International Journal of Advanced Smart Convergence Vol.10 No.2 21-30 (2021)
http://dx.doi.org/10.7236/IJASC.2021.10.2.21

IJASC 21-2-4

Panic Disorder Intelligent Health System based on IoT and Context-aware

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Abstract

With the rapid development of artificial intelligence and big data, a lot of medical data is effectively used, and the diagnosis and analysis of diseases has entered the era of intelligence. With the increasing public health awareness, ordinary citizens have also put forward new demands for panic disorder health services. Specifically, people hope to predict the risk of panic disorder as soon as possible and grasp their own condition without leaving home. Against this backdrop, the smart health industry comes into being. In the Internet age, a lot of panic disorder health data has been accumulated, such as diagnostic records, medical record information and electronic files. At the same time, various health monitoring devices emerge one after another, enabling the collection and storage of personal daily health information at any time. How to use the above data to provide people with convenient panic disorder self-assessment services and reduce the incidence of panic disorder in China has become an urgent problem to be solved. In order to solve this problem, this research applies the context awareness to the automatic diagnosis of human diseases. While helping patients find diseases early and get treatment timely, it can effectively assist doctors in making correct diagnosis of diseases and reduce the probability of misdiagnosis and missed diagnosis.

Keywords: *Artificial intelligence, big data, panic disorder, context awareness technology, ontological reasoning*

1. Introduction

Phobia is a very common mental illness in people's daily life. In this age of materialism, phobia has become deeply ingrained in people's daily lives, severely infringing on people's fragile psychology and causing unpredictable harm to people. This long-term mental instability will reduce the body's immunity, cause endocrine disorders, and easily lead to an increased risk of various diseases, such as cardiovascular and cerebrovascular diseases, diabetes, and gastrointestinal diseases [1]. Thus, understanding the development of panic disorder and its complications is of great significance to control and prevent the occurrence of panic disorder, and improve the patient's self-supervision ability [2]. Ordinary residents, especially patients with panic disorder, hope that the daily physical health care, disease diagnosis and other activities are no longer limited to the scope of medical institutions. Apart from that, they want to understand their panic disorder risk

Manuscript Received: April. 2, 2021 / Revised: April. 6, 2021 / Accepted: April. 9, 2021
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and disease status without leaving the house, and keep abreast of their own health information, and make health decisions timely [3]. This provides a direction for the development of health assessment. In order to meet the needs of residents for self-health management, related technologies and services have also emerged. With the advent of the “Internet +” era, information technology has been widely used in the medical and health field and is playing an increasingly important role. Medical institutions have accumulated a large amount of medical diagnostic data, containing rich value and laws. In addition, various sensor technologies have advanced by leaps and bounds, which has given birth to a large number of wearable health monitoring devices, such as smart bracelets and smart blood pressure monitors [4]. The panic disorder intelligent health system based on the Internet of Things and situational awareness allows users to analyze the health data of panic disorder and build a corresponding disease assessment model. It can efficiently and conveniently predict the severity of panic disorder in patients, help users find the risk of panic disorder early, and meet people’s health needs for panic disorder and its application in the medical field. Taking the panic disorder prediction system as an example, this paper designs a panic disorder management system based on the historical model accumulated by the information system, the current status of risk development, as well as the management model of risk prediction and hospital management [5]. The creation of a system can make full use of a wide range of historical data to promote medical research and personal health care.

The rest of this paper can be organized as follows. Chapter 2 introduces association research and panic disorder. Chapter three designs the structure and process of the system. Finally, Chapter four draws conclusions.

2. Association research

Contextual computing involves a wide range of domains and presents complex system architecture levels and diverse technologies, which include the acquisition of contextual data, the establishment of formal models as well as the analysis and processing of the data. Since Schilit et al [6] proposed the concept of contextual computing in 1994. Besides, many scholars have studied context-aware information using Semantic Web, IoT technologies, ontology theory, cloud computing technologies, complex networks, SOA and many other approaches [7]. This paper focuses on contextual data acquisition technology, which has been researched by a lot of domestic and foreign scholars. For example, Device Information Access (DIA) middleware achieves the shielding of underlying heterogeneous data through a unified interface. Beyond that, the Cabot component of Xu et al. is dedicated to solving the consistency problem of dynamic monitoring data. Furthermore, Han et al [8] extracted user experience data through comprehensive experiments such as questionnaires, screen recordings, and audio recordings. In addition, in some specific domains, multiple approaches have been applied to collect data for industry services [9]. However, the concept of context-aware systems has not been precisely defined. It is generally believed that context-aware systems use contextual data to provide relevant information and offer services to users, and their association is dependent on the user task. Nevertheless, context-aware technologies have received much attention from industry and led to many applications [10]. It adopts event communication protocols to exchange data between various sensors, actuators, and applications so as to reason about new contextual information using event-conditional-behavior rules.

Although contextual information has many advantages, it lacks long-term operation model as well as large-scale and clustered industrial development, and there are issues of high cost, security and privacy [11]. (1) The main reason is the lack of effective data and data standards. At the same time, the suppliers lack clinical background, and there is also a lack of standard guidelines in shifting from standards to practical applications. (2) It involves the formation of many industry standards and data exchange standards, which need to be improved in the future. (3) A large amount of memory, computing power, and big data are needed to function, and the data must be sent to the cloud for processing. This paper makes simple improvements and explanations for the above problems.

3. Panic Disorder Management System

3.1 Based on smart devices IoT and Context

3.1.1 IoT-based smart devices

IoT-based smart devices make comprehensive use of the user's biometric data and external environment as well as data collection, storage and analysis to identify panic attacks and provide users with care information. The smart device detects the user's biometric information, transmits it to the phone via Bluetooth, and then uploads it to a cloud server data center via an application on the phone. After an inference process with this biometric information and activity information, the user can identify the level of panic and get care information. It consists of the original data layer, data storage layer, data exchange layer, context layer and visualization layer. Table 1 shows the composition of the IoT-based smart device system proposed in this project. This is the configuration diagram of the entire system of the IoT-based panic care smart device system board.

Table 1. System composition

System composition	Introduction
Raw data layer	It refers to the first storage medium obtained from various sensors of smart jewelry.
Data storage layer	It includes local storage and remote storage. Local storage means storing contextual data in the local lightweight database SQLite of the mobile phone. Remote storage means uploading contextual data to a remote server database via a Web service.
Data exchange layer	It not only provides technical support for contextual information sharing, but also provides a communication mechanism for the exchange of local and external contextual data.
Context layer:	Simple conditional rules are used to abstract the original data into primary contextual information. Primary contextual information can be shared at the communication layer, and the static contextual information generated can be further reasoned to generate dynamic contextual information.
Visualization layer	The contextual information of the contextual layer is simply visually presented using the contextual plug-in, so that users can interact with the contextual information.

The panic-aware smart system developed for this task Silabs Si1144 (heart rate sensor) is used to periodically measure the heart rate of the end user. Moreover, Silabs Si1133 (illumination and UV index sensor) is adopted to measure the level of outdoor activity and the body temperature. TI TMP006 (infrared temperature sensor) is used to obtain information about the user's activity, activity pattern and burning. ST Micro LIS2DH (tri-axis acceleration sensor) is adopted to deal with information on user activity, activity patterns and calories. Silabs BGM113 (BLE module) is used for wireless communication with smartphones.

Memoirs have been developed as Cypress CY15B104Q (4Mbits FRAM, option for storing measurement data in low-power memory) and FTDI FT234XD (option for transferring program images to a USB-UART bridge via USB). The size of the Panic Awareness Smart System board will be 35mm wide and 25mm long. The intelligent system which includes sensing, monitoring, analysis and feedback, can sense data about an individual’s activity level, outdoor exercise and pulse history, monitor the measured biometric information and exercise history information, and reduce panic attacks. Meanwhile, it determines the level of treatment, notifies users using LEDs or smartphones, and guides them through the care of their panic attacks. During this process, it manages the individual’s frustration by repeatedly warning the user of feedback on changes in panic status.

The inference is sequenced by creating a SPARQL query that enables query processing in the ontology environment and then reasoning through inference rules. The content of the service is available on the user’s smartphone and smart devices. This medical health model, which requires specialists, GPs and health managers for medical management, provides medical health management and general services through a mobile medical watch system. The sensor and specifications of this smart jewelry are shown in Figure 1.

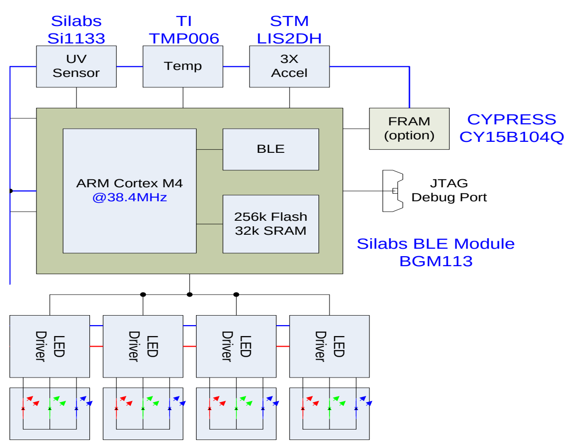

Figure 1. The scale’s IOT Device of panic disorder

3.1.2 Context information

A panic disorder may be accompanied by fear and avoidance of these conditions because of feeling insecure. In fact, people without panic disorder symptoms may have panic disorder, and some people without panic disorder may have panic disorder symptoms. According to the results of these studies, agoraphobia and panic disorder are diagnosed separately (Diagnostic and Statistical Manual of Mental Disorders (DSM-5)). The diagnostic criteria for panic disorder are as follows (11-12). First, at least four of these 13 symptoms appear when an unexpected panic attack or a peak of fear or discomfort occurs again within a few minutes.

- My heart rate is fast, my heart is beating
- I sweat a lot
- Shaking badly
- I am short of breath and feel unable to breathe.
- I feel suffocating.
- Chest pain or pressure.
- I vomit and feel sick in my stomach.
- Feeling dizzy or fainting.
- Chills or fever in the body.
- Abnormal perception, such as paralysis or numbness; feeling unreality or separation from oneself

(obvious).

• Fear of losing control or going crazy.

• Fear of death.

Second, after at least one panic attack, one or two of the following symptoms occur for a month or more: Constantly worrying and worrying about panic attacks and consequences (e.g. loss of control, heart attack, and confusion), severe maladaptive behavior changes associated with a panic attack (e.g. avoiding sports or unfamiliar situations to avoid a panic attack).

Third, these symptoms are not caused by the physiological effects of drugs or other medical conditions. Fourth, these symptoms are frightening social conditions, such as social anxiety disorder, certain phobias, obsessive-compulsive disorder, impulsive disorders, the separation of anxiety and attachment, the traumatic nature of post-traumatic stress disorder, and events or situations that cause fear. Other mental disorders (e.g. memories) cannot explain it better.

This research extracts contextual data from wearable devices, filters and uses input data for panic state inference, uses inactivity time in physical symptoms as well as smartphone use time, and applies user information and genetics factor. Furthermore, some information is inputted into the configuration file and saved. Contextual data is extracted from smart devices and the input data is filtered to infer the symptoms of panic disorder. Then, by filtering the heart rate, sweating volume, body tremor and breathing rate, it can extract chest pressure or pain, head dizziness and body temperature. Besides, time ontology is used, and the user's personal health information is inputted and stored in the profile database. In order to derive the current condition (i.e. the occurrence factors of the condition), the context information conditions for symptom management in Table 2 are defined. Specifically, the standards of fast heart rhythm, sweating, violent body shaking, shortness of breath, chest pain or pressure, dizziness, cold body or high fever, etc., are defined.

Table 2. Definition of the standard

Context Awareness	Definition
Gender	Male / female
Family inheritance	Yes/No
Heartbeat	Is the heart rate fast
Breathing	Is it short of breath
Dizziness	Feel dizzy or faint
Perception abnormalities	Paralysis or tingling
Sweating	Do you sweat a lot
Stomach upset	Vomiting, uncomfortable stomach.
Chest pain	Chest pain or pressure
Chills or flushing	Is the body temperature normal

3.2 Ontology-based reasoning

3.2.1 Ontology-based reasoning engine

Generally speaking, the file format defined by the ontology description language is used to describe the attributes and relationships of the ontology. The computer understands the meaning and hierarchical relationship of the ontology according to these ontology descriptions files, and then establishes relevant reasoning rules to reason about it, so as to realize the ontology-based reasoning engine. The block diagram of the ontology-based reasoning engine is shown in Figure 2. First, it takes the domain ontology as the basis for transformation. After the Sensor receives the external raw data, the Data Mapper will convert the raw data into an instance stored as Context Instances Data according to the domain ontology, which is an OWL file that Context Mediator will access later. On the one hand, OWL is used to define contextual knowledge (terms), the relationships between them and their attributes. On the other hand, SWRL and the terms defined in OWL are adopted to define inference rules. This integrates OWL knowledge and rules well.

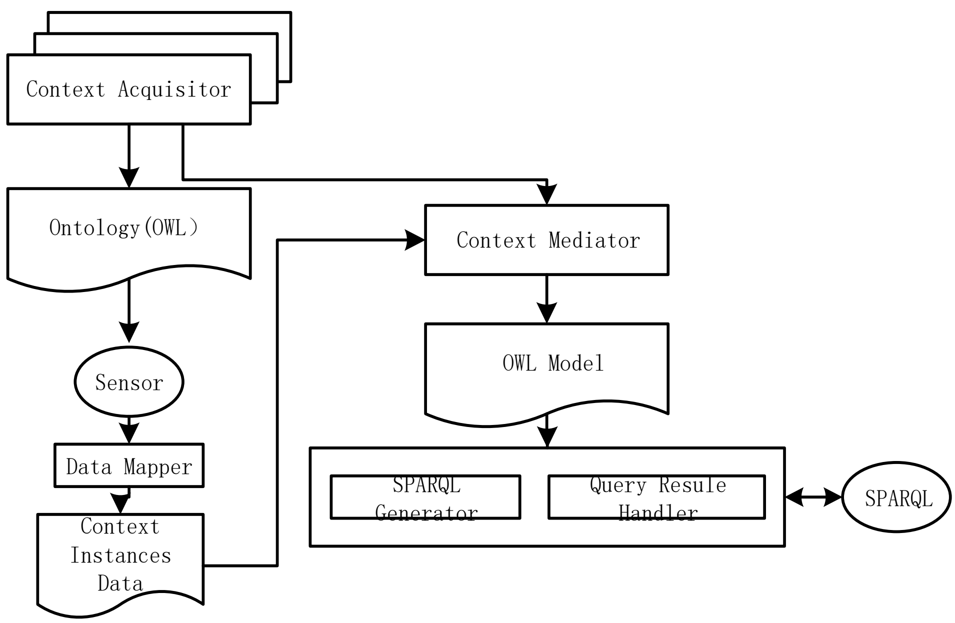

Figure 2. The block diagram of the ontology-based reasoning engine

3.2.2 Ontological composition

In order to design the second-stage panic disorder care ontology in the entire system structure, this paper analyzed and modeled the relationship between the concepts used in the field. Ontology modeling is the use of classes, attributes, and instances to define the relationships between conceptualized domains. Furthermore, the result of the ontology defined in the context information is expressed and constructed as knowledge. For ontology configuration, user ontology, symptom ontology, equipment ontology and service ontology are created. The body composition is created by the user body, the wearable body, the smart phone body, and the service body. Figure 3 shows the schematic structure of the ontology knowledge system.

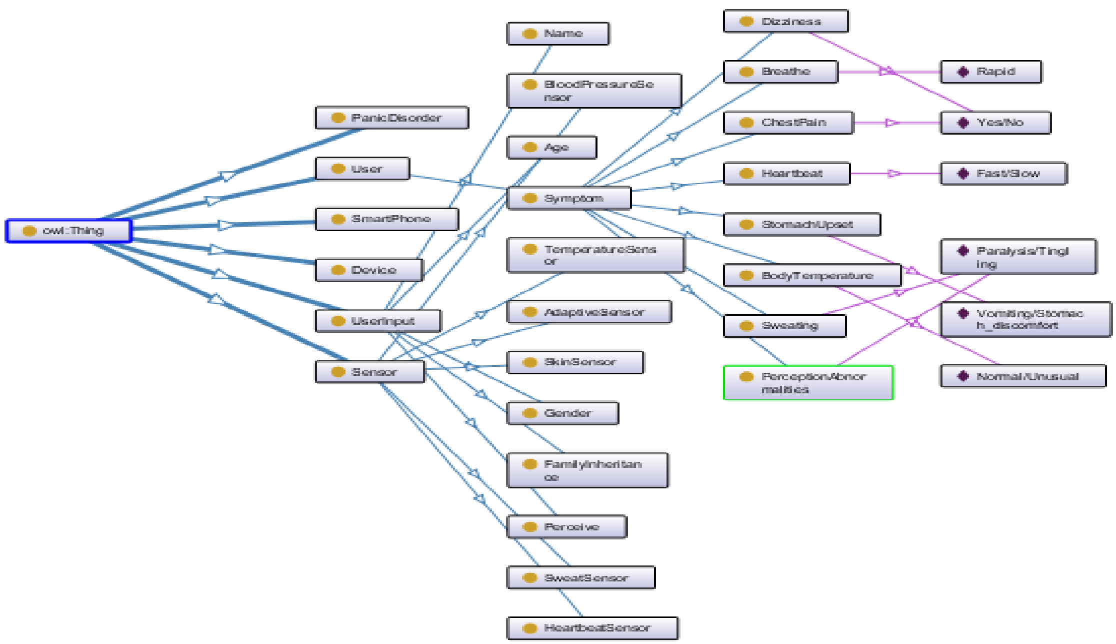

Figure 3. Schematic structure of the ontology knowledge system

3.2.3 Rules

According to the severity of panic disorder symptoms, diagnostic rules are used as criteria for safety diagnosis. When defining inference rules, people need to consider the following things. First, to minimize the number of inference rules, all rules should be specifically defined. When the platform maintains many rules, there will be performance overloads to find the correct rules for the disease. Secondly, inference rules are the result of knowledge, and it is essential to keep up-to-date information. In order to determine the degree of panic disorder, the results can be inferred through inference rules about the relationship between categories and attributes. Through the generated ontology model and reasoning rules, the reasoning engine is used for reasoning, and the situation data is input and converted into OWL. The reasoning rules are shown in Figure 4.

```
Rule:
Gender(?x), hasGender(?x,?y) ->Cause(?x)
Heartbeat(?x), isAbove(?x,?y), isFast(?x,?y) ->Cause(?x)
Breathe(?x), isFast(?x,?y) ->Cause(?x)
Dizziness(?x), hasDizziness(?x,?y) ->Cause(?x)
Sweating(?x), hasSweating(?x,?y) ->Cause(?x)
Stomach(?x), hasStomach(?x,?y) ->Cause(?x)
Chest pain(?x), hasChestpain(?x,?y) ->Cause(?x)
Chills(?x), hasChills(?x,?y) ->Cause(?x)
Temperature(?x), hasTemperature(?x,?y) ->Cause(?x)
```

Figure 4. Rules are the result of knowledge

The standards of fast heart rate, sweating, violent body shaking, shortness of breath, chest pain or pressure, dizziness, cold body or high fever, etc. are defined. According to the severity of panic disorder symptoms, diagnostic rules are used as the criteria for safety diagnosis. When defining inference rules, people need to consider several things. First, in order to minimize the number of inference rules, all rules should be specifically defined. When the platform maintains many rules, there will be performance overloads to find the correct rules for the disease. Secondly, inference rules are the result of knowledge, so that you should always keep up-to-date information. Therefore, in order to determine the degree of panic disorder, the results can be inferred through inference rules about the relationship between categories and attributes. Through the generated ontology model and reasoning rules, the reasoning engine is used for reasoning, and the situation data is input and converted into OWL. Inference rules are defined in a typical form. This class will be converted to OWL data, and inference rules will be applied to create queries and display the results. In addition, the metadata about the service can be obtained from the user inference results in the cumulative database. The rules applicable to Panic Disorder are shown in Table 3.

Table 3. Rules applicable to Panic Disorder

```
[Panic Disorder:
 (User sf : Have_This_Symptom sf : fast),
 (User sf : Have_This_Symptom sf : many),
 (User sf : Have_This_Symptom sf : high),
 (User sf : Have_This_Symptom sf : normal),
 (User sf : Have_This_Symptom sf : pain);
 →(User sf : May_cause sf : Panic Disorder)]
```

3.2.4 Query

The contextual information ontology model of this paper uses Java-based service logic and Protege as an ontology construction tool. FacT+ is used as an inference engine. In addition, by creating a SPARQL query, rules-based inference is performed. Through the diagnosis of panic disorder, after FacT + infers input SPARQL query situation data, the situation data is converted into OWL. In order to infer the result of the situation state based on the symptom information and the form of the service output, the ow: EquivalentClass function is adopted to execute the query form (see Table 4).

Table 4. Query

SPARQL Query

SELECT ?CareInformation ?ServiceType
WHERE
{
  ?CareInformation
    Owl:equivalentClass ?ServiceType;
    hasCare ?SymptomInformation.
  ?PanicInformation ?CareInformation;
    hasPanic ?.
}

The relationship between terms used in the field is analyzed and modeled. At the same time, the result of the ontology defined in the context information is expressed and constructed as knowledge. A huge problem facing panic disorder diagnosis is that it is a heterogeneous disease. The American Psychiatric Association has long criticized the 2001 CCMD-3 (Chinese Classification and Diagnosis of Mental Disorders, 3rd Edition) diagnostic criteria for anxiety disorders and various scales used to measure the severity of panic attacks. Indeed, panic disorder has many different causes and manifestations. Imagine that a doctor in charge sees hundreds of patients every week, and their conditions are varied. Without doubt, it is difficult to find a diagnosis of mental illness from a bunch of cases with obvious symptoms that can be diagnosed by general consultation. “Diagnostic heterogeneity” refers to a wide range of non-specific symptoms in patients. In the psychiatric research, machine learning algorithms are used to better define panic disorder and predict who may be a panic disorder patient. The biomarkers (measurable biological indicators) of panic disorder can be explored by”mining”data from a larger data set. A computer can be taught how to recognize patterns in patient-reported surveys, demographic data, cognitive assessments, and even neuroimaging studies that correlate blood oxygen levels with brain activity in specific areas. As shown by the previous research studies, panic disorder patients tend to show flat or negative emotions, and the language of panic sounds to be tenser in the vocal tract and vocal cords. This is a typical machine learning problem, which is to make predictions based on the data carried. The so-called physiological characteristic analysis is one of the main branches in this field.

4. Conclusions and future research projects

An important way for the intelligent health management system to ultimately reflect its value is to provide personalized medical guidance services for each user. Whether it is monitoring or diagnosis, users need to take timely measures to cure the disease or take preventive measures after understanding their health conditions.

The app can monitor not only exercise data such as steps, distance and calories burned, but also health data such as heart rate and sleep. In addition to continuous monitoring of sports and health big data, a complete set of big data analysis, operation and maintenance and output mechanisms have been established by combining with massive user data and in-depth industry insights. According to the needs of the industry and users, it can comprehensively process and analyze sports-related big data and monitor sleep health. Meanwhile, the massive user sample, accurate and complete data collection, and the seamless connection of software and hardware make it more conveniently and timely acquire users’ information to effectively predict panic disorder and seek medical attention timely.

One important way for an intelligent health management system to ultimately demonstrate value is to provide personalized medical guidance services for each user. Both monitoring and diagnosis require users to take timely measures to cure diseases or take preventive measures after understanding their health status.

The paper analyzes the theoretical knowledge of the context-aware system construction comprehensively, focuses on the related technical methods, and elaborates the construction process of the context-aware system, which provides methodological help for the research and construction of the context-aware system.

The purpose of this paper is to study the impact of context awareness on panic diseases and apply it to the detection of panic diseases to improve the efficiency of panic diseases diagnosis. In addition, a context-aware technology is used to assess the risk of panic disorder.In the field of medical and health care, smart hospitals based on context-aware technology capture the physical condition of patients through various biological sensors, which can not only realize real-time monitoring and early warning, but also provide preliminary disease diagnosis. The context model needs to facilitate the addition of descriptions of new concepts and support the contextual reasoning function. In this paper, OWL and ontology are used to build a model, which can express contextual information, and relatively conveniently use rule-based reasoning machines to reason about obscure contexts in order to obtain higher-level information.

Acknowledgememt

This paper was supported by the research grant of the Wonkwang University in 2020

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