Research Article

Computer Internet of Things-Based Intelligent Medical System to Be Applied in Home Care of Senile Dementia Patients

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It was to explore the accuracy of intelligent home medical system based on Internet of Things (IoT) technology and its application value in home care of senile dementia patients. Based on IoT, 5th generation wireless systems (5G), and smart wearable technology, intelligent home medical system was designed from the perspectives of system environment and system design. Smart wearable technology-based wearable smart clothes could recognize and collect electrocardiosignal, breathing signal, body sway signal, and body temperature signal. The data were transmitted to the application layer through the information transmission and processing modules of middle layer, and the extraction accuracy of behavioral features and behavior correct recognition rate of the system were analyzed. 64 senile dementia patients treated in the hospital between January 2019 and June 2020 were selected as the research objects. They were divided into control group (routine family care) and observation group (intelligent medical care system) according to different nursing methods. Each group included 32 cases. Activity of daily living (ADL) scores, nursing satisfaction, and the accidents during care of the patients in two groups before and after care were summarized. The results showed that the behavioral feature extraction accuracy of intelligent home medical system was above 74.59% and its correct recognition rate of different behaviors reached over 98.5%. ADL score in the observation group was lower than that in the control group 3 months after care \((P < 0.05)\). ADL score in the observation group was significantly lower than that in the control group \((P < 0.01)\) 6 months after care. The satisfaction of the observation group was 78.13% (25 cases), which was remarkably higher than that of the control group \((31.25\%, 10\) cases) \((P < 0.001)\). The total satisfaction of the observation group amounted to 93.75% (30 cases), which was higher than that of the control group \((68.75\%, 22\) cases) \((P < 0.01)\). The total incidence of accidents in the control and observation groups was 28.13% and 3.13%, respectively. Obviously, the total incidence of accidents in the observation group was lower than that in the control group \((P < 0.001)\). The above results showed that the established intelligent medical care system demonstrated potential application values in home care, which provided a new idea for the nursing methods for senile dementia patients.

1. Introduction

In recent years, with the accelerated aging process, the number of elderly people over the age of 60 has increased significantly, accompanied by a significant increase in the incidence of senile dementia [1]. According to statistics, there are more than 24.3 million patients with senile dementia worldwide, with an average annual increase of more than 4.6 million [2]. More than 750,000 people in Britain suffer from senile dementia [3], and the number of dementia patients in China is about 7 million, which is estimated to exceed 22 million by 2040 [4]. The incidence of senile dementia disease in people over 65 years of age is about 10%, and the incidence is as high as 47% in people over 85 years of age in China [5]. Senile dementia is mainly characterized by chronic, progressive, and irreversible significant reduction in cognitive function, inability of patients to take care of themselves [6], accompanied by mental disorders, behavioral disorders, and other symptoms [7], requiring special care by others, which brings great pressure to the whole society and family. At present, there is no
2. Materials and Methods

2.1. Model Structure of Intelligent Home Medical System. In this study, the intelligent home medical system is designed from two aspects of system environment and system design. System environment mainly includes two parts: user behavior and its surrounding environment entity modeling. System design is mainly composed of data monitoring, transmission, and monitoring result response of the IoT structure. The main framework of the intelligent home medical system model is illustrated in Figure 1.

2.2. Total Structure of IoT-Based Intelligent Medical System. In this study, the structure of intelligent home medical system based on IoT mainly includes three parts: perception layer, middle layer, and application layer. The sensing layer collects the information of the temperature, humidity, brightness, gas concentration state, and fire state of the living environment of the patient with the working state of household appliances through the equipment installed indoors and collects the information related to the patient’s behavior, location, and physical health status through various sensors worn on the human body. The sensing layer transmits all the acquired data to the middle layer. The middle layer processes the information transmitted by the sensing layer through the information transmission and information processing modules and then passes it to the application layer. The application layer responds to changes in the patient environment and events based on the information transmitted by the middle layer. The application layer mainly includes two parts: device management module and service module. The overall frame diagram of intelligent medical system based on IoT is given in Figure 2.

2.3. Design of IoT Structure of Intelligent Medical System. In this study, a variety of indoor sensors was designed based on the room where the patient was frequently active to collect relevant activity information. Indoor sensors mainly include radio frequency identification (RFID) reader, pressure sensor, passive infrared detector, light sensor, and temperature sensor. The RFID system is mainly composed of three parts: electronic tag, reader, and data management. There was unique coding corresponding to the patient within the electronic label. The RFID reader identifies the user by a bracelet with an RFID tag worn by the user and sends it to the data management system. RFID reader could recognize and collect electrocardiosignal, breathing signal, body sway signal, and body temperature signal by the smart clothes worn by the elderly. The temperature sensor mainly monitors the indoor temperature. The combination of pressure sensor and displacement sensor was mainly used to monitor the behavior change of users. The distribution of different sensors of intelligent medical system in the room is given in Figure 3.

The perceived layer of intelligent medical system obtains electrocardiosignal mainly by the smart clothes worn by the elderly. Next, it filters and amplifies ECG data by acquiring circuits and then transforms the simulation signal into digital signal. After that, it displays electrocardiogram in real time and transmits relevant data to personal health database. When detecting danger, intelligent medical system automatically sends out distress signals to hospital and guardians. The proposed smart clothes worn by the elderly mainly includes the collection of electrocardiosignal, breathing...
signal, body sway signal, and body temperature signal. Figure 4 shows the structure of wearable smart clothes below.

The noises of electrocardiosignal mainly come from power source noise, electromyography noise, electrode, and skin friction noise. Digital filter is used to process electrocardiosignal. Finite pulse response digital filter can not only ensure that amplitude characteristics meet the requirements but also maintain the strict linearity. The filter has no feedback loop. Hence, it never becomes unstable. Therefore, finite pulse response digital filter is adopted to process electrocardiosignal, and its transfer function is expressed by

$$A(e^{j\mu}) = |A(e^{j\mu})|e^{j\phi(\mu)}.$$  \hspace{1cm} (1)

In equation (1), $A(e^{j\mu})$ represents amplitude-frequency characteristic and $\phi(\mu)$ refers to phase-frequency characteristic.

Finite pulse response digital filter can be divided into low-pass filter, high-pass filter, band-pass filter, and band
stop filter. Band-pass filter is utilized to filter out the frequency component without ECG signal. As a result, the calculation method of maximum allowable attenuation in passband $\beta_p$ is expressed by

$$
\beta_p = 20 \log \frac{A(e^{\mu_0})}{A(e^{\mu_p})}.
$$

The calculation method of minimum allowable attenuation in stopband $\beta_s$ is expressed by

$$
\beta_s = 20 \log \frac{A(e^{\mu_0})}{A(e^{\mu_s})}.
$$

In equation (3), $\mu_p$ denotes the cutoff frequency of passband and $\mu_s$ refers to the cutoff frequency of stopband.

The middle layer transmits the sensed information, and the information is processed by the controller and inference engine. 5G can realize the connection of objects and objects and has a good application prospect in intelligent manufacturing, unmanned, and telemedicine [16]. In this study, 5G technology was used to transmit data from the sensing layer to the upper application. 5G medical monitoring network system mainly transmits data through two major parts: communication module and network module. The application layer is the response to the middle layer information, mainly including such information as patient bathing time control, bathroom residence time control, room light and temperature regulation, faucet switch configuration, patient positioning,
If the patients could self-care economy. The scores of all items were at 4 levels.ing phone call, shopping, preparing meals, doing housework, to toilet, eating, dressing, grooming, walking, bathing, make the ability of daily living of the patients in the two groups. ADL included a total of 14 items, including going the nursing with IoT intelligent home care system. The age, gender, and education level of the patients in the two groups were summarized. ADL was adopted to compare the corresponding warning function of potential safety hazards. The environmental structure of intelligent home medical system is illustrated in Figure 6.

2.4. Environmental Design of Intelligent Home Medical System. The system environment design mainly detects the occurrence of patient’s behavior, the closure of natural gas and bath head. The occurrence of behavior mainly uses the displacement system to analyze, at the same time detects the closure of natural gas and bath head in the kitchen and bathroom, and establishes the corresponding warning function of potential safety hazards. The environmental structure of intelligent home medical system is illustrated in Figure 6.

2.5. Application of Intelligent Home Medical System Based on IoT. In this study, 64 elderly patients with dementia who visited the hospital from January 2019 to June 2020 were selected as the study subjects, including 35 males and 29 females, with the age range of 60–84 years and the average age of 75.18 ± 4.56 years. Inclusion criteria: patients aged 60 years old and above; patients who meet the diagnostic criteria of senile dementia [17]; patients without other serious organ disease. Exclusion criteria: patients with mental disorders caused by various diseases; patients with severe organ diseases. The included research objects were divided into control group (conventional care) and observation group (intelligent home care system) according to different nursing methods. Each group included 32 cases. The study procedures were approved by the ethics committee of the Hospital, and the subjects included in the study signed the informed consent form. The compliance, nursing satisfaction, and accidents during nursing were statistically analyzed between the two groups.

2.6. Nursing Methods and Observation Indexes in Different Groups. Home visit to the patients in the control group occurred once every two months. During the home visit, conventional family nursing guidance and health education were carried out. Based on the conventional nursing for the control group, the patients in the observation group received the nursing with IoT intelligent home care system. The age, gender, and education level of the patients in the two groups were summarized. ADL was adopted to compare the ability of daily living of the patients in the two groups. ADL included a total of 14 items, including going to toilet, eating, dressing, grooming, walking, bathing, making phone call, shopping, preparing meals, doing housework, washing, using transportation tools, taking medicine, and self-care economy. The scores of all items were at 4 levels. If the patients could finish the work completely, they were scored 1 point. If they had some difficulties finishing it, they were scored 2 points. If they needed some help, they were scored 3 points. If they could not finish it on their own, they were scored 4 points. The scores of 14 items were aggregated. The total score equal to or lower than 16 points indicated normality. The total score between 17 and 36 points represented mild decline. The total score equal to or higher than 37 points meant significant decline. Besides, a questionnaire was used to assess the patients’ satisfaction of two nursing methods. The statistics on the fall, the diseases caused by indoor discomfort, the incidence of accidents caused by open natural gas, shower, or other appliances among the patients in the two groups during the care was implemented.

2.7. Statistical Methods. Test data processing was performed using SPSS 19.0 statistical software. Measurement data were expressed as mean ± standard deviation (± s). t-test was used. Enumeration data were expressed as percentage (%). χ² test was used. P < 0.05 indicated statistically significant difference.

3. Results and Analysis

3.1. Test of Intelligent Home Medical Detection System Based on IoT. The intelligent home medical system established in this study was tested (Figure 7). The user sensor recorded the clinical sign data according to different detection points and enters the monitoring center. The change of relevant sign data within different time periods can be obtained. In addition, the sign data curve at different time points can be obtained by analyzing the number.

3.2. Evaluation of Behavioral Feature Extraction Accuracy of Intelligent Home Medical System Based on IoT. The results of behavioral feature extraction by the intelligent home medical system established in this study were analyzed (Figure 8), and among the 20 test samples, the accuracy of behavioral feature extraction by the intelligent home medical system was more than 74.59% and was 98.33% at most.

The correct recognition rates of intelligent home medical system for detecting different behaviors were verified. The results are given in Figure 9. The correct recognition rate of different behaviors by the system was higher than 98.5%; the correct recognition rates of intelligent home medical system for bending, kicking, waving, walking, running, sitting, lying, standing, squatting, and falling behaviors were 98.9%, 99.2%, 98.9%, 99.2%, 98.8%, 99.7%, 99.5%, 98.7%, 99.6%, and 98.9%, respectively.

3.3. Analysis of IoT-Based Intelligent Home Medical System Body Temperature Return. The results of infrared body temperature monitoring data return and performance analysis were further analyzed (Figure 10). In this study, the maximum difference between the results of body temperature monitoring in intelligent home medical system based on IoT and the actual monitoring value was 0.015°C after the results were transmitted back through 5G network.

3.4. Analysis of Abnormal Alarm Correctness of Intelligent Home Medical System. In this study, 37.2°C was used as the threshold to trigger the remonitoring of body temperature, and the return of body temperature by 5G network and the initiation of abnormal alarm function were statistically analyzed (Table 1). All the test results showed that this system can 100% correctly start the abnormal temperature alarm function.
Figure 5: Middle layer structure based on 5G intelligent medical system.

Figure 6: Environmental model structure of intelligent home medical system.

Figure 7: Intelligent home medical system test.
3.5. Comparison of Basic Information about the Patients in Two Groups. The age and the proportions of gender and different education levels of the patients in two groups were summarized and analyzed (Table 2). The comparison of age and the proportions of gender as well as different education levels in the two groups showed no statistical differences (P > 0.05).
3.6. Comparison of ADL Scores of Different Nursing Methods. ADL scores of control and observation groups before and after care were compared, and the result is shown in Figure 11. Before care, the comparison of ADL scores in the two groups showed no statistical difference ($P > 0.05$). After performing with two different nursing methods, patients’ ADL scores both demonstrated an evident descending trend. The ADL score of the observation group was lower than that of the control group 3 months after care. The comparison of ADL scores in the two groups revealed statistical difference ($P < 0.05$). The ADL score of the observation group was notably lower than that of the control group 6 months after care ($P < 0.01$).

3.7. Analysis of Nursing Satisfaction with Different Nursing Methods. The nursing satisfaction of patients with different nursing methods was statistically analyzed (Figure 12). The results showed that 10 patients (31.25%), 12 (37.50%), 10 (31.25%), and 22 (68.75%) in the control group were satisfied, basically satisfied, dissatisfied, and totally satisfied, respectively; 25 patients (78.13%), 5 (15.63%), 2 (6.25%), and 30 (93.75%) in the observation group were satisfied, basically satisfied, dissatisfied, and totally satisfied, respectively. The satisfaction rate of nursing methods in the observation group was significantly higher than that in the control group ($P < 0.001$). The proportion of patients who were basically satisfied and dissatisfied with the nursing methods in the control group was higher than that in the observation group ($P < 0.05$).

3.8. Statistics of Accidents under Different Nursing Methods. In this study, the accidents caused by fall injury, illness, and failure to close household appliances in the control group were 6.25%, 9.38%, and 12.50%, respectively. The incidence of fall injury was 3.13%, and the incidence of accidents caused by illness and failure to close household appliances was 0. The incidence rate of fall injury in the observation group was lower than that in control group, and the difference had statistical significance ($P < 0.05$); the incidence rate of illness caused by indoor discomfort in the observation group was significantly lower than that in the control group, and the difference had statistical significance ($P < 0.01$); the total incidence rate of accidents in the control group and the observation group was 28.13% and 3.13%, respectively. The total incidence rate of accidents in the observation group was significantly higher than that in the control group, with very significant difference between the two groups ($P < 0.001$).

### Table 1: Correctness verification of abnormal alarm of body temperature monitoring.

| Test serial number | Actual body temperature (°C) | Temperature returned by 5G network (°C) | Whether the alarm function is triggered |
|--------------------|------------------------------|----------------------------------------|----------------------------------------|
| 1                  | 36.1                         | 36.1                                   | No                                     |
| 2                  | 38.2                         | 38.3                                   | Yes                                    |
| 3                  | 36.5                         | 36.5                                   | No                                     |
| 4                  | 35.5                         | 35.6                                   | No                                     |
| 5                  | 37.2                         | 37.2                                   | Yes                                    |
| 6                  | 36.2                         | 36.1                                   | No                                     |
| 7                  | 39.1                         | 39.1                                   | Yes                                    |
| 8                  | 35.9                         | 35.9                                   | No                                     |
| 9                  | 37.3                         | 37.2                                   | Yes                                    |
| 10                 | 38.6                         | 38.6                                   | Yes                                    |

4. Discussion

Senile dementia belongs to the abnormal degeneration of the brain, with the clinical characteristics of high morbidity and mortality [18], which has seriously threatened the life and health and quality of life of the elderly. As the condition worsens, communication in speech will gradually appear impaired, and patients have difficulties in the use of existing knowledge structures or vocational skills [19]. The nursing time of patients with senile dementia is long, and many difficulties in patients’ life need to be considered [20], which brings more troubles to the nursing of senile dementia. At present, long-term escort of nursing staff is the main nursing modality for senile dementia, but this modality causes great pressure on the time and economy of family members [21]. In recent years, home care has gradually replaced a variety of elderly care modalities. Under the home care model, the elderly lives in their own homes and can enjoy professional and diversified old-age and nursing services [22]. Intelligent home medical systems apply the IoT in home care models to provide diverse care services to meet the needs of users and improve quality of life [23]. In this study, an intelligent medical system is established based on the IoT technology, and five sensors, including RFID reader, pressure sensor, passive infrared detector, light sensor, and temperature sensor, are set up. These sensors can collect the indoor and physical sign information of patients, monitor the indoor activity of users, perform automatic alarm, and notify caregivers when patients experience falls and high-risk events, which greatly ensures the life safety of users and provides an effective guarantee for the home life of users. On the other hand, the sensor in this study can also detect the physical index data of patients, and these data are transmitted to the expert medical system through the network, which can predict and prevent the development of diseases and other diseases of patients. Wearable device refers to electronic health information recorder that can be worn during daily activities. It is featured with convenience, efficiency, and intelligence and shows good effects in chronic disease management [24]. Zhang et al. [25] fitted the device to patients with senile dementia and followed them regularly for 1 year. The result suggested that the indoor fall of senile dementia patients...
wearing the device was obviously decreased, which demonstrated that remote wearable device technology could improve patient safety. Lazarou et al. \[26\] applied “intelligent home” system to monitor the sleep of senile dementia patients. The result showed that the device could provide early care for them to optimize their sleep quality. It was pointed out in the above studies that wearable smart clothes showed significant advantages in home care. Based on these advantages, intelligent home care system was established. The included wearable smart clothes could collect ECG

| Name                          | Control group (n = 32) | Observation group (n = 32) | P value |
|-------------------------------|------------------------|---------------------------|---------|
| Age (years old)               | 74.85 ± 3.96           | 75.22 ± 4.52              | 0.255   |
| Gender [case (%)]             |                        |                           |         |
| Male                          | 18 (56.25)             | 16 (50.00)                | 0.683   |
| Female                        | 14 (43.75)             | 16 (50.00)                |         |
| Education level [case (%)]    |                        |                           | 0.591   |
| Junior high school and below  | 5 (46.88)              | 17 (53.13)                |         |
| Senior high school            | 11 (34.38)             | 10 (31.25)                |         |
| Junior college and above      | 6 (18.75)              | 5 (15.63)                 |         |

Figure 11: Comparison of ADL scores of different nursing methods. (∗ indicated that the comparison with the control group revealed statistical difference, \( P < 0.05 \). ∗∗ demonstrated that the comparison with the control group showed significant difference, \( P < 0.01 \).)

Figure 12: Comparison of patient satisfaction with different nursing methods. (∗ indicates statistically significant difference from the control group, \( P < 0.05 \); ∗∗ indicates significant difference from the control group, \( P < 0.01 \); ∗∗∗ indicates very significant difference from the control group, \( P < 0.001 \).)
signal, breathing signal, body sway signal, and body temperature signal. When detecting danger, it automatically sent out distress signal to hospital and guardians, which lays the foundation for the application of the system in the patients with senile dementia.

The detection accuracy and correctness of intelligent home medical system are closely related to the patient’s life support, which has a significant impact on the patient’s physical health status and life safety [27]. Therefore, this study analyzes the behavior recognition accuracy of intelligent home medical system and finds that the behavior feature extraction accuracy of intelligent home medical system is more than 74.59%, up to 98.33%. This indicates that the intelligent home medical system established in this study has high accuracy for behavioral feature extraction. The included results show that the correct recognition rate of different behaviors by intelligent home medical system reached above 98.5%, which can effectively guarantee the accuracy of alarm and reminder when patients have an accident. It was pointed out that the probability that the nursing system successfully monitors the user’s fall behavior is 7/8 [28], and the accuracy of different behavior recognition was significantly improved in the results of this study. In this study, after monitoring a fall, the system will respond accordingly, reducing the possibility of accidents in patients. Further analysis of the results and performance of infrared body temperature monitoring data returned suggested that in this study, the temperature monitoring results of the intelligent home medical system based on the IoT were returned through the 5G network, and the difference between the results and the actual monitoring value was 0.015°C. 37.2°C is used as the threshold to trigger the remonitoring of body temperature. The startup of the abnormal alarm function of the test was counted and analyzed. All the test results indicated that the intelligent home medical system can correctly start the abnormal alarm function of body temperature. These results revealed that the intelligent home medical system based on the IoT has high accuracy in data monitoring and backhaul. At present, it is believed that the infrared monitoring temperature cannot truly reflect whether the human body is in a state of fever due to its non-contact and fast speed [29]. Therefore, the intelligent home medical system based on the IoT in this study presets 37.2°C as the threshold to trigger the redetection of body temperature [30]. For this automatic detection scenario, the abnormal alarm function involves the emergency rescue model. The system depends on the amount of data and training time and will be more accurate as the data increases.

The home care model for elderly patients with dementia has certain benefits for the memory structure of patients, which can reduce the life problems caused by memory impairment, and living habits are less affected. In order to verify the application effect of intelligent home medical system based on IoT in the nursing of senile dementia, the research results revealed that ADL scores of patients after being performed with two different nursing methods both showed a remarkable descending trend. The ADL score of the observation group was lower than that of the control group 3 months after care (P < 0.05). The ADL score of the observation group was significantly lower than that of the control group 6 months after care (P < 0.01). The satisfaction of nursing methods in the observation group was remarkably higher than that in the control group (P < 0.001). The total satisfaction of nursing methods in the observation group was dramatically higher than that in the control group (P < 0.01). Besides, the total incidence of accidents in the observation group was apparently higher than that in the control group (P < 0.001). The results suggested that the living ability of the patients in the observation group was obviously improved after care. In addition, the satisfaction of nursing methods was increased compared with that of conventional nursing method and the incidence of accidents during care was evidently reduced. Bernini et al. [31] used bisimulation system to train the daily life of

![Figure 13: Statistics of accidents under different nursing methods. (∗ indicates statistically significant difference from the control group, \( P < 0.05 \); ∗∗ indicates significant difference from the control group, \( P < 0.01 \); ∗∗∗ indicates very significant difference from the control group, \( P < 0.001 \).)
patients with senile dementia. The result indicated that the system could significantly enhance patient’s daily living ability. Arenella and Steffen [32] discussed the effects of family care for senile dementia patients by video conferencing. The study showed that the method could reduce the stress on caregivers the sense of social isolation. McGarrigle et al. [33] used an online tracking tool to trace the symptom of displaced objects among patients with senile dementia. The result demonstrated that health tracking technology could be used to formulate personalized nursing intervention for the patients with different levels of senile dementia. Based on wearable technology, intelligent home medical system was established with the results similar to the above studies. All of them could enhance home nursing effects for patients with senile dementia, which provided referable basis for the establishment of home care mode.

5. Conclusion
This study establishes an intelligent medical nursing system based on IoT technology and applies it to home care of patients with senile dementia. The accuracy of the intelligent medical nursing system and its application value in home care of patients with senile dementia are discussed. The results show that the network backhaul and action recognition accuracy of the medical nursing system established in this study are high, which can increase patient care compliance and satisfaction and reduce the incidence of accidents. However, there are still some shortcomings in this study. This study included fewer samples and only tested the network backhaul effect of temperature detection results and did not further analyze other indicators. In the future work, all indicators involved in this study will be further verified to provide more data support for detection. In conclusion, the established intelligent medical care system showed potential application values in home care for patients with senile dementia, which provided referable basis for senile dementia home care methods.

Data Availability
All the research data used to support the findings of this study are included within the article.

Conflicts of Interest
The author declares that there are no conflicts of interest.

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