ChatGPT Powered Digital Healthcare System

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***Abstract*—ChatGPT has revealed its capability in generating high-quality textual content. And numerous researchers are experimenting with ChatGPT in various application fields. In particular, the utilization of ChatGPT within the healthcare system has become active due to its potential in resolving shortage of medical staff and high-quality healthcare services. We design a ChatGPT powered healthcare system with prompt engineering to enable continuous care for chronic pain patients. We also demonstrate the results of the prompt engineering, along with the penitential of integrating with various smart devices.**

***Index Terms*—ChatGPT, Health Management System, Digial Healthcare, Prompt Engineering, Diagnosis, Monitoring, Intervention, Smart Device**

I. INTRODUCTION

ChatGPT is a LLM(Large Language Model) developed by OpenAI, capable of generating high-quality textual content. ChatGPT interacts with users in the form of a chatbot, generating content according to user's requests. Among the numerous application field, its potential in clinical decision making and diagnosis support have raised interest of both healthcare providers as well as general population patients. ChatGPT powered healthcare systems can be time and cost efficient [1], [2], which can resolve the lacking medical staff issue [2]. For the patients, the availability of rich medical information anywhere/anytime may guide them toward healthier behavior and increase the possibility of early diagnosis.

We envision ChatGPT to play a core part of a medical system which performs diagnosis to health management and guidance. However, there are multiple hurdles for the general users to utilize current ChatGPT powered chatbot itself for healthcare purposes. First, the diagnosis accuracy [3], [4] and its quality heavily depend on the user's input prompt [5], [6]. For example, lack of symptom information may lead to incorrect diagnosis. Second, the ChatGPT's output may not be easy to comprehend for the patient, due to the vast amount of information it outputs. Third, ChatGPT chatbot interface passively responds to what has been asked at the moment. This means ChatGPT's chatbot interface itself cannot serve as a continuous real-time health intervention service guiding the user on the daily basis. Fourth, the user is not able to provide sensor data information in natural language. For example, there could be valuable time series data of biometric data including heart rate and body temperature that can be essentially utilized for continuous symptom analysis and prescription generation. But it can only be accessed through a digital system.

To overcome the issues listed above, we propose a ChatGPT powered system architecture that includes prompt engineering and pre/post-processing of user/sensor data to support the patient from diagnosis to real-time healthcare interventions. The system architecture is optimized for chronic pain patients, who require continuous diagnosis and monitoring of activities through sensors for behavioral guidance.

In the following sections, we describe the latest work in ChatGPT in medical applications and elaborate on our proposed system architecture. We also provide the potential of ChatGPT to be integrated with various IoT devices including smart appliances, smart watches and smartphones to sense user's conditions and actuate interventions to support healthy behaviors for pain management.

II. RELATED WORKS

We aims to design a ChatGPT powered system for diagnosing and managing the health of patients in pain, using prompt engineering. Prompt engineering can enhance performance without additional training for the LLM model. [7]. Based on this, there are numerous researches on the patterns and formats of prompting. J. White *et al.* studied various patterns of prompts for automating software development [6]. N. Wake *et al.* proposed a JSON formatted prompt approach enabling natural language control of robots [8], while G. Peikos *et al.* proposed prompt guidelines through JSON for summarizing information about provided files [9]. Prompt engineering is being actively researched in LLM-based healthcare service. G. Peikos *et al.* proposed an effective prompt format to summarize patients' clinic notes [9], and J. Wang *et al.* proposed the guidelines and discussed potential for using ChatGPT in healthcare systems through the application of prompt engineering [10]. G. Zuccon and B. Koopman studied how effectively ChatGPT provides answers when using prompt engineering for complex health information questions. Before the development of ChatGPT, there was some research focused on healthcare systems that utilized sensors in smart devices. L. Schrader *et al.* studied on methods of collecting sensor data related to the behavior of older adults in their daily lives. They discussed the potential of utilizing the collected sensor data for human activity recognition and the feasibility of contextually appropriate interventions determined through human activity recognition [11]. Y. Nakamura designed a system that recognizes the user's health behavior through sensors and provides feedback accordingly [12]. J. Calvillo-

Arbizu *et al.* describes an m-health platform that uses sensors to determine and intervene in patient emergencies [13].

III. PROPOSED SYSTEM

A. System Diagram

Fig. 1 shows the comprehensive diagram of the system. The system receives patient information to diagnose a patient's pain. This information is transmitted to ChatGPT through prompt engineering, where ChatGPT conducts diagnosis by providing tasks and task rules. The diagnosis results, along with the pain management method, are presented to the patient. After the diagnosis, the system determines the optimal timing for intervention through real-time monitoring and provides a pain management method based on the patient's current condition. If the system determines that it is appropriate to intervene with the patient, ChatGPT suggests a suitable pain management method based on the patient's current condition. The suggested Method is applied to patients through various smart devices.

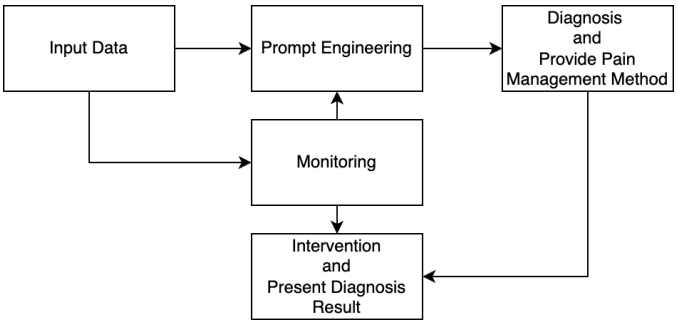

Fig. 1. System Diagram

B. Proposed System Architecture

Fig. 2 show the comprehensive system architecture. The system consists of an input module, diagnosis module, monitoring module, and output module. The input module collected patient information, including the patient's pain symptoms and the patient's health data such as biometric data, as well as sensor data from accelerometers and gyroscopes. The collected patient information is analyzed and pre-processing before being transmitted to the diagnosis module. In the diagnosis module, the system employs prompt engineering to transmit patient information along with task and task rules in ChatGPT. Based on the task rules and the patient's information, ChatGPT diagnoses the patient and provides the diagnosis results and pain management methods including exercise methods and precautions. All information is stored in the database. The monitoring module monitors the patient in real-time by analyzing the patient's health data collected from the input module, comparing it with the diagnosis results and pain management methods stored in the database. If the system determines that it is appropriate to intervene with the patient, ChatGPT suggests a suitable pain management method based on the information regarding the patient's current condition. The suggested method is transmitted by the output module to intervene with the patient through a variety of smart devices.

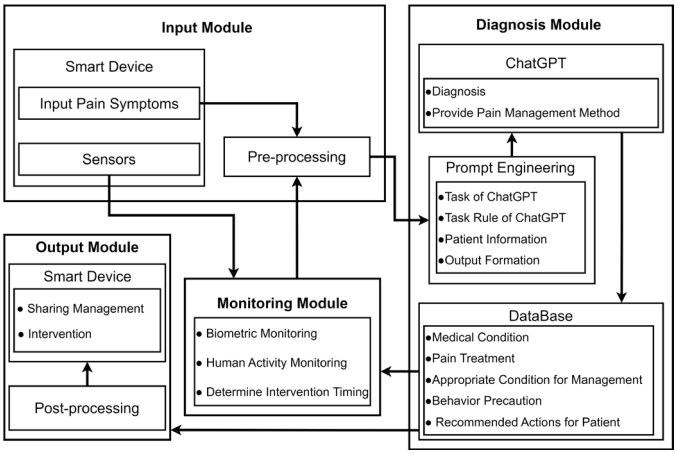

Fig. 2. System Architecture

1) Input Module: Receive input and integrate data for patient diagnosis and pain management.

a) Smart Device(Input): Collect patient information, including patient pain symptoms and patient's health data, through input-enabled smart devices such as smartphones, smart watches, IoT devices, etc.

- Input Pain Symptom: The pain symptom information input by the patient is collected based on the PQRST pain assessment tool, encompassing pain provokes/palliates, pain quality/quantity, pain region/radiates, pain severity, and pain timing [14]. The collected information undergoes pre-processing before being transmitted to the diagnosis module.
- Sensors: To monitor the patient's condition in real-time, patient's health data is collected through the sensors of smart devices and transmitted to the monitoring module. The sensors used include biometric sensor, which collect physiological data such as heart rate, body temperature, and respiration, as well as motion sensors like accelerometers, gyroscopes, and speed sensors.

b) Pre-processing: The analyzed patient health data is integrated with the patient's pain symptoms before being passed to the diagnosis module. It is then passed to the prompt engineering of the diagnosis module.

2) Diagnosis Module: The information collected from the input module is transmitted to ChatGPT through prompt engineering, and ChatGPT provides the patient with diagnosis results and appropriate pain management for the current patient in real-time.

a) Prompt Engineering: is an effective approach for enhancing ChatGPT's performance in the healthcare [7], [10], [15]. Prompt engineering can clarify the task and task rules of a model, and clearly provide examples of the outputs, which can help achieve better results than just communicating information [16], [17]. There are various patterns and forms of prompt engineering [6], [8]–[10]. In this study, we designed a

JSON formatted prompt that allows ChatGPT to clearly set the data ChatGPT wants to obtain and easily give examples of the output in order to remove ambiguity in the data transmitted to and obtained from ChatGPT as much as possible [8], [9]. Fig. 3 is an example of a prompt to diagnose patient information. The prompt contains the following contents:

- The task of ChatGPT: Setting ChatGPT's task to enable ChatGPT to perform the task of a doctor such as "From now on, you are a doctor. Please diagnose the patient based on the incoming patient information." and "Diagnose the patient and prescribe an exercise regimen based on the incoming patient information".
- The task rules of ChatGPT: Setting clear ChatGPT's task rules such as "Please structure the response as a single JSON object", "The JSON object should include keys like 'Medical Condition', 'Exercise Method', 'Patient's Condition and Situation Appropriate for Management', and 'Precaution'", and "Please provide one 'medical condition', five 'Exercise Methods', five 'Patient's Conditions and Situations Appropriate for Management', and five 'Precautions'".
- Patient's Information: It contains the patient's pain symptoms received from the Input module and the patient's health data analyzed by the monitoring module.
- Return Format Example: To return effective ChatGPT output, examples of the output are provided. These examples include the desired JSON format and the respective meanings of each key.

재용

```
{
  Task:[
   "From now on, you are a doctor. Please diagnose the patient based on the incoming patient information.",
   "Diagnose the patient and prescribe an exercise regimen based on the incoming patient information."
  ],
  Task_Rule:[
   "Please return as a single JSON object",
   "The returned JSON object will contain 'medical condition', 'Exercise Management Method', 'Patient's Condition and Situation Appropriate to manage', and 'Precaution'.",
   "Please provide one 'Medical Condition', five 'Exercise Method', five 'Patient's Condition and Situation Appropriate to manage' and five 'Precaution'"
  ],
  Patient_Information:[
   "Heart rate" : '80 bpm',
   "Body temperature" : '36.5 degrees',
   "Pain Provokes/palliates":'Overexertion',
   "Pain Quality/quantity":'Stabbing pain',
   "Pain Region/radiates":'Shoulder',
   "Pain Severity":'6/10',
   "Pain Timing":'2 weeks'
  ],
  output_format:[
   {
   "medical condition": "ex. expected disease name",
   "Exercise Method": "ex. Effective exercise regimen for pain management",
   "Patient's Condition and Situation Appropriate to manage": "ex. The patient's condition for when it is appropriate to perform pain management",
   "Precaution": "ex) Prohibited behavior",
   }
  ]
}
```

Fig. 3. Example of a JSON formatted prompt for diagnosing patient information

Fig. 4 shows an example of prompt input in a situation when it is necessary to intervene with a patient during post-diagnosis monitoring. The patient's health data is communicated to ChatGPT through a set of prompts. The prompt contains the following contents:

- The Task of ChatGPT: Setting ChatGPT's task to enable ChatGPT to perform the task of a doctor such as "Please provide recommended actions based on the current patient condition".
- The Task Rules of ChatGPT: Setting clear ChatGPT's task rules such as "Please return as a JSON object", and "The JSON object will contain 'patient should do'".
- Patient Information: It contains the patient's health data analyzed by the Monitoring Module.
- Return Format Example: These examples include what the patient should currently do based on their conditions.

재용

```
{
  task:[
   "Please provide a recommended actions based on the current patient condition."
  ],
  task_rule:[
   "Please return as a JSON object",
   "The JSON object will contain 'patient should do'."
  ],
  patient_information:{
   "Heart rate": '70bpm',
   "Condition": 'holding a heavy object for a long time'
  }
  return_format:[
   {
   "patient should do": "E.g. recommend management, tell them they should stop the behavior or that it is okay to proceed",
   }
  ]
}
```

Fig. 4. Example of diagnosis result

b) ChatGPT: Based on the information received through prompt engineering, provides a diagnosis and pain management method for the patient. ChatGPT returns a JSON object containing 'Medical Condition', 'Exercise Method', 'Patient's Condition and Situation Appropriate to Manage', and 'Precaution'. An example of the JSON object is shown in Fig. 5. After the diagnosis, the system monitors the patient and intervenes when specific situations are detected. ChatGPT returns a JSON object containing information on what actions the patient should take based on their current condition, referred to as 'Patient should do'. The returned examples are shown in Fig. 6 and are stored in the database.

c) Database: it stores the 'Medical Condition', 'Exercise Method', 'Patient's Condition and Situation Appropriate to manage', and 'Precaution' and is used to make decisions about interventions while monitoring. 'Patient should do' is stored and used when the system intervenes with the patient.

3) Monitoring Module: Utilizing the patient's health data collected through the sensors of the Input module, real-time analysis and monitoring of the patient's activities and physiological data are performed. Monitoring is conducted through through human activity recognition, which detects

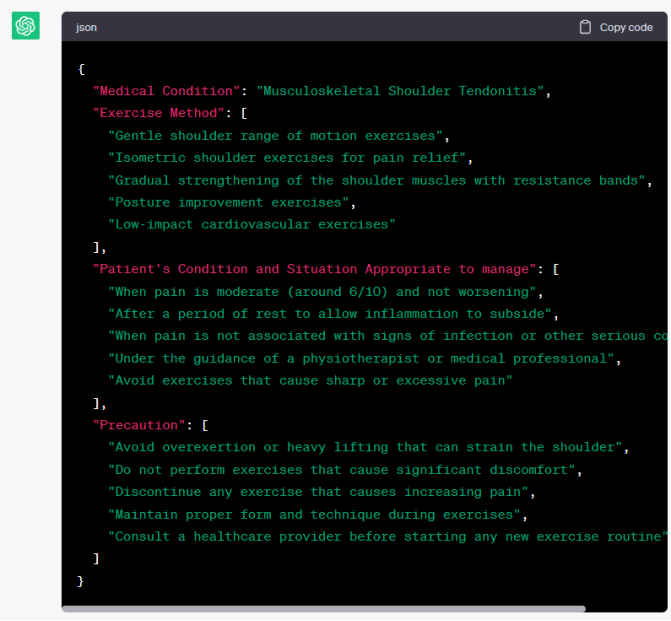

Fig. 5. Example of diagnosis result

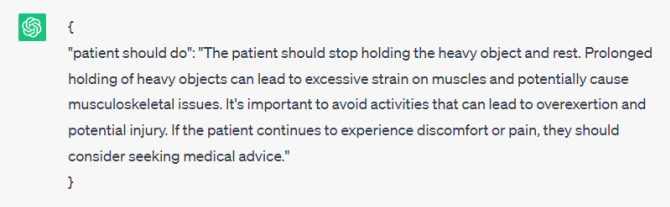

Fig. 6. Examples of recommended behavior based on a patient's condition.

current human behaviors, and biometric monitoring, which monitors physiological data. In the event of sudden changes in the patient's physiological condition or the detection of behaviors corresponding to 'Patient's Condition and Situation Appropriate for Management' and 'Precaution' stored in the Database, the current patient's behavior information is processed through pre-processing and Prompt Engineering. It is then transmitted to ChatGPT, requesting recommendations for 'Patient should do'.

4) Output Module: If monitoring module determines that the system should intervene, the system transmits the current patient's health data to ChatGPT and requests recommendations for the patient's appropriate behaviors. The requested information is stored in the database. Subsequently, following the post-processing, the information is transformed and utilized for intervening with the patient.

a) Post-processing: The information received from ChatGPT and stored in the database is transformed into a format appropriate for the smart device utilized for intervention, and then transmitted to the smart device

b) Smart Device(Output): After the diagnosis, the smart device presents the diagnostic results to the patient. During the monitoring phase, if it is determined that the patient is suitable for pain management, an effective exercise method is provided for patient assistance. Conversely, if specific actions are found to worsen pain due to precautions or sudden physiological changes, a warning intervention is triggered to stop the patient's actions. The devices used for interventions encompass a wide range of smart devices, including smartphones, smartwatches, and IoT devices, capable of internet connectivity and information communication. These devices can employ various intervention methods, such as delivering visual messages through displays or using auditory cues, depending on the presence or absence of a display.

IV. CONCLUSION

We proposed and demonstrated a ChatGPT powered healthcare system with a prompt engineering module for medical purposes. This system intervenes with chronic pain patients by providing medical information through various smart devices. The smart devices serves as a patient monitoring system, used for both diagnosis and real-time health intervention services. The patient's information collected during the diagnostic process and sensor/activity data collected over time could aid doctors in achieving more precise diagnoses, especially during the in-person diagnosis.

There are several limitations of the proposed system. First, relying solely on sensors to accurately track all aspects of a patient's real-time human activity recognition presents challenges. This limitation leads to an inability to determine the optimal timing for intervention defined by the ChatGPT. Second, the reliability of the medical information provided by ChatGPT has not been fully validated. However, if the reliability of human activity recognition through sensors or the trustworthiness of the LLM model reaches commercial levels, the system proposed in this study is anticipated to offer an experience of intelligent health management by automating medical intervention and management in everyday life.

V. ACKNOWLEDGEMENT

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