Crowd Naturalness Driven Mobile Cognition Scheme in Human Computer Interaction Dialogue System

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Abstract —In order to improve the quality and efficiency of the system, we proposed a mobile cognitive mechanism based on crowd. In order to meet the users and complete tasks in real time, based on the intelligent interaction of human and machine, the dialogue system can be adapted to the work situation and the allocation of resources. In addition, in order to meet the needs of intelligent interactive dialogue system, we give a method for computing the natural degree of human computer interaction in time domain and spatial domain. Based on the natural degree of crowd, a mobile cognitive mechanism is proposed, which is suitable for the interactive dialogue system. Simulation results verify the effectiveness and feasibility of the proposed scheme.

Index Terms—Human computer interaction, naturalness driven, crowd mobile cognition, dialogue accuracy

I. Introduction

Mobility management and resource scheduling in mobile cognitive [1] can be perceived by users and dialogue tasks in real time. Mobile cognitive technology can effectively improve the efficiency of human-computer interaction [2] and dialogue quality. However, how to integrate mobile cognitive technology into the human computer interaction system [3]. How to effectively merge mobile cognition with system dialogue [4]. These 2 issues have become the key factors that restrict the working efficiency and the accuracy of the [5] man-machine interactive dialogue system.

The relationship between the communicative goals of an utterance was explored and the salience of specific word classes was presented for each speech act [6]. Based on the review of learning theories and insights gleaned from prior research on intelligent tutoring systems, the functional architecture was described [7]. A fusion approach was developed based on psychological factors to recognize Interaction Style in spoken conversation [8], which plays a key role in creating natural dialogue agents. Skowron M *et al.* [9] presented an integrated view on a series of experiments conducted with an affective dialog system, applied as a tool in studies of emotions and social processes in online communication.

A fuzzy cognitive map denotative model was presented by Mei S *et al.* [10] to describe how the factors of individual emotions and cognition influence each other. A novel credible crowdsourcing assignment model was proposed based on social relationship cognition and community detection [11].

A new foundation with the distributed cognition was studied in article [12] for human-computer interaction. The authors of article [13] researched the human computer interaction based on the hand gestures of human. The overlap between human-computer-interaction and sense of agency was explored in article [14] for computer input modalities and system feedback, computer assistance, and joint actions between humans and computers. The authors of article [15] addressed issues of automatically detecting significant dialog events in naturalistic HCI, and of deducing trait-specific conclusions relevant for the design of spoken dialog systems. The touch screen gesture interaction and voice interaction was developed and used on the mobile terminal applications for studying the principles of human-computer. The authors of article [17] provided an overview of reconfigurable radio and small cell technologies, then introduce the tentative network architecture for 5G. A novel central cognitive structure for broadband Air-to-Ground communications is established in article [18].

Therefore, based on the crowd human computer interactive dialogue system, we conducted the crowd naturalness driven mobile cognition scheme for improving the quality and efficiency of the system.

The rest of the paper is organized as follows. Section 2 shows the crowd human computer interactive dialogue system. Mobile crowd naturalness driven cognitive was discussed in Section 3. The experimental results are shown in Section 4. Finally, Section 5 concludes this paper.

II. Crowd Human Computer Interactive Dialogue System

In order to satisfy the users' requirements and complete tasks in real time, the scheduling situation and resources allocation must be adapted to the man-machine interactive dialogue system. In the process of adaptive scheduling and distribution, how to establish an intelligent user service model between the user and the virtual machine is the key to realize the intelligent human-computer interaction dialogue system.

The working condition and the level of the interactive dialogue system would be changed in real time. Because

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of the randomness and the jitter of the user's spontaneous behavior, there is a delay in human-computer interaction. Because of the diversity of data resources and heterogeneity, the quality assurance of interaction is difficult.

We designed three crowd modules in the human computer interaction dialogue system. They are crowd users, neighborhood crowd perception and interaction crowd dialogue. The intelligent level of human computer interaction dialogue system depends on the degree of integration of the three crowd models. Crowd user model is used to capture the user's existing knowledge level. Neighborhood crowd sensing model is used to real-time schedule system resources. Interaction process would be optimized by the interactive crowd dialogue model. Based on the change of interactive dialogue, the model is fused with the crowd user and the neighborhood crowd sensing model. The model can improve the working efficiency of the system and adjust the performance of the system.

The crowd system and the perceptual structure of the intelligent interactive dialogue system are shown in Fig. 1. The logical description of the three crowd modules is as follows:

Crowd user model: through interaction with the user dialogue, this model can listen and access to the user's knowledge level, as well as get user matrix UA (knowledge).

Neighborhood crowd sensing model: this model can real time schedule resource and obtain the resource matrix RA (session).

Interactive crowd dialogue model: this model can realize the organic integration of crowd module and obtain the matrix CDA (dialog) of crowd dialogue.

Here, the organic integration of the three crowd modules refers to the integration of UA and RA, UA and CDA, RA and CDA.

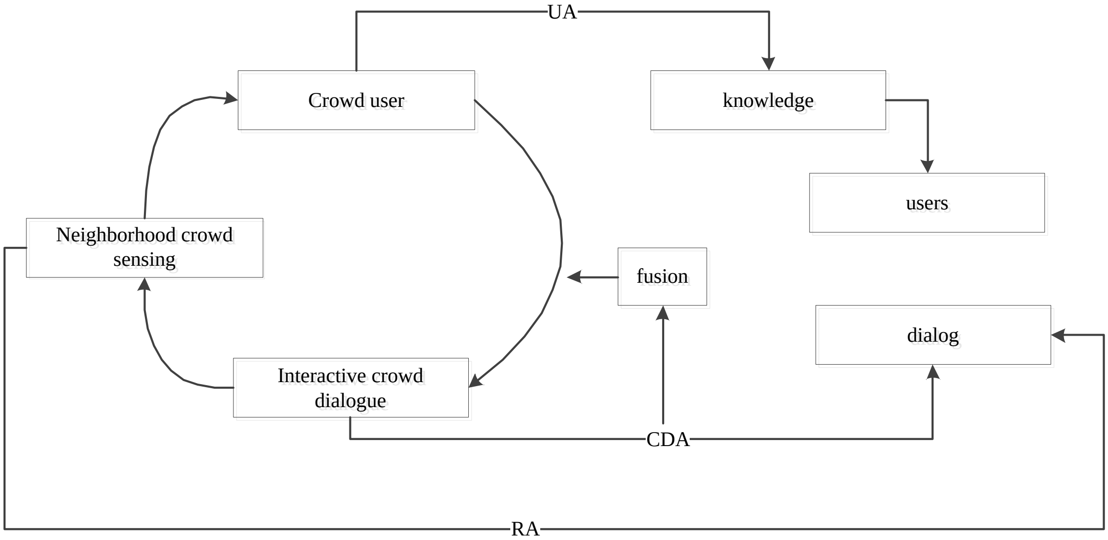

Fig. 1. crowd and sensing architecture.

UA, RA and CDA crowd scheme are given as follows.

(1) UA crowd scheme
1: Listening
 a: Obtain the knowledge of users
 b: Crowd processing this knowledge
2: Evaluation
 a: Obtain the matrix UA(knowledge)
 b: Evaluate the level of knowledge
3: Fusion
 a: To RA
 b: To CDA

(2) RA crowd scheme
1: Scheduling
 a: Obtain the requirements of users interaction
 b: Crowd processing this requirements
2: Neighborhood sensing
 a: Obtain the matrix RA(session)
 b: Sensing the set of neighborhood with session
3: Fusion
 a: To UA
 b: To CDA

(3) CDA crowd scheme
1: Interaction
 a: Obtain the sequence of users dialog
 b: Crowd processing this dialog sequence
2: Crowd fusion
 a: From UA
 b: From RA

III. Mobile Crowd Naturalness Driven Mobile Cognitive

In general, the natural degree of human-computer interaction is the number of data units of the user dialogue system in the unit time. The natural degree is the ratio of the number of conversations in the system and the user's dialogue in the unit space. The natural degree L_N can be obtained by the formula (1).

$$L_N = \begin{cases} \sum_{t=1}^{T} RA\left(t_{dialog}\right) \\ \dfrac{\prod_{t\to T} N_t\left(dialog\right)}{\sum_{j\to S} N_{dialog}\left(j\right)} \end{cases} \tag{1}$$

here, N_t(dialog) identifies the number of system dialogue in the time domain. N_{dialog} (T) is the number of users in the airspace. Symbol T represents the upper bound of the time domain. Symbol S represents airspace ceiling. In order to satisfy the perceptual demand of the intelligent interactive dialogue system, we improved the formula (1) to calculate the crowd degree of human computer interaction dialogue. The classification scheme is shown in Table I, which shows the object, formulation and requirements of classification scheme.

TABLE I: THE CLASSIFICATION SCHEME OF NATURAL DEGREE

Object	Formulation	Requirements
RA⊕UA	$L_{N1} = \dfrac{\sum_{t=1}^{T} RA\left(t_{dialog}\right)}{T}$	Time
RA⊕CDA	$L_{N2} = \dfrac{S}{\sum_{j\to S} N_{dialog}\left(j\right)}$	Space
CA⊕CDA	$L_{N3} = \dfrac{\prod_{t\to T} N_t\left(dialog\right)}{\sum_{t=1}^{T} RA\left(t_{dialog}\right)}$	Intersection of time and space
RA⊕UA⊕CDA	$L_N = \dfrac{L_{N1}+L_{N2}+L_{N3}}{S\oplus T}$	fusion of time and space

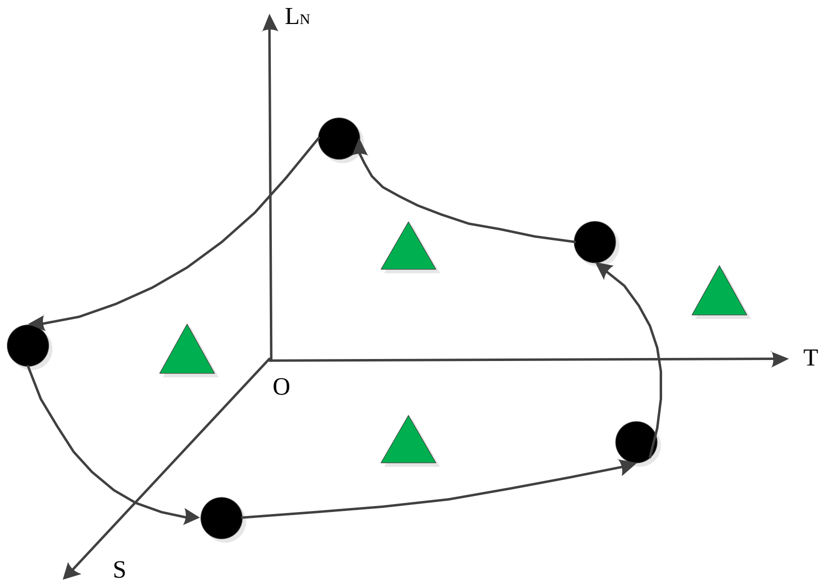

Fig. 2. Crowd driven mobile cognitive mechanism.

Fig. 2 shows the three-dimensional model of crowd naturalness driven mobile cognition with time, space and nature. Here, the circle represents the prototype of human-computer interaction, the triangle represents the neighborhood. A human computer interaction dialogue track consisting of circles maybe affected by the triangular. But it can eliminate the interference and utilize the neighborhood perceptual set through crowd processing. This can effectively improve the quality of human-computer interaction. The time utilization rate of S_E and the space utilization rate of T_E of the mobile cognitive mechanism driven by the crowd nature degree can be obtained by the formula (2).

$$\begin{cases} T_E = \dfrac{\sqrt{4L_N \sin\alpha}}{\gamma T} \\ S_E = \dfrac{e^{L_N}}{S^{\gamma}}\left[\dfrac{\prod_{t\to T} N_t\left(dialog\right)}{N_{dialog}\left(T\right)}\sin\beta\right] \end{cases} \tag{2}$$

here, parameter α is the angle between the circular point and the triangle point in the direction of nature. Parameter

β is the angle between two adjacent triangle points in time domain in Fig. 2. Parameter γ is the trace length of a dialog consisting of circular points. Parameter e^{L_N} is crowd weights of natural degree. Parameter S^{γ} is the degree of fusion in the airspace.

IV. Experimental Results

The proposed crowd naturalness driven mobile cognition scheme denoted as CNDCS and adaptive resource scheduling based on the cognitive mechanism denoted as ARSC are simulated and evaluated with NS-2. User interaction data is a video segment. There are 10 different users in this video. The video time length is 20 minutes. There are 31000 video frames. The experimental time is 1200 seconds.

Under the different number of concurrent users, Fig. 3 and Fig. 4 present the analysis results of man-machine interactive recognition accuracy with the video frames. From Fig. 3 and Fig. 4, we found that the increasing of concurrent users makes the quality of interactive dialogue recognition drop. The increase of video frames makes the interactive dialogue serious recognition accuracy jitter. However, CNDCS can eliminate the jitter and improve the accuracy by the crowd user model, neighborhood crowd sensing model and interactive crowd dialogue model.

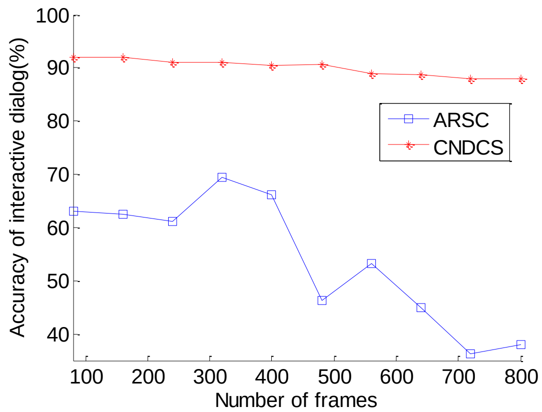

Fig. 3. Accuracy of interactive dialog with 2 concurrent user.

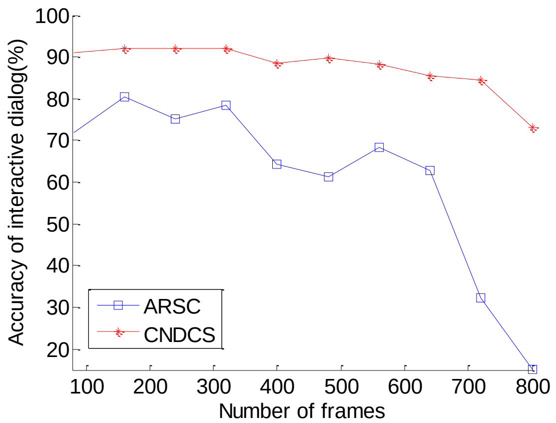

Fig. 4. accuracy of interactive dialog with 3 concurrent user.

The time variation of the recognition outage probability in the interactive dialogue process is shown in Fig. 5 and Fig. 6. Because the CNDCS has the three-dimensional model architecture in mobile cognitive mechanism driven by the crowd nature. By crwod processing, CNDCS can eliminate the interference in time domain and spatial domain. CNDCS can effectively improve the quality of human-computer interaction and reduce the identifying outage probability by using the neighborhood sensing set. From Fig. 7, we can see that the space utilization rate of ARSC is 2 times of CNDCS algorithm. This is due to the crowd driven mechanism of CNDCS.

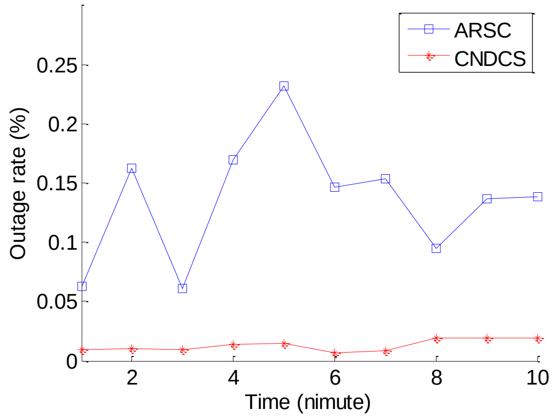

Fig. 5. outage rate with 2 concurrent user.

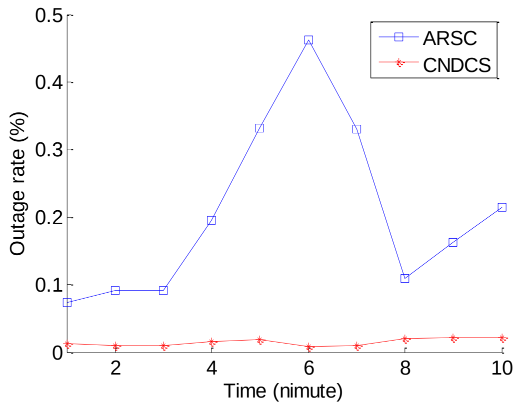

Fig. 6. outage rate with 3 concurrent user.

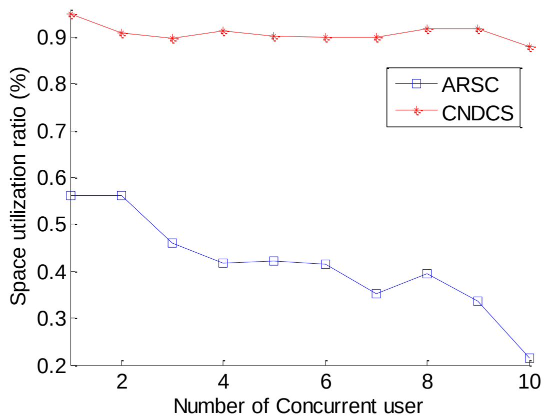

Fig. 7. Space utilization ratio.

V. Conclusions

Aiming at the problem of low accuracy and low efficiency of human-computer interaction dialogue system, we proposed a mobile cognitive mechanism based on the crowd naturalness driven scheme. On the one hand, based on human computer interaction, the mechanism of dialogue system can schedule the work situation and the allocation of resources adaptively. This can satisfy the requirements of users in real time and complete the dialogue task. On the other hand, we give a method for computing the natural degree of human computer interaction in time domain and spatial domain. At this point, the human-computer interaction dialogue system can accurately perceive the user requirements. On the basis of the above, based on the crowd natural degree, a mobile cognitive mechanism is proposed, which is suitable for the man-machine interactive dialogue system. Simulation experiments are made to compare the cognitive mechanism of the proposed crowd mobile identification scheme and the adaptive resource scheduling scheme. The results show that the proposed scheme has high recognition accuracy, low outage probability and high space utilization.

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