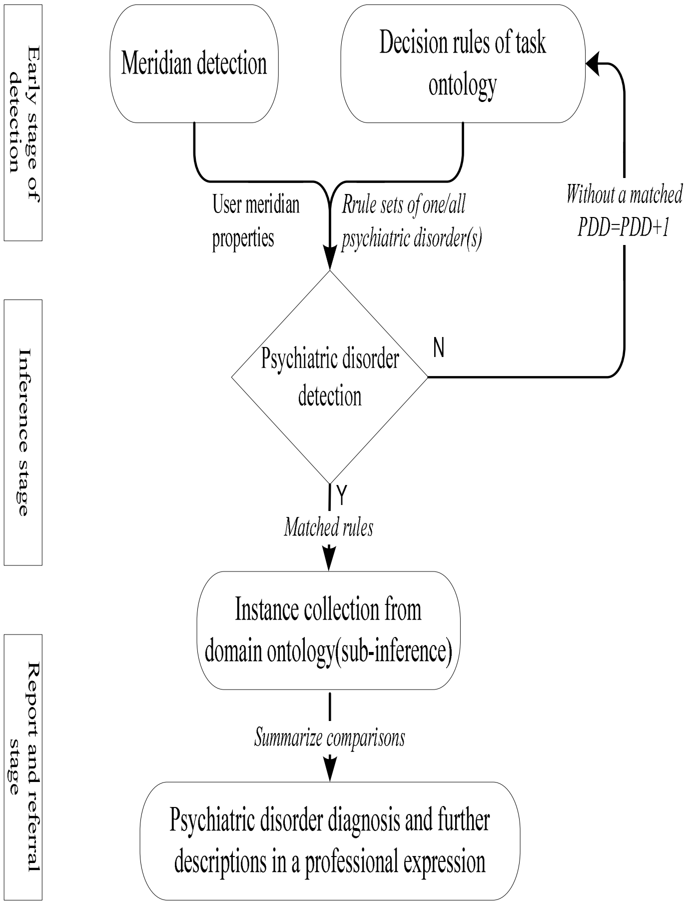


Fig. 9 Flow chart of psychiatric disorder detection

3.2 Formulating the Domain Ontology

The first step is to construct the meridian domain ontology, to describe the domain knowledge for further descriptions of meridian properties. As noted earlier, through the derived ontology, our system is not only able to store the domain knowledge, but also reuse and share knowledge among organizational members. Furthermore, the constructed domain ontology offers a good foundation for extending or maintaining domain knowledge. In the study, we employed Nataya and Deborah's seven-step approach to develop the related domain ontology [20]. This process of interactive design will likely continue through the entire lifecycle of the ontology. The flow chart for formulating the domain ontology is shown in Figure 10.

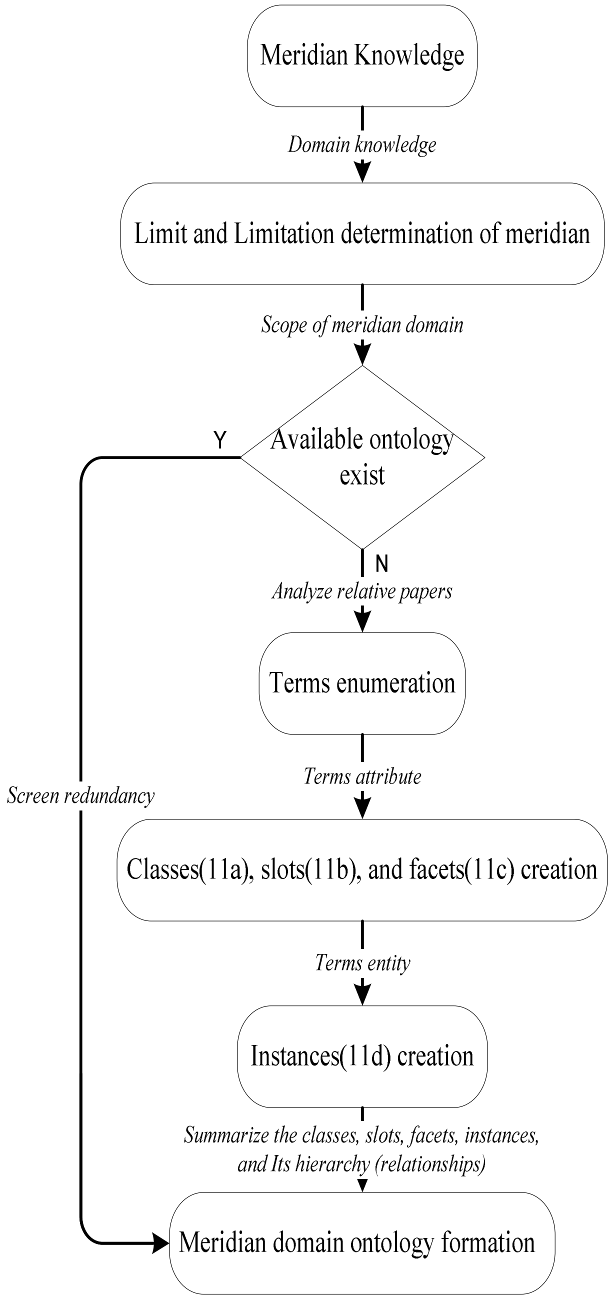
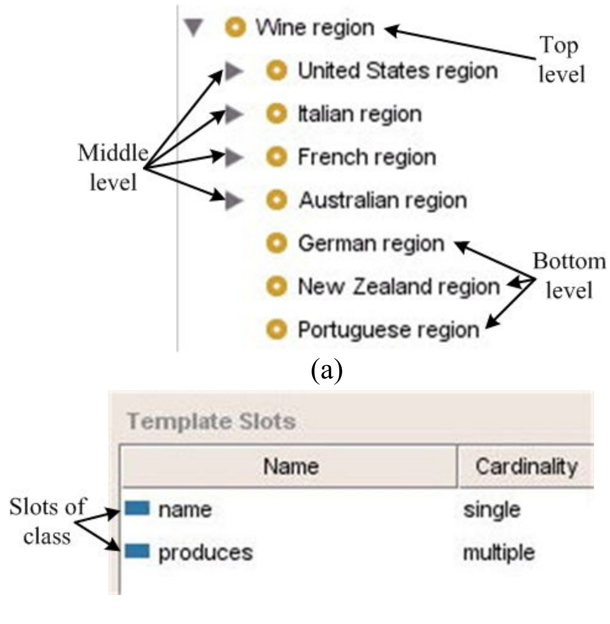


Fig. 10 Flow chart of meridian domain ontology formation



(b)

Fig. 11 Interface of two pages of the domain ontology

3.3 Designing the Task Ontology

The second step in designing the ontology-based system is to generate the task ontology. The task ontology is designed to describe the rules and threshold values of meridian diagnoses of psychiatric disorders, by making rule-based inferences. Inferences following the if-else rule screen are used to establish whether the user satisfies the specific rule set (or not). In this study, we employ a decision-tree algorithm that can minimize the expected number of comparisons, to generate the task ontologies of meridian diagnoses of psychiatric disorders. The flow chart for generating the task ontology is shown Figure 12. In addition, in order to reuse knowledge, the decision rules are split into their minimum units and are restructured for specific inferences. Tables 3 and 4 present the task ontology of a simple case.

In particular, the task ontology could support the inference of certain or all psychiatric disorders while diagnosing multiple disorders. In task ontology, every decision tree (i.e., targeted psychiatric disorder) is generated from the training data of a specific disorder and utilized to detect a specific disorder. The user could acquire a comprehensive diagnostic result by selecting certain or all task ontologies. Moreover, the implicit connections among disorders are found if the same decision rules exist among disorders. The same meridian patterns among different disorders will be able to form connections that have, apparently, not yet been found by modern medicine.

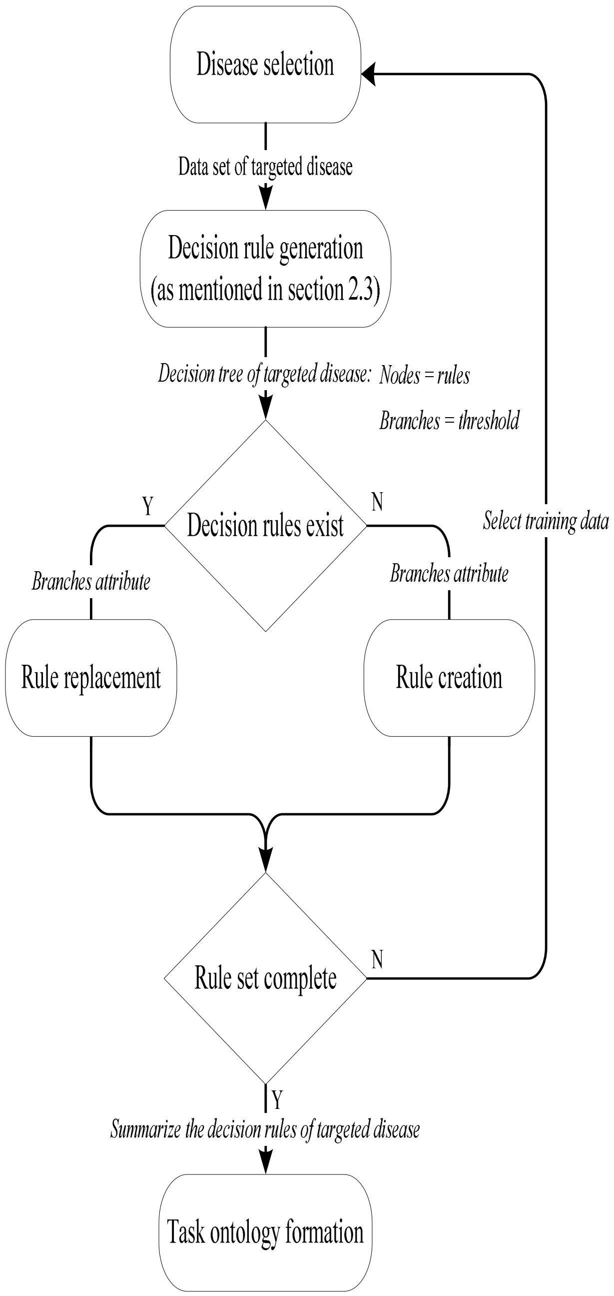


Fig. 12 Flow chart of meridian task ontology formation

Table 3 Task ontology of a simple case

N1	Pathological stimulation of the Pericardium meridian	L2 = 2
N2	Physiological stimulation of the Pericardium meridian	L2 = 1
N3	Normal Pericardium meridian	L2 = 0
N4	Physiological weakness of the Pericardium meridian	L2 = –1
N5	Pathological weakness of the Pericardium meridian	L2 = –2
N6	Physiological stimulation of the Bladder meridian	L10 = 2
N7	Physiological stimulation of the Bladder meridian	L10 = 1
N8	Normal Bladder meridian	L10 = 0
N9	Physiological weakness of the Bladder meridian	L10 = –1
N10	Pathological weakness of the Bladder meridian	L10 = –2
N11	Physiological stimulation of the Stomach meridian	L12 = 2
N12	Physiological stimulation of the Stomach meridian	L12 = 1
N13	Normal Stomach meridian	L12 = 0
N14	Physiological weakness of the Stomach meridian	L12 = –1
N15	Pathological weakness of the Stomach meridian	L12 = –2

Table 4 Inference rules of a simple case

Rule set	*Inference rules*	*Level of disorder*
1	Is satisfied (N15)	Serious
	Is satisfied (N9 or N10)	
2	Is satisfied (N15)	Slight
	Is satisfied (N6)	
3	Is satisfied (N11, N12, N13, or N14)	Normal
	Is satisfied (N3, N4, or N5)	
4	Is satisfied (N11, N12, N13, or N14)	Slight
	Is satisfied (N4 or N5)	

4 Implementation and Exemplary Disease Results

The proposed method serves as the basis of a system structure for detecting psychiatric disorders. Furthermore, the case of an exemplary disorder was executed, to verify the usefulness of the system in a real-life setting. The results thereof are discussed below.

4.1 Implementation

The system is being further developed using Java, Java Server Pages, Protégé 3.1, and MySQL. Figure 13 shows the system structure. In rule generation, the Java Decision Tree program is designed to communicate with the MySQL database, to acquire the training data of the targeted disorder and generate the decision rules of that targeted disorder. In the MySQL database, every patient case history is measured by the MEAD equipment. The scale of each meridian is 2 to –2. The decision rules of the

targeted disorder are stored in the rules base of the Protégé 3.1 knowledge base.
In disorder detection, the user will be measured by the MEAD equipment and the system will interact with him or her through a web-based front-end interface. The Java inference program is designed to infer the values of a user's meridians, which are acquired from the MEAD equipment. According to the selected disorder, the inference program will call the suitable sub-inference program to acquire the indices and its values, to examine whether or not the user suffers from the targeted disorder. The sub-inference program communicates with the rules base and integrates with the domain base to return a set of comprehensive examination results. Both the rules base and domain base are stored in the Protégé 3.1 knowledge base.

4.2 Exemplary case results
An exemplary case study was conducted in a well-known city hospital in Taiwan. The exemplary disorder in question was Geriatric Depression (GP), which is as easily cured as many other physical disorders or normal reflections.
For this exemplary case, we enrolled 70 subjects who took part in examinations related to the Geriatric Depressive Scale (GDS) and meridian measurements.
In every case, the 24 meridians were always used as the input and the DSM as the output of the decision-tree program. The output of the decision tree program should be a category type; with GDS, any value >21 is defined as serious, 11–20 as slight, <10 as normal.
For rule generation, the decision-tree program processed the examination data of 70 geriatric subjects and generated eight rule sets in the knowledge base, as shown in Figures 14a and 14b.
In disorder detection, the user/doctor selects two subjects to determine whether or not they suffer from GP, as shown in Figure 14c. Next, the inference program generates inference results according to the subject's meridian measurements and the GP rule sets, as shown in Figure 14d. In addition, the user/doctor is also able to acquire details pertaining to meridian knowledge, thus obtaining a better understanding through the system.
In this case, the subject of case number 1 was found to suffer from GP at a slight level, according to rule number 2. The left side liver meridian was debilitated (L12 = –2.0), the left side SanJao meridian hyperfunctioning (L10 = 2.0), and the left side bladder meridian was weak (L7 = –1.0). The diagnosis of case number 2 was fine.

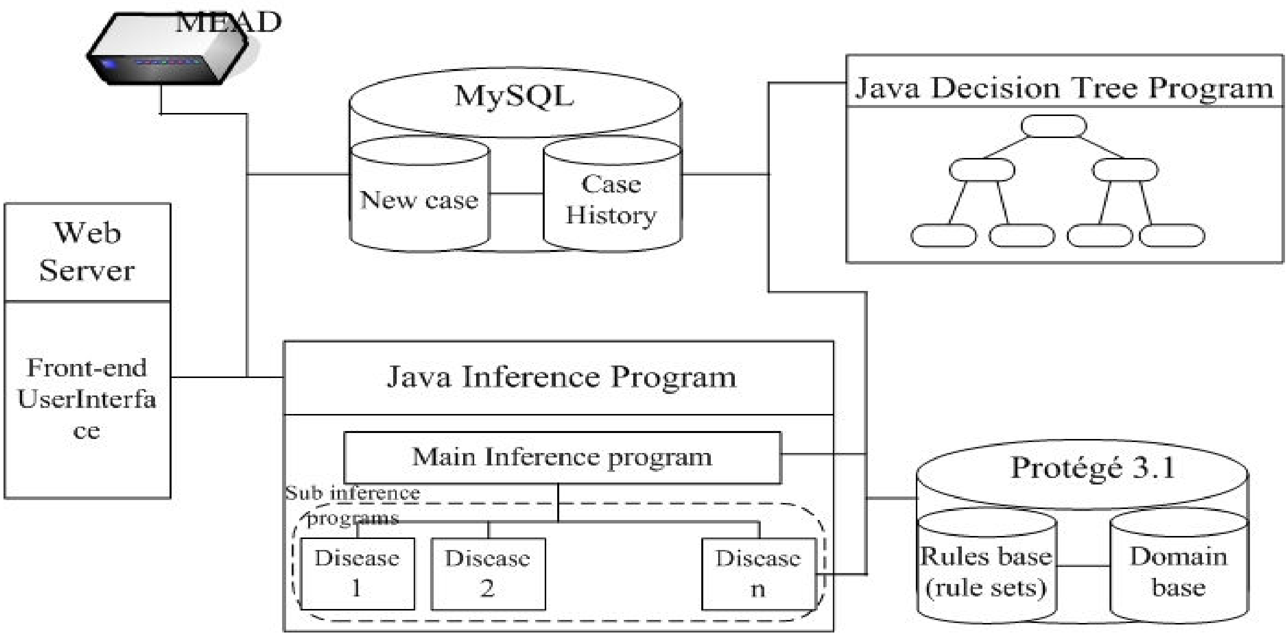
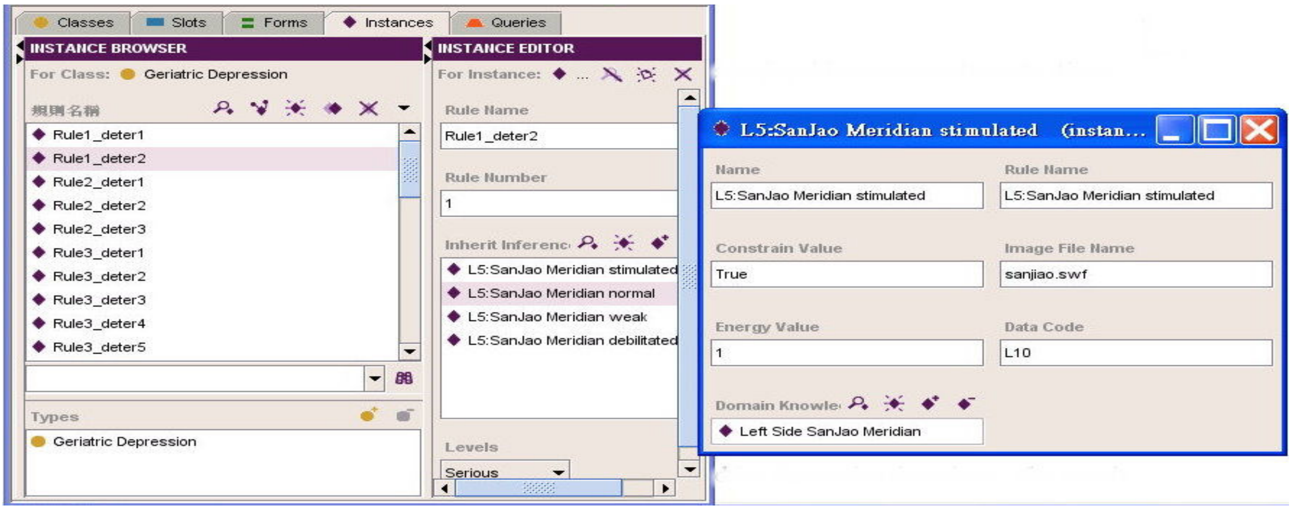


Fig. 13 Structure of an ontology-based psychiatric disorder detection system

Rule Set

Number	Rule	Level
1	L12 <= -2 && L10 <= 1	Serious
2	L12 <= -2 && L10 > 1 && L7 <= -1	Slight
3	L12 > -2 && L2 <= 0 && T7 > 0 && L9 <= -1 && L6 > -2	Slight
4	L12 > -2 && L2 <= 0 && T7 > 0 && L9 > -1 && T1 <= 0 && L5 <= 1 && T4 > 3	Slight
5	L12 > -2 && L2 <= 0 && T7 > 0 && L9 > -1 && T1 <= 0 && L5 > 1	Slight
6	L12 > -2 && L2 > 0 && L1 <= 0 && L5 <= -1	Slight
7	L12 > -2 && L2 > 0 && L1 <= 0 && L5 > -1 && R8 > 1	Slight
8	L12 > -2 && L2 > 0 && L1 > 0	Slight

(a)



(b)

Patient Data	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	Date	Check
Case No: 2	-1.0	-1.0	2.0	-1.0	-2.0	-2.0	-2.0	0.0	-2.0	-1.0	2.0	1.0	2006-08-31 15:41:06	☑
ID No: Gender: 1	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12		
Age: 84	0.0	0.0	2.0	0.0	-1.0	0.0	0.0	2.0	0.0	0.0	2.0	2.0		

Patient Data	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	Date	Check
Case No: 1	0.0	0.0	0.0	-1.0	0.0	0.0	-1.0	2.0	0.0	2.0	0.0	-2.0	2006-08-30 15:41:06	☑
ID No: Gender: 0	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12		
Age: 84	2.0	2.0	-2.0	-2.0	0.0	0.0	0.0	0.0	0.0	2.0	-2.0	-2.0		

(c)

Patient Data	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	Date
Case No: 2	-1.0	-1.0	2.0	-1.0	-2.0	-2.0	-2.0	0.0	-2.0	-1.0	2.0	1.0	2006-08-31 15:41:06
ID No: Gender: 1	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	
Age: 84	0.0	0.0	2.0	0.0	-1.0	0.0	0.0	2.0	0.0	0.0	2.0	2.0	

Result : Fine

Patient Data	L1	L2	L3	L4	L5	L6	L7	L8	L9	L10	L11	L12	Date
Case No: 1	0.0	0.0	0.0	-1.0	0.0	0.0	**-1.0**	2.0	0.0	**2.0**	0.0	**-2.0**	2006-08-30 15:41:06
ID No: Gender: 0	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	
Age: 84	2.0	2.0	-2.0	-2.0	0.0	0.0	0.0	0.0	0.0	2.0	-2.0	-2.0	

Result :
Left Side Liver Meridian debilitated [L12 = -2.0]
Left Side SanJao Meridian hyperfunction [L10 = 2.0]
Left Side Bladder Meridian weak [L7 = -1.0]
Diagnosis Fell ill Slight (Rule 2) 。
L12 <= -2 && L10 > 1 && L7 <= -1

(d)

Fig. 14 Four sample pages of the proposed system

5 Implications and Contributions of the Proposed Method

Recessive disorders have a detrimental impact on people's everyday health, and so detecting recessive disorders both effectively and accurately is a key issue nowadays. This study incorporating a meridian-based system, an ontology-based approach, and a decision-tree algorithm is suggested to provide a sound approach to addressing detection problems. Although this study applied this method to recessive disorders for the first time, the exemplary case suggests the proposed system is feasible and applicable to modern medical practice.

One feature of the proposed system is that the system offers a new way of detecting psychiatric disorders. Employing the 24 meridians as detection indices assists in detecting targeted disorders by compensating for the gaps and vulnerabilities of modern medicine. The meridian-based medical practice executed through the implementation of the presented system makes use of a decision-tree algorithm and takes an ontology-based approach.

Another advantage of the proposed system is its contribution to an effective framework of disorder detection. Newly discovered disorders can be addressed through this framework, so long as one constructs its inference rules through a decision-tree algorithm and detects it through the ontology-based approach. Additionally, the framework can also comprehensively support situations in which there are multiple disorders. Ultimately, it can detect multiple disorders and acquire the hidden relationships, using the common rules and values.

This study also establishes an interaction between domain ontology and task ontology. Every inference rule can be made to correspond with its relevant domain knowledge, through the domain ontology of meridians. This system offers comprehensive results and generates for the user a concrete tangible of meridian knowledge.

However, we also acknowledge that the proposed method has limitations. The proposed approach depends upon effects that, in turn, depend upon the availability of task ontology inference rules. Using inference rules, the study aims to provide an available framework of disorder detection, rather than an accurate inference outcome—the latter of which would be based on a complete training dataset. Moreover, the provision of a complete training dataset highly depends upon access to hospital and patient data. Therefore, we were unable to make use in this study of a complete training dataset.

In addition, some limitations of the proposed method—such as the scale of meridian measurement and the domain knowledge of the meridians system—may not be clear. Modifying and enhancing this knowledge base requires the expertise of a domain expert. These constraints diminish the efficiency of the proposed method; nonetheless, the proposed approach is still significant, since an effective detection system for recessive disorders is as yet unavailable.

6 Conclusion and Future Research

This paper studied the feasibility of integrating an ontology-based approach with a decision-tree algorithm, to detect psychiatric disorders. We elucidated the associations between the meridian system and modern medicine in detecting psychiatric disorder, thus addressing problems 1 and 2 of the study. Next, we employed an ontology-based approach that includes domain ontology and a task ontology, to construct the psychiatric disorder inference and meridian knowledge and thus address problem 3 of the study. Finally, we used a decision-tree algorithm to classify and generate decision rules in the overall calculation, to address the final problem of the study. These propositions are supported by the empirical exemplary case results presented here.

Follow-up studies should execute the system in a real-life medical practice to increase the available detections for different disorders. By capturing sufficient data regarding a variety of disorders, the system will be able to detect disorders and uncover the valuable relationships between them. The application of comprehensive disorder detection and the hidden relationships therein will be of great value to medical practice in general. In addition, it is recommended that data regarding the domain ontology of meridians be captured by collecting domain expert feedback, such as that of doctors of traditional Chinese and experts of traditional Chinese theory.

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Notes:

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