Ambient Intelligence Based Context-Aware Assistive System to Improve Independence for People with Autism Spectrum Disorder

Ziying Tang, Jin Guo, Sheng Miao, Subrata Acharya, Jinjuan Heidi Feng
Department of Computer and Information Sciences
Towson University
Towson, MD21252, USA
{ztang; jgou2; smiao1; sacharya; jfeng}@towson.edu

Abstract

Individuals with Autism Spectrum Disorder (ASD) can face great challenges in learning and maintaining basic living skills. This not only reduces their possibilities of independent living and employment, but also continuously brings social and financial burdens to their caregivers/mentors. Although research has been proposed to help autism users, most of them focus on improving social and communication skills or providing help for emergency situations. In this paper, we propose a novel portable context-aware assistive system to help autism users in their daily activities such as cooking and cleaning. To make it easily accessible and cost effective, we employ mobile devices and cheap context sensors. Our care system has been implemented and tested under different settings, and a user study involving ten pairs of autism users and their caregiver/mentors has been carried out to evaluate our approach. User feedback is highly positive.

1. Introduction

Autism is the fastest-growing developmental disorder in the U.S., and it affects over 3 million individuals in the U.S. and tens of millions worldwide. Unfortunately, there are no medical detection or cure for autism till now. Some individuals with Autism Spectrum Disorder (ASD) may have to deal with their symptoms lifelong even after treatment and interventions, and autism can cost a family $60,000 a year on average [1]. In addition to social impairment and communication issues, the autism individuals may face significant challenges from the following three aspects. First, they need considerably more time to acquire a skill to fluency and often have difficulties maintaining the skill [2, 3]. Second, individuals with ASD often lack of executive functioning skills such as time management [4, 5]. Third, they also have sensory-based challenges that can cause significant distraction, pain or negative sensory experiences that can result in debilitation or panic. Therefore, individuals with ASD normally need constant prompts and continuous support during their skill development, acquisition, as well as skill maintenance and generalization, even for basic living skills such as eating and cleaning [2, 6]. And they also need continuous interventions to help them stay focused, even when completing familiar tasks. Because of the intensive level of prompts and personal attention needed by individuals with ASD, many of them cannot have an independent and self-conducted life. In order to take care of them, many autism individuals’ caregivers have to work from home or do part time job. It increases stress and personal fatigue to the caregivers, and brings growing social and financial burdens to them.

With the fast development of information technology and various sensors, research on Ambient Intelligent (AmI) System becomes very active in the past few decades, and one of its applications is to provide living assistance to people with disabilities such as autism. Different methods and technologies have been proposed. However, most of them are for autism children and focus on improving their social, academic or organization skills [7-11]. How to help young adults with autism improve their basic living skills is still a challenge. There is also research proposed for other populations such as deaf children [12] and older adults [13], but it doesn’t satisfy requirements from our target users.

In this paper, we propose an ambient intelligence based context aware assistive system for young adults with ASD to improve their living skills, as demonstrated in Figure 1. Our goal is to use various context information including location, time, schedule, personal preference, functionalities and so on to automatically provide customized and real-time support for individuals with ASD on their daily activities. In order to provide a cost effective, flexible and easily accessible method, we combine smart phones with low cost sensors to build our system. Noticing that many individuals with ASD have unique communication needs [2, 4], we propose to deliver the...
previou works are designed for the academic setting. For example, Cramer et al. study how to use vSked, an interactive system to improve student independence in classrooms and reduce prompts initiated by the educators [9]. Escobedo et al. propose a mobile tool for autism children to practice social skills [10]. Fage et al. develop a tablet-based application for activity schedules that addresses classroom routines and verbal communications [11]. There is research on supporting everyday activities and workplace tasks, but most of them are in the conceptual, exploratory stage without actual implementation or user involvement [14, 15]. Studies of using context information to provide services to people with cognitive disabilities have also been explored. For example, Mihailidis and Fernie [13] describe a context aware device that uses a camera to assist people with dementia in independent living tasks such as using the bathroom. Similarly, Chang et al. [16] use location-based information to provide prompts to individuals with cognitive disabilities for catering tasks. However, both of these studies only explore one type of context information. Bodine et al. [17] and Melonis et al. [18] separately examine a much broader range of context information (location and motion information collected through sensors, visual information collected through cameras) for the purpose of providing automatic prompting for people with cognitive disabilities. But their study focus on workplace tasks and the use of cameras raises privacy concerns in the independent living environment, which can be very sensitive for our user population.

3. AmI Context-aware support system

Through the proposed AmI context-aware support system, we would like to provide young adults with ASD an easily accessible virtual caregiver/mentor who can assist their daily activities. With it, they can learn living skills progressively and improve the ability to
live independently. In the following few sections, we explain our system in detail.

3.1. Target users

The proposed system is designed to mainly serve the following user groups, but it can be easily extended to other similar populations.

- Teenagers and adolescents with ASD: due to the challenges from different aspects, most of young adults with ASD don’t have basic living skills, are not able to live independently, and have less employment opportunities. Their functionality level may vary a lot. Our system is designed to support most of them but those with very low functionality level who may not be able to understand how to use mobile devices are not our target users.

- Caregivers/mentors of the teenagers and adolescents with ASD: as the people who have to take care of individuals with ASD everyday, caregivers/mentors are normally very stressful. The mobile app can provide them the autism users’ activity records, notify them when their interventions are needed, and reduce their workload, stress, and financial burden.

The information recorded by the system can be useful for health professional and behavior analysis too. Besides, the proposed system can be easily applied to other populations such as individuals with Attention Deficit Hyperactivity Disorder (ADHD), Dementia and Alzheimer. It can also bring benefits to older adults.

3.2. System architecture

In general, we follow the traditional client and server (C-S) network architecture, as shown in Figure 2. There is one dedicated central server which is in charge of real-time context analysis and decision-making. A back end database is used to store various data including user profiles, task information, context data and so on. The server works as an alternative virtual caregiver/mentor who “observes” users with ASD through various context information and “tells” them what to do by sending them guidance and suggestion automatically. Instead of broadcasting general prompts, the server treats each individual client separately. Based on every client’s contexts it sends customized prompts to satisfy his/her specific needs.

The client in the proposed system refers to the individuals with ASD who use our mobile application. The mobile device can work as a normal interaction platform for autism users to perform general activities (such as checking emails or making schedules), or as an assistant for some specific living task (such as cooking some food or using washing machine). In either way, users’ data are detected and collected automatically in the background and sent to the server for analysis. In addition, external sensors for location and event detecting are included to provide precise and detailed context information. Similarly, data from external sensors are also sent to the server automatically. By doing so, we can ensure a less distractive and non-intrusive approach when communicating with autism users. Through the mobile app, users receive interventions from the server, providing guidance, suggestions and warnings. The prompts can be a general event reminder, such as a schedule notice, a suggestion on some specific task or a warning on some coming event. For example, when an autism user is following the app to cook a dish and he/she may receive a prompt, telling her/him where to find the cookware. And when he/she opens heat on the stove, the system will warn him/her that the cooktop can be hot. The prompts can be delivered through various ways, including texts, video, audio and haptics.

Caregiver/mentor can be treated as a client too. However, instead of traditional users their roles are observers and helpers in the proposed system. Whenever the autism users get lost and prompts from the app are not enough, the caregiver/mentor needs to be notified and get involved. For example, when an autism user should leave home to school according to his/her schedule but the context information indicates he/she still stays at home after receiving prompts, his/her caregiver/mentor needs to be notified so that corresponding actions can be taken. Therefore, caregiver/mentor uses the mobile app as a way to monitor the autism users, so context data from the caregiver/mentor are not necessary. Through the app, caregiver/mentor can also provide autism users’ profile and personal data to the server, as some autism users may not be able to do this by themselves.

3.3. System modules

The overall system comprises of five basic components, as shown in Figure 3. They are the task module, the user module, the context module, the interface module and the decision module. The interaction amongst these modules enables and contributes towards the efficiency and precision of the proposed solution.

3.3.1. Task module. Every user activity such as cooking, getting dressed, doing laundry, taking medication and so on, is represented as a task in the proposed system. The application database constitutes
of numerous task for the autism user to make his/her selection based on his/her requirements. The caregiver/mentor could also invoke and pre-select a group of tasks as per the user requirement for any given time period (day/week/month/etc.). The system provides flexibilities for both autism users and/or caregivers to modify the task group based on the appropriate user specifications and subsequent user proficiency in the tasks. Each task constitutes of a sequence of sub tasks, which is built as a stepwise flow of instructions necessary for the successful completion of the overall task. Initially on a new task input, the system establishes an appropriate information flow template, which then is incorporated into the mobile app. The system mandates various feedback mechanisms from autism users, caregivers and domain experts to best represent the flow of information and builds the appropriate sequence of sub-tasks. The task module design is user-friendly and provides for customized interfaces via appropriate color mapping and multiple user assistive modes (text, audio, video and image). Individual user task setting and their progress in task execution are logged in real-time and communicated to the centralized server for analysis and decision making.

3.3.2. User module. To address our goal of a user-specific assistive design, the system enables the autism user and/or caregiver/mentor to incorporate relevant user information. The user information includes, but not limited to, the user schedule (e.g., daily/weekly/monthly/etc.), the user preferences (e.g. food preferences such as vegetarian/non-vegetarian, etc.), the educational background of the user (e.g., language and expertise of use of technology and understanding of caregiver cues/prompts), the user technical expertise level (e.g. technology usage, mobile phone usage, etc.), the past user performance (e.g., regarding the bottlenecks and difficulty for any specific task usage), and other caregiver/mentor experience in regards to the autism user. In addition, user module also includes user’s functionality level, mobile app calibrations and preferences, and their caregivers/mentors’ contact information. The system considers and includes the above user specifications to make informed decisions for every specific usage of the app. Each real-time activity is constantly monitored and logging by the system to provide a feedback mechanism to further tune the system to address appropriate user requirements.

3.3.3. Context module. Context information is the key data for the system to provide appropriate assistance. Therefore in the context module, we can include various sources to detect and collect context data:
- The environment context: As a very important component in our design, the environment context can include the current physical location of the user (approximated location and detailed location), the current room/appliance/environment attributes such as temperature and lighting associated with the corresponding task performance, the orientation of the user during task performance. Both a semi-automatic caregiver monitored design and an automatic sensor design can be used to get these contexts.

![Figure 3. System modules.](image-url)
The temporal context: Usually for the target user domain, there is a typical schedule of tasks predetermined by the caregiver based on the appropriate user needs in any given time period (day/week/month/etc.). It is included as the “current time” in our design. Temporal context also includes personal schedules, appointments and special date and time on the calendar.

The behavioral context: Based on the current task the system can determine the appropriate “user status attributes” and aid the user to adhere to them during their task execution. For example, such user attributes can be standing near stove area (during cooking activity), walking to public transport service (during communication activity), being seated (during reading activity), and so on. The system design is flexible to include the specific user attributes for every task innovation to better orient and monitor the user for successful and independent task completion. In addition, social contexts are considered too. It can include the professional and home settings. It could also include the state of the task performance, e.g., if the user performs the task independently or with caregiver observation and support.

The context module is responsible for collecting and utilizing the context information to infer user’s current state. This module supports the collection and query of temporal, environmental, and behavioral information and sends the data to the decision module to determine appropriate promptings. Mobile devices such as Android smart phones can be used both as a tool to collect context information and as the prompting interface. For example, tri-axial wireless accelerometers can provide useful cue regarding user status and behaviors (e.g., seated or walking). External sensors can be employed in the context module too. For example, RFID tags or infrared sensors can be used to track and identify location. Acoustic software can be used to analyze environmental sound to provide cues about both physical and social environment (e.g., a quiet home or a noisy room).

3.3.4. Interface module. The interface module not only provides users a platform to perform interactions and input feedback but also outputs interventions and prompts to users. To fulfill the requirements from different users on the autism spectrum, we provide various output options through text, video, audio, image and haptic. By doing so, we can improve the effectiveness of the communication between autism users and virtual caregivers/mentors. Users or their caregivers/mentors can easily configure the interface based on their special needs.

Another function of interface module is to provide scalable display. Depending on the functionality of autism users, they may need the task instructions to be displayed at different level of details. For example, if a high functional autism user sees the instruction “Fill a large pot with cold water”, he may be able to find the pot by himself and fill with water. But a low functional autism user may need further instruction about where to find the port and how the pot looks like. Therefore, a single level task instruction is not enough to satisfy users’ requirements. Thus, in our system, users are able to easily choose the level of details they would like to see, from abstract instruction steps to tedious detailed description. Figure 4 demonstrates how our method displays instructions at different level of detail. We also include video and audio explanations to provide a more intuitive instruction in addition to using texts and images. For example, as shown in the right image of Figure 4 (b), “Tell me what to do” button can give users an audio instruction.

![Figure 4](image_url)

Figure 4. The proposed system provides instructions in different level of details. (a) Abstract instruction steps for a cooking procedure. (b) Corresponding mobile app interfaces of (a).
3.2.5. Decision module. The decision module incorporates inputs from the other modules and performs informed decision to provide accurate and timely cues and appropriate prompts. Various machine learning models, both linear and non-linear approaches can be used to build this component. In our method, we follow a probabilistic approach to complete this procedure, because the computational cost is very low and we can reach real-time performance. Initially, the module includes semi-automatic decision inputs by caregivers/mentors to help in specific user activity. After learning/training from many user activities, the system can operate in an automatic mode to aid in everyday activities. Different features are extracted from the input data and sent to make decision. The overall strength of the system depends on the performance accuracy of this module. Our goal is to enable accurate cues and appropriate timely prompts to provide ease of use and effective user experience.

3.4. Mobile application

We believe a smart device based solution can address our challenges better, as it is easily accessible, cost effective and has many useful built-in sensors. Therefore, a mobile application, working as an intermediary between supportive system and end users, is included in the system. It is served as the user’s agent and in charge of detecting and collecting context information from different sensors. For example, when a user with a mobile device enters the kitchen, after communicating with the sensor at the kitchen’s door the mobile app can detect this event and send the corresponding context data to the server. Note that attached body sensors are not adopted here, as it is a more intrusive approach and not suitable for our users on daily activities. In addition, the mobile app is the platform where users can follow instructions to perform actual tasks. It not only provides instructions at different level of details, but also tracks each user’s interactions closely and then sends to the server.

The mobile app works as a virtual caregiver/mentor and provides suggestions and reminders through prompts. After analyzing context information and real-time user data, decisions are made by the server and sent to the mobile app. If it is necessary to give any intervention, the mobile app will deliver it to the end user accordingly. Because of the special features of our target user group, in order to make the intervention noticeable while not disturb users’ normal activities or trigger their sensitivities, we provide different intervention options including visual, audio and haptic prompts. Users can set up easily based on their preference. Moreover, when the intervention does not reached its purpose, the mobile app will notify the server. After analyzing by the server, user’s caregiver/mentor may be contacted and further actions may be taken. Additionally, the mobile app can also be served as a learning interface where users acquire the knowledge of how to complete basic living tasks such as cooking and eating.

4. Experimental results and analysis

The proposed system and mobile application have been implemented and tested under different settings and user studies have been performed to evaluate the system. Our experiment focus is set to be cooking assistance. In the following sections, we explain our experimental results and related analysis in detail.

![Experiment environments. (a) The Life Skills Lab for user study. (b) User performs cooking experiment using the proposed method.](image)
4.1. Environment setting

The proposed system server is implemented using Perl and PHP on a PC with Debian Operating System. MySQL and PHP are used to build the database. The web access and website implementation utilize HTML and PHP. On the client side, the mobile app is developed with Eclipse IDE Android Development Tools on a Windows 7 machine with 4GB RAM. The Android app has been tested on two Samsung Galaxy S3 phones which are built with ARMv7 Processor, Android version 4.2.2 and 832 MB memory. The proposed mobile app has been tested at various network conditions to evaluate its performance and stability. Specifically, four wireless connections, i.e., 50Mb/s Wi-Fi, 4G, LTE and very low speed wireless, have been used for experiments. At all conditions, our mobile app performs very stably and effectively.

As the main objective of our system is to support the independent living for the users with ASD, we would like to conduct our experiments in the daily living setting. The Life Skills Lab allocated in a special Autism Center of a public university is chosen to be our experimental environment. The Lab is a fully functional apartment with kitchen, living room, bathroom dinner room, and laundry room. Our focus is set to be the kitchen where we can evaluate how our system works on assisting autism users regarding the cooking activities. Figure 5(a) displays the Life Skills Lab and Figure 5(b) shows a user perform cooking task in the Lab using the proposed method.

4.2. Context sensors

Location sensors are the key context sensors for the independent living assistance such as cooking assistant. In our experiments, two kinds of sensors, namely infrared sensor and Bluetooth wireless sensor, have been tested.

As one of the most popular infrared sensor, Sharp GP2D12 has been employed for location measuring. The sensor uses LED drive circuit with integrated signal processing and outputs analog voltage. The effective range is 10 to 80cm while output is 0.4V to 2.4V voltage signal. In order to process and transfer these analog voltage signals, an Arduino board with 32-bit ARM processor and six analog input channels is used. Moreover, with the help of CC3000 Wi-Fi shield manufactured by Adafruit, the Arduino board could host a micro-server in wireless Ethernet and transfer real-time distance data in telnet method. Figure 6 (a) shows the infrared sensor we build for capturing location contexts.

In addition, Estimote beacon sticker [19], a small wireless sensor that broadcasts radio signals to communicate with smartphones, can also be used to get the location information. It includes a powerful 32-bit ARM processor, 256kB memory, and 2.4GHz Bluetooth Smart module. The broadcasting range could be as little as 2 inches and as far as 230 feet. This kind of sensor follows the iBeacon protocol and uses the Bluetooth for data transmission. When a mobile device enters region of a beacon, it will receive various kinds of information including distance which is broadcasted by the beacon. We put the beacon sticker which has a unique ID at the major locations such as on the refrigerator, on microwave, in front of sink, on the entry door, and so on. When the user with the smartphone gets close to any sticker, we are able to get his/her exact location immediately. Figure 6(b)
demonstrates a user with smart phone communicates with the beacon sensor. Infrared sensor is much cheaper than Bluetooth one, but its coverage range and data precision are not good as the Bluetooth sensor. Infrared sensor can work independently without interaction with mobile devices, but the Bluetooth sensor has to communicate with mobile devices to get the location data. So choosing which location sensor is highly depending on the application objectives.

4.3. User study

Our user study consists of two phases: the first phase is to identify user needs and challenges for project design and development, and the second phase is a field study for user evaluation and feedback collection. In the middle of the development, we have also conducted some preliminary user testing.

4.3.1. First phase user study. In order to collect user requirements, ensure effective and user-friendly design, and identify important tasks that individuals with ASD need to complete in the independent living setting, we have conducted first phase user study. Specifically, ten observation sessions conducted in a library setting, a food catering service setting, and a home setting are completed. During these sessions, we have observed autism individuals completing a variety of tasks and gathered preliminary data on user capabilities, needs, challenges, as well as how they interact with their caregivers. In addition, we have also interviewed domain experts who work with individuals with ASD on a daily basis, including student mentors and professionals from schools for children and adolescents with learning disabilities. Through the first phase user study, we have identified the strategies employed by the individuals when completing those tasks. We have also documented the type of assistance or instructions provided by the caregivers during those tasks as well as when and how the assistance is provided. By understanding the challenges and the existing assistance provided by caregivers, we are able to identify the key activities and main focus when designing our solution.

4.3.2. Second phase user study. After the development of the proposed system, we have conducted a second phase user study in an independent living setting which focuses on cooking tasks. Specifically, ten young adults with ASD and their caregivers/mentors have participated in a two-session user study. The ages of the autism participants are between 19 to 26, with an average of 22.7 (stdev. = 2.26). Six of them are male and four are female. All of them have graduated from high school and have experiences with computers, Internet, and smartphones. The functional levels of our participants cover a wide range. Two participants are high functional and can manage many daily routines independently. One participant is very low functioning, has short attention span, and needs constant assistance and reminders from his mentor. The functionality of the rest of the participants is somewhere in between. Nine of the participants did not have any cooking experience except the use of microwave. The only participant who has cooking experience is very interested in cooking and has taken cooking classes before. During the cooking classes, her caregiver has to closely monitor her all the time to provide assistant and ensure safety. In addition, we have seven caregivers and three mentors involved in the study. All caregivers of our autism participants are their parents, especially mothers. Only a few of them have part time jobs and the others work from home or are stay-home moms. The mentors involved in the study are students who are similar age as autism participants and studying health professions in the university.

The first session focuses on the user-guided learning functionalities. During this session, the proposed mobile app has been introduced to the autism users and their caregiver/mentor. Then they can explore the app to get familiar with it. After this short training, the autism user is required to cook a dish (egg salad) with the help from the app. Users can navigate the app to find information about cooking materials and/or procedures. In the second session, autism users are required to complete the same cooking task based on their previous experience with limited accessing of the app. During both sessions, autism users may receive interventions from the system. The caregivers/mentors have observed the study with researches closely and provided their feedback. All participants have answered a questionnaire after each session to evaluate their interaction experience.
and provide suggestions. The participant feedback is highly positive. As demonstrated in Table 1, all participants strongly agree or agree that the app is helpful, all participants strongly agree or agree that the app is easy to use. Regarding the distraction caused by prompting, three participants strongly disagree that the prompts are distractive, three choose disagree, two choose neutral and one thinks that the prompts are distractive. Using the assistive app, nine out of ten participants are able to complete the cooking task independently. One participant (P10), with the lowest functionality level, cannot complete the task due to his own sensory challenge.

4.4. Experimental data and intervention

During experiments, context data are automatically collected by the mobile app and sent to the server. Specifically, the data recorded include:

- User profile data
- User preference and setting
- Current app page which the user is visiting
- History of app pages which the user has visited
- Duration of every page been visited
- Functionality level of the user
- Current user location
- History of user locations
- Number of prompts sent to the current user
- Current page properties
- Starting time of every page visited
- Whether the current viewing page is a prompting page sent by the system or a regular page visited by the user
- Whether the user checks the prompt or not.

Some of these data are very time sensitive and collected in real time, for example the time stayed on a particular page on the mobile app. Some of them are less time sensitive, such as user preference and setting, and only need to be recorded once. Based on these data, more information can be derived, for example the average time spent on a particular app page, the average time needed for completing a page step for the current user. All these information is analyzed by the server’s decision module to determine whether an intervention is necessary for the current status and what intervention can satisfy users’ current needs.

Based on the data analysis, a three-level rule based prompting can be sent to assist user. The first level is for mess navigation, which means it is to help users back to the correct route. Prompting message leads users to the first page of current category and helps users navigate to the right step. The second level of prompting is based on location detection. A location based time threshold can be used to determine when users are not in the correct location. For example, if the user is on the page of “look for green onion in the refrigerator” but the location sensor indicates that he/she stands in front of microwave for more than the preset time threshold e.g. 10 second, then a prompting may be needed. The third level of prompting is for step overtime. If the system thinks the user spends more time than it is required on a task step (an app page), an intervention is necessary. Step overtime can be affected by many aspects, including the difficulty of the current page, the functionality level of the current user, the average time spent on every page and so on.

5. Discussion and conclusion

In this paper, we have proposed a portable ambient intelligence based context aware assistive system for young adults with Autism Spectrum Disorder and their caregivers/mentors. The objective of our research is to build a virtual care system to help autism users learn and maintain basic living skills such as cooking and cleaning so that to improve their possibility of living independently and reduce the social and financial costs. Following the client-server network architecture, the proposed support system involves a mobile application and five system modules, i.e. context, user, task, decision and interface module. It works as a virtual caregiver/mentor and decides if an intervention is needed based on the real-time context information. Autism users are able to interact with the proposed mobile app through various channels including video, audio and haptic. Our system has been implemented on Android mobile device and tested under different conditions. We have performed some experiments, focusing on the cooking assistance, and location sensors have been included. A user study involving ten pairs of autism participants and their caregivers/mentors has been conducted to evaluate our approach too. The study results indicate that the proposed method is very helpful for autism users on daily activities.

In the current research stage, we focus on indoor assistance for improving independent living skills. But assistance for emergency situations like panics is also very important for autism users and will be considered in the future. In addition, outdoor living assistance is another vital but challenging research topic for our user group. However, the context detection and collection can be very difficult in the outdoor setting, as things can be highly unpredictable and unstable. During our study, we choose to use mobile devices instead of body sensors at the end user side. One reason is that mobile devices can provide much user-friendly interface and deliver more information to the user. But the
assumption here is that users carry the mobile devices or are very close to them all the time. Another reason is mobile devices are less intrusive compared with body sensors. However, body sensors may be more accurate and able to capture detailed information about the user. In the future, we also consider including body sensors into the care system. Wearable smart devices such as smart watches will also be considered in the future. Besides, the decision module still needs to be improved in our system. We use the Wizard-of-Oz approach to make decisions for the user study, and then based on the collected data we train a probabilistic model for the three level prompting. Our decision making module has been implemented but due to the lack of user data for training, it cannot get very good result yet. So getting more autism users’ data to further test the probabilistic decision module is also part of our future research plan.

6. References


