Using Virtual Agent for Facilitating Online Questionnaire Surveys

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Abstract—In this paper, we present a novel system, called Formroid, which facilitates answering online questionnaire surveys with the virtual agent technology. For a questionnaire given by an investigator, Formroid commands the virtual agent to ask each question to the respondent. Through conversation with the virtual agent, a respondent can answer the questionnaire. Thus, Formroid transforms the conventional form input task into a face-to-face interview conducted by the virtual agent. In this paper, we especially address the design issues of Formroid, and the implementation of prototype system. We also introduce an experiment, where Formroid is extensively used for questionnaire-based assessment of quality of life.

Index Terms—virtual agent, questionnaire, Web form, speech dialogue system, human-computer interaction

I. INTRODUCTION

The questionnaire survey [1] is a fundamental but important method of measurement in applied social research and investigation. The method is widely used in, for instance, national census, market research, customer satisfaction, product usability testing, health-care assessment, subjective experiment, etc. In a questionnaire survey, an investigator first develops a questionnaire form, which generally consists of multiple questions relevant to the study. The form is then delivered to target people, called respondents. Each respondent answers the questions in the form, and sends the completed form back to the investigator. Traditionally, the questionnaire-based survey has been conducted using paper-and-pencil instruments.

Nowadays, the questionnaire surveys become online, due to the wide spread of the Internet. In the online survey, an investigator develops a questionnaire form in HTML, called Web form. In the Web form, questions are instrumented by GUI components, such as radio button, check box, drop-down list, and text box. The developed Web form is deployed on a Web server, and a URL of the form is notified to respondents. Using a PC or a smartphone, a respondent opens the URL with a Web browser, then selects (or fills) a value for each question, and finally submits the answers by pressing a “submit” button. The values of the form are sent to the server, and stored in a database, designated by the investigator.

Compared to the paper survey, the online survey allows quick delivery and collection of questionnaires, and reduces the effort of transcribing handwritten answers. Therefore, investigators can perform research and investigation quite efficiently. There are also useful cloud services (e.g., Google Forms [2]), with which non-expert users can easily develop Web forms for online questionnaire survey of their own.

In exchange for the benefit of investigators, the online survey requires respondents to do input operations on a Web form using a PC or a smartphone. This would cause mental obstacle especially for elderly respondents. Even for general respondents, input operations on a long Web form are quite monotonous and tedious. The text-based appearance of Web forms also decreases the user engagement for the survey. The problem lies in the poor capability of Web forms on human-computer interactions with the respondent.

Of course, there are many other factors that can influence user engagement in survey research, as studied in [3] [4]. However, this paper especially aims to enhance human-computer interactions in online questionnaire surveys, so that broader range of respondents can enjoy answering the questions. To achieve the goal, we propose to use the virtual agent [5] [6] as an alternative technology of the Web form. The virtual agent is an animated, human-like graphical chat-bot program, running on a PC. Exploiting the speech recognition and synthesis technology, the virtual agent can communicate with a human user via voice. Our key idea is to wrap the Web form with conversation between a respondent and an agent.

In this paper, we present a new online questionnaire survey system, called Formroid. Formroid is supposed to be installed in a PC (or a smartphone) of each respondent. An investigator first develops a questionnaire form and posts the form in a cloud database. Formroid interprets the posted questionnaire data, and then commands a virtual agent to ask each question to the respondent. For every question given, the respondent inputs the answer via voice or a simple click operation. Based on the input, the virtual agent performs reactions to encourage the respondent to keep answering. Thus, the respondent completes the whole questionnaire just through the conversation with the virtual agent. Formroid finally sends the collected answers to the cloud database. Consequently, Formroid virtually transforms the conventional form input task into a face-to-face interview conducted by the virtual agent.

In this paper, we especially focus on the design issues of Formroid, including the system architecture, data models, screen layout, and scenes. We also implement a prototype version of Formroid, using C# and Unity platform [7].

Moreover, we introduce our on-going experiment, where the prototype is used for questionnaire-based assessment of quality...
of life (QoL). Specifically, each subject is instructed to answer designated questionnaire forms SF-12 [8] and SF-8 [9], with the support of Formroid. Through three-weeks trial, we receive positive feedback from the subjects, indicating that Formroid facilitates answering questionnaire surveys.

II. FORMROID

A. System Architecture

Figure 1 shows the system architecture of Formroid. In the figure, there are two actors: investigator and respondent. The investigator is a person who wants to conduct a questionnaire survey, while the respondent is a target person who answers the questionnaire. There are two databases deployed in clouds: form database and answer database. The form database stores the questionnaire form developed by the investigator, while the answer database stores answers sent from the respondent. The two databases have Web-API through which external applications can insert (or retrieve) data by HTTP-POST method (or HTTP-GET method, respectively).

Formroid is an application software running on a PC (or a smartphone) of the respondent. Formroid retrieves a designated questionnaire from the form database. It then parses the structure of the questionnaire to identify a set of questions. For each question, Formroid asks the respondent via a virtual agent. As the respondent answers the question via voice or a simple click operation, Formroid records the answer. When all questions are answered, Formroid sends the recorded answers to the answer database.

B. Data Models

This subsection describes how the questionnaire form and the answer data are managed by the databases.

First, we explain data schema of form. Figure 2 (a) shows an instance of form data, represented in JSON format. Each form consists of four attributes: id, name, creator, and questions. id is an unique string identifying the form. name and creator are the name of the form and the identifier of the creator, respectively. questions is an array of questions, which is the main body of the questionnaire.

```json

{
  "id": "LRAE01-SF12",
  "name": "SF-12 for life-rhythm assessment experiment 01",
  "creator": "longniu@ws.cs.kobe-u.ac.jp",
  "questions": [
    {
      "qid": "q1",
      "type": "select",
      "valueType": "int",
      "question": "What is your health condition?",
      "choices": [{"5": "the best"}, {"4": "very good"}, {"3": "so-so"}, {"2": "Not so good"}, {"1": "bad"}]
    },
    {
      "qid": "q2",
      "type": "select",
      "valueType": "int",
      "question": "Do you feel difficult to do light work for health reasons? For instance, clean your house and garden, or go out for a walk?",
      "choices": [{"3": "Very difficult"}, {"2": "A bit difficult"}, {"1": "Not difficult at all"}]
    },...
  ]
}
```

Fig. 2. Data schema of Formroid (in JSON format)

Each question is identified by qid. type defines the type of the question, specified by one of the following values:

- select: select one from given choices.
- check: check all items that apply within choices.
- value: answer a specific value.
- free: describe a free comment.

valueType defines the expected type of the answer value. question defines the description of the question. choices is a set of choices associated to the question, each of which is specified by a pair of the answer value and the description.

Figure 2 (a) shows a part of questionnaire SF-12 [8], developed for an experiment in our project. The first question q1 asks health condition of a respondent. Since the type is select, the question expects that the respondent selects one from the five choices from “the best” to “bad”. The answer is returned by an integer value.
Next we explain data schema of answer. Figure 2 (b) shows an instance of answer data. Each answer consists of id: an identifier of the answer, timestamp: the time when the answer is collected, respondent: an identifier of the respondent, form: an identifier of the corresponding form, and answers: an array of collected answers. Each answer is specified by a pair of question id and the answer value. Figure 2 (b) represents that it is the answer of the form LRAE01-SF12, responded by takatsuki... on 2018-07-10T12:34:56. The answer values for questions q1, q2, ..., q6 are 3, 4, 4, 1, 2, 3, respectively.

C. Screen Layout

We design the screen layout of Formroid shown in Figure 3. A virtual agent is placed in the middle of the screen, speaking each question to a respondent. The speech is also shown in text in the above balloon. The choices for the question appear in the right side, where each choice is represented as a button. To answer the question, a respondent speaks a choice, clicks a corresponding button, or touches the button when a touch-screen display is available. The left side of the screen enumerates option tools, by which the respondent can configure Formroid. The configurations include appearance of the virtual agent, camera angle, screen magnitude, etc.

D. Scenes for Questionnaire Survey

The behaviors of Formroid are constructed by scenes. A scene is a building block of Formroid which defines how the virtual agent interacts with the respondent in what order. The current version of Formroid is built by the following scenes:

(Scene 1) Introduction: The virtual agent greets the respondent, and tells simple instructions.

(Scene 2) Check name and date: The virtual agent checks respondent’s name and the date of survey. If incorrect, the respondent tells the correct name and date.

(Scene 3) Choose survey: From the form database, Formroid obtains a list of surveys that apply to the respondent. Then, the virtual agent asks which survey the respondent wishes to answer. The respondent chooses one, and then the virtual agent confirms if the respondent is ready to start.

(Scene 4) Start survey: Formroid retrieves the JSON data of the selected form from the form database, then extracts the set of questions. The virtual agent tells to start a survey session.

(Scene 5) Ask questions: For each question, the virtual agent speaks the question, and shows the choices in the screen. The respondent answers the question by speaking the choice that applies, or click (or touch) the corresponding button. Formroid records the answer for the question. During the interaction, the virtual agent presents some reactions with animated motions, based on the progress of the survey and the previous answer. The reactions are, for instance, “Great! You reached 10th question.”, “Cool! you have done half of the survey!”, “Good job! Keep going!”. These reactions are intended to encourage communication that increase the respondent’s engagement.

(Scene 6) End survey: When all questions are finished, the virtual agent tells to end the survey. From all the recorded answers, Formroid constructs answer data in the JSON format, and posts the JSON to the answer database.

(Scene 7) Epilogue: The virtual agent appreciates the respondent’s effort of the survey, and closes the survey session.

In order to achieve a survey session personalized for each respondent, Formroid dynamically creates the above scenes. More specifically, for each of the above scenes, Formroid manages a scene template, where some parts of the scene are open variables. Based on given respondent’s name, date, and the designated questionnaire survey, Formroid assigns concrete values in the variables, which constructs a personalized scene during run-time.

III. Prototype Development

We have implemented a prototype version of Formroid. Technologies used for the prototype are as follows:

- **Language:** C# 7.2
- **Scene Engine:** Unity Personal 2018.2.8f1
- **Agent 3D Model:** Renderpeople Free Rigged Models

We used Unity [7] to implement the scenes of Formroid, since Unity has powerful toolkit for manipulating 3D/2D objects and sounds. It also has a variety of assets, which are ready-to-use data resources. In the prototype, we borrow a free asset of 3D human model for the avatar of the virtual agent. It is easy for Unity to replace the 3D model with another. This means that we can easily change the avatar of the agent.

IV. Preliminary Experiment

In another project of our research group, we are investigating the relationship between daily habits of one-person household (OPH) and the quality of life (QoL) [10].

Currently, we are conducting an subjective experiment recruiting students living alone. In the experiment, the daily habits of each subject at home are monitored automatically by our environmental sensing and indoor positioning system [11]. As for QoL, since every subject has his/her own sense of value, we use well-known questionnaire surveys SF-12 [8] and SF-8.
Every subject is instructed to perform self-assessment of QoL, and to submit SF-8 every day, and SF-12 every week. To facilitate the surveys of the subjects, we have introduced the prototype of Formroid. About three weeks have been passed since the experiment started. As for the usability of Formroid, we received positive feedback for the moment. However, we need more data to prove its effectiveness. Thus, the detailed evaluation of Formroid is left for our future work.

V. CONCLUSION

We presented a novel system, called Formroid, which facilitates answering online questionnaire surveys with the virtual agent technology. This paper addressed design issues and prototype of Formroid. We also introduced an experiment, where Formroid was used for questionnaire-based assessment of QoL. We are currently refining the implementation, taking other possible use-cases and feedback into consideration.

Our future work includes elaborate evaluation to clarify the advantage and limitations of Formroid. Especially, we are interested in impression and mental bias introduced by Formroid, compared to the conventional online or paper surveys.

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