Research on intelligent service of customer service system

Jinji Nie | Qi Wang | Jianbin Xiong

Guangdong Polytechnic Normal University, Guangzhou, Guangdong, China

Correspondence
Qi Wang, Guangdong Polytechnic Normal University, Guangzhou, Guangdong, China.
Email: aotomoq@ sina.com

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Abstract
With the development of the wireless network, from 4G network to 5G network, people's communication quality has improved significantly and the processing requirements of operators' customer service systems will ameliorate, whereas the business undertaken by the intelligent network becomes more difficult. Customer service system, which can convey files and video, has evolved from manual to intelligent. At the same time, this system establishes a knowledge base based on the process of solving problems with customers. The customer service system can also undertake the task of process control within the enterprise. The ultimate goal is to understand the needs of customers through the knowledge base and develop corporate products based on customer data. Furthermore, this study proposes a network architecture of an intelligent customer service system to provide a reference for the construction.

1 | INTRODUCTION

On 4 December 2013, China's three major operators obtained 4G licenses. On 6 June 2019, the Ministry of Industry and Information Technology issued 5G network licenses to the three major operators and the China Broadcast Network. The 5G commercial package was launched on 1 November 2019, marking the official launch of the 5G network. The new generation networks which had shorter delays, faster transmission speeds, and more real-time products appeared in people's lives in the future. As a result, operators' customer service systems will be under pressure.

The traditional data management model of the communications industry needs to be innovated. As the management of big data, the management of data is rooted in the application of data operations and algorithms. It's necessary to mine the complaint information, consultation information from user. What's more, the data acquired on the system needs to be tapped for commercial value, which may determine the company's future development speed.

Currently, the operator's customer service system mainly communicates information with customers through online methods, which are mainly divided into four categories [1–3]. The first type is the call centre [4], which implements user consultation information through telephone, such as 10086 and 1000. The second category is online customer service robots [5] which use customer service robots instead of customer service to record questions and answer the questions through extracting matched answers in data base automatically, such as operator web version robots. The third type is automatic question-and-answer system [6]. It can read the question with natural language, analyze the questions based on information retrieval technology, and obtain concise and accurate answers. The fourth category is an instant messaging customer service system [7], which uses chat tools and other channels to establish information exchange channels with users that have been successful in marketing applications, such as QQ and Alibaba. From hotline, APP robot service to WeChat platform robot service, the customer service system has been developed to a certain extent. However, this process requires more manual processing of information. In order to reduce the work intensity of people, the intelligent customer service system comes into being. With the emergence of the internet of things (IoT) and cloud services, a new generation of customer service system should be able to unify service interface, large data analysis ability, and the access ability. Furthermore, it not only gets access ability and intelligent interaction to solve the problem of the user dynamically, but also helps the enterprise to establish personalised customer service.

Regarding the current customer service system, document [8] provides a general development trend of the customer service system under 5G technology. However, it does not describe the process execution flow of the customer service system. Many optimised methods are proposed for access and...
run the customer service system. For example, in [9], an outbound call system that can be integrated with the web and a way to expand the outbound call system for seats are proposed. In [10], it proposes a multichannel access, unified and comprehensive customer service system which provides a unified interface to facilitate user information management. Based on the video-streaming technology, the authors in [11] propose the technology of video access to customer service system, and described the processing of its video data, but did not propose the function of interacting with the user terminal to generate data. In [12], a global traffic manager, global load balancing method for the remote active-active system of the customer service centre is proposed, which ensures the diversion operation of the customer service system based on the data distribution method.

In [13], the knowledge base is introduced into the customer service system, so that the information obtained by the outbound system can be classified, collected, and stored, and the data can be updated. The data processing of the knowledge base is an important part of solving the service efficiency of the customer service system. In order to accelerate the ability to modularised customer service messages, a proximity algorithm is applied to design a calculation model for sentence similarity which is based on the same factors of the word vector in [14]. In [15], the method of applying the knowledge graph library to manage the data of the knowledge base which help the customer service system of the scene automatically answers the question and graph customer's information. In [16], a deep confidence-enhancing network ensemble classification model is proposed, which provides an exploration of data network classification base on neural network. It can achieve better feature expression based on unsupervised learning or supervised learning in the process of feature learning. In [17], a structured speech technology is applied to deal with speech recognition problems. However, it cannot be better trained when the amount of data increases. Ref. [18] provides a research on the user complaint prediction model based on deep learning, which is an algorithm structure that needs to be based on user-side data collection and classification. Besides, deep learning and neural network are summarised in [19,20]. It pointed that the shallow and deep learners are distinguished by the number of network layers, and explained supervised learning, unsupervised learning, reinforcement learning, evolutionary computing, and deep coding network in detail.

The development of the customer service system and the knowledge base algorithm is ultimately used to facilitate enterprises, mining user needs, and striving for good returns. In [21], the influence of the customer service system with multichannel information on the company’s operations was studied, and the self-service channel supported by information technology (IT) was used to supplement the information of the customer service system. In [22], a dynamic model is proposed to construct a customer service system, and through simulation and analysis of key factors affecting the operation of the customer service system, accurate information can be obtained. In [23], the concept of IT service management is introduced, and the core standards and strategies of information technology infrastructure library (ITIL) were applied to the customer service system to satisfy customer's personalised services.

2 | PRELIMINARIES

The knowledge base is a data centre, which is based on graphs to construct a number of structures and is one of the basic technologies for intelligent services such as semantic search and intelligent answering. Building a knowledge base requires a large number of structured and unstructured data sources. It can obtain entity relationships from them, including concepts, corresponding entities, application scenarios, relationship recognition, data aggregation, etc. The knowledge base is stored in the cloud service network, and its data update is divided into two steps. The collection is based on the user's demand and the enterprise solution forms two different types of object-oriented databases. The two databases have an association relationship. The combination of the two databases will be suitable for user demand mining and enterprise program formulation.

The knowledge base should form modular knowledge groups according to the application domain, background characteristics, attribute characteristics, etc. For a certain problem, the policy, rule, and fact are given with confidence label, and the determinative measurement is made which is stored in the extensible knowledge base. A high degree of confidence is given to determine solution, and this part is stored in the typical knowledge base as an affirmative solution to the problem. In order to construct the logical model of the system, we have to conceptualise knowledge, determine the division of knowledge types between concepts, and determine the control flow and constraint conditions. The application of the knowledge base can put knowledge group and information in order, thus accelerating the information flow of the knowledge groups. It also helps enterprise to realise the cooperation between employees and the management of customer information.

The voice recognition system needs to be built with an intelligent voice system that includes voice recognition judgement, the function of noise elimination, and transforming speech input into text. According to the translated text content, the knowledge base is searched and the corresponding content is extracted and pushed to the user. The intelligent voice system needs to include general used languages and the language characters converted into the interface are set according to the system design. The language of the interface is divided into the text on the user and the text showing the customer service staff, which ensure people with different native languages can communicate and reduce the communication cost between the user and the customer service staff. In addition, the speech recognition system should have the image recognition function, which extracts the characters or numbers in the image according to the photos provided by the user. The knowledge base can locate the knowledge group of information according to the translated speech and text information, and then push it to the user to choose the content.
The knowledge base and voice recognition system can be constructed using models such as machine learning and deep learning, which can sort, update, and analyse data content. The data set of the voice recognition system is a continuously updated database based on voice recognition and image recognition. Its function is to clearly obtain the information expressed by the user. The knowledge base updates the information according to the text information obtained by the voice system which comes from the user. The two systems need to generate data linkage processing to achieve data flow, while the intelligent customer service system is an interactive system. These two systems are able to adopt similar algorithms to manage information for their data sets and knowledge bases. It is recommended that the presentation of the intelligent customer service system is as concise as possible, and the operation ensures that the system is effective and as simple as possible.

3 | RESEARCH ON INTELLIGENT APPLICATION OF CUSTOMER SERVICE SYSTEM

3.1 | Implementation process of customer service system

The operation of the user should be as simple as possible to facilitate the user to obtain the input content. It can be used to call the customer service hotline directly or consult through the app interface [24]. Figure 1 is the execution flow chart of the customer service system. The execution flow chart of the customer service will be explained in detail.

3.1.1 | The first step

The voice interface or text window of the customer service system. If it is a voice interface, users need to select the language according to their own voice characteristics, so that the voice system can convert voice to text according to the translation rules of the corresponding language. After the system successfully obtains the text content of the user’s voice recognition, it calls the corresponding text content knowledge group from the knowledge base, and at the same time transfers the user to the robotic customer service, which will receive the reception and perform the skill conversion. If the user is satisfied with the robot customer service reception and the answer to the question, the one-time telephone customer service is completed. If the user selects the text window, the knowledge base calls the relevant knowledge group according to the text content entered.

In this process, the content pushed by robot customer service is text or video, so the user must install corresponding App to receive the corresponding content, which can be pushed for large interactive platforms such as the WeChat platform. After the user’s voice problems are converted into text, the data in the knowledge base will be recorded in the knowledge base at the same time, and the data statistics will be generated. The record is used for the follow-up user demand analysis and in-depth learning of user needs.

3.1.2 | The second step

If voice recognition system or robot customer service cannot solve the customers problem, a voice recognition system or robot customer service will be transferred to manual customer service for processing. At this time, the manual customer service transfers the knowledge base data manually. After digesting the user’s personalised needs, the corresponding data group content is extracted to provide solutions to the problems raised by users.

In this process, it can help to obtain the general description quickly for the user’s voice problem through converting it to text which needs to supplement the unrecognised voice content or the problem that the customer has not solved by human customer service. In the process of supplement, the human customer service can establish a file transmission channel or a video channel with the user when the voice channel has already been generated. Let the user pass language analysis through picture display, video display, text display, etc. A comprehensive description

![Figure 1](image-url)
of the question is no longer a pure speech description, but a combination of pictures and texts which makes the question more readable and the answer more acceptable. According to the content information provided by the user, the system records it in the knowledge base and uses image recognition or deep learning of the knowledge base to record the corresponding data group on the knowledge base and increase the data generalisation among different problems. The operation of calling the knowledge base and the operation of manual customer service will also be incorporated into the corresponding data to update the knowledge base.

3.1.3 | The third step

If manual customer service cannot solve the customer's problem timely for the user, it needs to ask the staff in the relevant field to solve it. The manual customer service will record the problem in the customer service system, and the internal work order scheduling system will carry out the dispatch work which can find the corresponding handler for processing.

Most of the user's upgraded complaints are caused by the failure to get a reply in time or without a reply. After entering the scheduling system, the user's problems will be handled by using the project management mode, which mainly depends on the time sequence. The manual customer service needs to urge the staff in the corresponding field to follow up the problem at the time point when the user negotiates the question response. After the processing time reaches the deadline, the knowledge base will update the corresponding problem work order in the knowledge base according to the processing result replied by the processing personnel. At the same time, it will trigger the text information and push it to the user actively. If the problem cannot be solved or cannot be solved in a short time before the deadline, the manual customer service shall negotiate with the processing personnel for the solution, and reply to the user by voice dialling.

After a new problem is solved, it will be updated to the knowledge base as a new data. The knowledge base keeps, learns, and classifies dynamically. If a user raises a similar question, the corresponding data in the knowledge base can be transferred. The results and processing time of similar problems make the knowledge base continuously improved, which can be used for data transfer of project management [25]. The project management system analyses the cost and input resources during the processing of the knowledge base. The enterprise can manage the corresponding project and run a dynamic data monitoring mode.

3.2 | Composition mode of customer service system

The new generation of customer service system mainly consists of three parts: outbound call system, enterprise internal management system, and knowledge base. As shown in Figure 2.

3.2.1 | Outbound call system

The outbound call system consists of a voice recognition system and a communication system. The voice recognition system needs the support of an intelligent voice system [26]. In addition to providing sufficient voice recognition functions, it also needs to aggregate data, a search function, and be able to extract data from the knowledge base information. The speech recognition system has a database of major languages, including Mandarin, English, Cantonese, etc. The communication system is mainly used to establish different communication channels with users. It can communicate through multiple channels [27]. It adopts an asymmetrical way and breaks the customer service outbound system that uses text or voice communication alone. The use of a communication system with a voice module, a video module, and a file
transmission module achieves a full range of listening, viewing, and communication methods, making the communication between the customer and the manual customer service smoother and reducing the time cost of communication.

The voice recognition of outbound call system generally encounters the problems of colloquialization and semantic irregularities. Spoken language refers to the formal language expression habits of customers for a long time in their daily life, and even regional things. Semantic irregularities refer to the irregularities of the chat corpus, such as missing subjects, grammatical errors, etc. The omission of the subject is generally due to the situation where the context already has a description. Grammatical errors in spoken language are mainly caused by the order of sentence components. Therefore, the recognition accuracy can be improved by recognising the user's question and the specific scene. The omission of the subject is generally due to the situation where the context already has a description. The grammatical errors of spoken language are mainly caused by the order of sentence components. Therefore, the accuracy of recognition can be improved according to the questions and scene analysis of the user's consultation. In other words, a continuous word sequence is recomposed according to certain specifications to construct a word sequence. It scans the phrase through the prefix dictionary, constructs the vocabulary composition according to the frequency of its use, and uses the maximum path probability path to find the optimal phrase combination. For the processing of big data text, the speech recognition system also needs to include Chinese and English word segmentation, entity extraction, keyword extraction, semantic extraction, text classification, semantic depth expansion, automatic phonetic notation, text clustering, etc.

The extraction of the picture content is also based on semantic recognition. It can obtain the main text information on the picture. The customer service has been connected to the manual customer service. The main task of the manual customer service is to read the text information of the customer service and apply information to complete the text. With the access of video chat, the artificial customer service will be able to obtain the user sentiment analysis displayed by the video communication module. The sentiment analysis includes happiness, anger, sorrow, and joy. It allows the artificial customer service to deploy an emotional management plan, perform emotional analysis, and improve user satisfaction.

3.2.2 | Enterprise internal management system

Enterprise internal management system is mainly composed of a work order scheduling system and a project management system. The work order scheduling system performs intelligent scheduling based on the type of business described by the user's problem and the street agency where it is landed. If it is a tariff issue, it is transferred to the street market department for processing. If it is a group issue, it is transferred to the street government and enterprise department for processing. If the work order is repeatedly dispatched in the same link, the manual customer service will confirm the processing personnel of the work order. The problem work order which exists in this processing process will also be recorded in the knowledge base. If you consult with the customer, the customer service system can quickly locate the corresponding handler, reducing the time cost and flow process management of the same work order. If users consult similar events, historical processing records provide reference data and information, and corresponding process support.

The project management system can be used to record the labour cost, time cost, and capital cost of problem handling. The project management system is embedded in the customer service system, which can contact the actual needs of users from the front, update the project management model of the enterprise, and distinguish the processing methods of different projects and the methods of allocating resources.

By applying custom relation management (CRM) [28], the enterprise can adjust the project management plan. The core of CRM is user-centred. It is a new marketing strategy to realise the value of the enterprise by improving the user's information and analysing the user's needs in depth. It is also a strategy that takes IT as the media, takes the interests and expectations of customers as the core, and manages the relationship between users and enterprises to achieve the aristocracy of the interests of both parties and achieve a win-win strategy. This system can improve service quality, and specify enterprise management methods and user policies according to the knowledge base. With the support of the knowledge base, it not only can designate corporate management methods, but also can improve the quality of service. User strategies based on professional knowledge can improve the efficiency of the enterprise, reduce repetitive work, and improve the quality of work and marketing efficiency. In order to reduce costs, a large number of programs have been archived and stored in the enterprise management system which can be used for online learning within the enterprise.

The project management system adjusts the scope, cost, resources, risks, scope, and schedule of the project according to user expectations. When there is a temporary change in the project, it performs feasibility analysis based on the library information provided by the knowledge base. The most important thing in project management is schedule management, which can be in the form of key date tables, Gantt charts, etc. However, it is also the key point of the adjustment of the project management system that sets the stage time based on user's expectations, achieving real-time performance with the establishment of progressive goals.

3.2.3 | The knowledge base

The knowledge base is the core of the entire customer service system. The location in its network structure is stored in the cloud server room for centralised management of information. Due to its importance, it is necessary to develop a global load balancing method and set up redundant computer rooms to deal with emergencies. The knowledge base is actually a
collection of knowledge concepts and their interrelationships. Through organising and modelling, the discreteness and relevance of keywords are constructed to process the map. The knowledge graph is constructed based on the structure of topic words and keywords. It can locate the position of related knowledge points and the connections between them. The final composition is a noncollection of basic names, topic names, and ranking names. Associating different types, the function of subject terms will be more powerful, so different data aggregations can be established according to the type of association. Not only according to the context of the upper and lower, but also the degree of influence between different subject words will also affect the range display on the map.

Knowledge graphs need to study historical training samples, and complete automatic question and answer requirements through technical means such as lexical and grammatical segmentation, associated sequence mining, and question template classification. On this basis, we develop the scalability of the knowledge base, ensure the optimisation of the data set in the case of open source, and use attention and two-way connections to achieve the effect of natural language fuzzy recognition. We expand the amount of knowledge in the knowledge base, use the knowledge group stored in the history of the customer service system, and use the data mining model to achieve the effect of improving the answer to the question.

If the knowledge base develops to a certain scale, the edge gateway can be arranged to distribute the data of the knowledge base. The network location of the edge gateway can be installed in the outbound call system. The agent of the manual customer service can follow the close data collection terminal to solve the low-level data access and update. Furthermore, the knowledge base can have more space for data analysis and intelligent services.

### 3.3 Introduction of deep Boltzmann machine model

The data update of the knowledge base and the feature extraction of the data, and the management of the database need to be able to process according to different types such as data extraction, data processing, and knowledge base. The deep learning methods of the neural network are discussed [30].

Deep Boltzmann machine (DBN) belief network is an improved model based on neural networks [31]. It uses restricted Boltzmann machine (RBM) to construct an unsupervised deep learning model, which is based on a probabilistic image model. The basic deep learning model is also a generative model for obtaining the probability of high-level data represented by the training data in the hidden layer.

RBM is a kind of random neural network model with a two-layer structure with visible layer and hidden layer [32]. The layers are fully connected and there is no connection within the layer. It has the ability to provide a good initial value under the supervision of academia, and limit its beneficial weights based on the global training, and can hide binary numbers, and then propagates back to guess the probability distribution of the original input. Finally, the reconstruction results are compared with the original data to evaluate the reconstruction, and the first two steps are continuously repeated to make the mean square error small enough. RBM is good at processing unlabelled data. It can extract important features from the input, and make the dimensionality reduction effect is more effective.

As shown in Figure 3, the structure of a neural network contains the input layer, hidden layer, and output layer [19]. Each neuron receives the input from the previous layer of neurons and outputs the results to the next layer of neurons. There is no connection between neurons in the same layer. The

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**FIGURE 3** Neural network composition

**FIGURE 4** DBN model structure
input layer receives the external data, which is processed by the hidden layer and output layer neurons, and the output layer neuron operation result is the final output. The hidden layer learning process is to adjust the connection weights between neurons according to the input training data [33,34].

As shown in Figure 4, on the basis of this neural network, we can choose the integrated DBN model as the input layer and choose the deep promotion layer as the hidden layer, to construct the DBN model structure.

The integrated DBN model is divided into single DBN network construction and integrated DBN construction [19]. The single DBN collects the extracted features by individuals, while the integrated DBN centrally manages the extracted features by each individual and extracts the common features again. The number of different hidden layers and the number of nodes of different hidden layers need to be selected based on the optimal network structure. In order to maintain the diversity of feature extraction, the number of DBNs has a multiple relationship with the number of hidden layers.

The training steps of DBN [8] are as follows: Firstly, the input is used to train the first RBM model. Secondly, RBM uses observation samples to train and fix the model parameters of RBM. Thirdly, the output of low-level RBM is used as the input of high-level RBM for training. Fourthly, repeat second and third steps, train all RBMs repeatedly to realize the model parameters initialization. Finally, after determining the model parameters, the self-associated memory module of DBN uses self-labelled data to adjust all RBM model parameters through a bottom-up feedback learning method.

For the features extracted by the DBN model, the deep learning layer uses a cascade method for further deep learning and vectorisation. From the second layer, each layer is the vectorisation processing of the previous layer in which the information is fused and enhanced. Then, the information is passed to the next layer, and the current prediction accuracy and the variance of the learner are calculated to achieve the effect of data comparison, and perform the classification and generalisation of data features. Each time the deep-level boosting network is based on the inductive learning of the previous layer, the training is carried out by supervised learning, and the number of hidden layers is adjusted in an adaptive way. According to the data scale extracted by DBN, it is automatically adjusted, so it can depict complex data structures, and obtain high-level performance of the data. It gets probabilistic data output and more accurately understands the changes in the learning process.

Through the training data structure, we can obtain the weights of the joint distribution and the largest probability influencing factors that are close to the training sample, build differences between individuals, and achieve better learning results. The integrated deep confidence learning can improve the generalisation ability of the system. The adjustment of the adaptive [35,36] network layer improves its computing power by reducing the construction mode of the hidden layer.
3.4 Customer service system network building model

Figure 5 is a schematic of the intelligent customer service system network, including servers that require switches, routers, robotic customer service, manual customer service agents, processor computers, edge gateways, and knowledge bases. The network routing process from manual customer service agents to processors is ignored. This set of centralised management network equipment needs to be constructed in the same office location, except for handling personal computers.

The construction of the knowledge base server adopts a cabinet server and uses the open architecture of Intel architecture to ensure the scalability of the knowledge base. It is necessary to equip the computer room with a stable operating environment [37,38], such as temperature and humidity to provide stable operating power. Servers are electronic devices that are sensitive to temperature and humidity. Too much dryness can easily cause static electricity in the server, and too much humidity affects the speed of the device's operation or causes leakage. Similar to hardware, corresponding security policies need to be configured on the software system. The data source of the knowledge base is based on user feedback information and self-updating information within the enterprise. It contains a lot of trade secrets. Once leaked, it will have an immeasurable impact on the enterprise and user groups. Therefore, the security strategy should contain the information security of the knowledge base, network information security, hardware security, and network access security. The functional areas that are deployed need to contain network interconnection area, application area, core data area, and storage area. Only by ensuring the safety of its operation the equipment works efficiently and the stability of the knowledge base improves.

In order to perform cloud computing more efficiently, the concepts of edge computing and edge gateway are proposed. The edge gateway has the ability to support distributed computing and storage, and can manage distributed resources [39]. Decisions need to be made by sharing data and calculations between edge devices, which can help divert the work of the knowledge base, reduce excessive information access, filter unimportant information, and retain important knowledge group data. The edge gateway serves as the access node of large-scale distributed equipment. Task scheduling can realise the optimal configuration of resources and efficient load processing. It has the functions of data collection, equipment management, protocol analysis, edge computing, data transmission, and access to the knowledge base. For example, in manual customer service consultation, the edge gateway is designed between the knowledge base and the manual customer service agent. It can solve various computing tasks, including processing, storage, control [40], load balancing, and other functions. The edge gateway also has good scalability in the access of new devices, and can aggregate different types of devices, so as to realise the unified management of devices and the connection of the IoT.

The manual customer service agent adopts centralised management, which can cause noise problems. Therefore, the customer service handset and microphone need to have the function of noise reduction to reduce the noise problem. With the help of the outbound voice system, the manual customer service agent can clearly obtain the user's problems, and can know the user's real-time emotions, change the manual customer service's response strategy, and reassure the user in time. The centralisation of manual customer service agents can facilitate the management and control of enterprises. For the promotion of new policies and new products, the manual customer service group can be notified in time through meetings or announcements. The function of manual customer service is not limited to solving user consultation problems and data collection, and should allow it to develop personalised product design capabilities.

The robot customer service has the function of voice recognition, and the customer's access processing needs to be preprocessed by the robot customer service. The queuing machine sets levels and accesses to different customer groups according to the shortest time and optimal path. The level of the customer group can be set according to the communication package selected by the customer. The switches and routers in front of the robot customer service have general communication access and routing functions. These devices should have the ability to access and process large bandwidth.

4 CONCLUSION

This article introduces the intelligent customer service system and the updated functions. The methods of accessing the intelligent customer service system and the whole workflow are described. Based on the application of cloud service and IoT technology, the intelligent customer service system establishes a dynamically updated knowledge base and forms a management model dominated by the knowledge base. This study introduces the principle of the outbound call system, the enterprise internal management system, and the knowledge base, and also explains the network structure of the intelligent customer service system. In the intelligent customer service system, we propose personalised solutions for different groups of users by mining user information, so as to solve the personalised needs of users.

Combining with the information of the user and the enterprise, the manual customer service agent can design communication products for different reception user groups and hand them over to enterprise management. Only in this kind of science and technology can we realise the updation of the enterprise system and the realisation of service innovation.

However, an intelligent customer service system proposed requires a high server carrying capacity and a high network security policy. Neither of these two conveniences has been mentioned, so it can be used as a future research topic. The manual customer service agent system proposed adopts a centralised management model, which is inconsistent with the decentralised management model advocated by modern technology. Therefore, the research on decentralised management and network security performance is also a topic to be researched in the future.
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ORCID
Jinji Nie https://orcid.org/0000-0001-7669-4342

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