Information and Communication Technology as a Provider of Food Security: Design of an Expert System to Assist in Communication where Non-Audible Communication is Expedient

O. T. Jinadu and O. V. Johnson

***Abstract* - Information and Communication Technology (ICT) is the design, development and distribution of data, using computer hardware, software and telecommunication systems. To appreciate the impact of ICT on food insecurity, it is important to engage in technological designs that could provide solutions to enhancing the way people solve their problems. ICT has made it possible for simulations and modelling kits to be applied to the understanding and solution of major scientific and engineering problems. With this strategy, ICT has greatly facilitated communication because handicaps and even the able-bodied men could participate in secured information communication. There should not be any limitation to whatsoever food-related service they want since information technology acts as solution providers by providing ways of interaction for these special groups. For the physically impaired persons, especially the dumb and deaf, this paper, therefore, designs an expert system to assist them communicate in environments where non-audio communication is not possible.**

(Keywords: *Information Communication, Expert System, Knowledge Base, Language Model, User Interface)*

I. INTRODUCTION

Request for service is a mandatory exercise in food centres [4]. Guests must provide personal requests and other information before he or she could be attended to. It is therefore, highly desirable that information be communicated in manners that would make them free from all attacks of eavesdropping and tapping as remarked in [7]. In cases, where the receiver may not be able to audibly receive spoken words, the information must then be communicated in non-audible form.

For the physically impaired persons, especially the dumb and deaf persons, access to good and quality foods and food-related services are sometimes limited because of their inabilities. It was recorded in [3] that in hotel settings, individual registration processes involves several steps of collection of information including guest name, surname, address, expected services, method of payments and other specially made requests.

Availability of devices, such as an expert system, (ES) that could assist them communicate, employing their hand and eyes would therefore provide a kind of panacea to food insecurity in their own domain. There would therefore, no limitation to any kind of service requested because they would be able to communicate using the ES.

Since ICT has made it possible for simulations and modelling kits to be applied to the understanding and solution of diverse scientific and engineering problems as remarked in [2], the design of an expert system (ES) is implemented in this research to assist in all types of communication where audio communication is practically impossible.

II. MATERIALS AND METHODS

To appreciate the impact of ICT on food security for some of the physically impaired persons, it is important to engage in technological designs that could provide solution in enhancing the way these people solve their problems. For the design of the Dumb and Deaf Special Interface (DDSI) Expert Systems, the neural network model is implemented.

A. Architecture of the DDSI

The framework for the development and implementation of the DDSI is modelled by a neural network. Evolution in data processing and information communication has enable information to be classifiable as deterministic or probabilistic [1].

The major components of the neural network based DDSI are shown below.

The feed forward parallel architecture exhibited by the adopted neural network model effects robustness in the design.

Generally, Expert systems are intrinsically, knowledge based systems that are capable of handling uncertainties and optional for providing specific problems [6]. Insert to predicate logic was employed on common forward service clauses, expressions and terms to represent knowledge.

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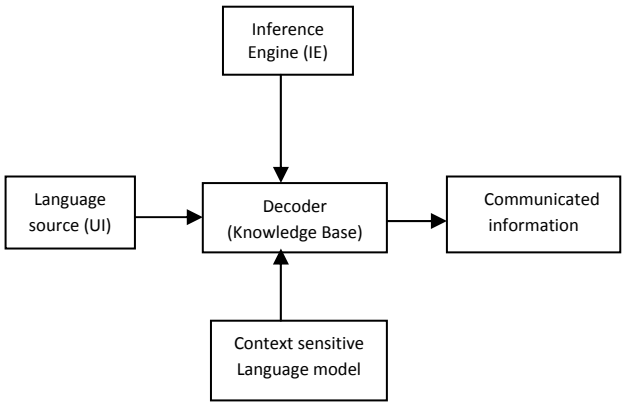

Fig. 1.1 Components of neural network modelled DDSI

These food language components were captured using the stochastic model as a testing speech *X*. *X* is classified as one of the menus, *M* of the training set using the Bayesian framework. Then, the approximation capability of the language model shown in equation (i) converges with the observation probability model expressed in equation (ii).

$$P(U) = \prod_i P(M_i \mid M_{i-2}, M_{i-1}) \qquad \text{.....(i)}$$

Stochastically, the observation probabilities of any utterance *U* is given as

$$\overline{U} = \arg\max_{\overline{U} \in U} P(X \mid U) \qquad \text{.....(ii)}$$

It is also opined in [8] that since the expert systems exhibit high performance, it serves as a useful tool for general reasoning and the neutral network model is equipped with enough architectural parallelism to make the developed system more tolerant to errors and imperfect knowledge.

B. Building the Vocabulary (Knowledge Base)

The knowledge acquisition tool employed in this research is identification of prototypes and idealized situation of a customer (dumb and deaf) requesting for special services in a hotel. Most of the suspected problems are converted into the facts used in this design to provide the required knowledge. This modelling simulates the statistical acoustic and language modelling employed in most neural networks for pattern recognition.

Since neural networks use simple algorithm to provide the essential useful data manipulation capabilities, the feature extraction methodology of distilling the required information in the knowledge base into a more concentrated and manageable form. Predicate logic was employed on common food service clauses, expressions and terms to represent knowledge. These food service communication language components were captured using a stochastic model as a testing speech *X*. This speech is classified as one of the vocabulary menu *M* of the training set as shown in equation (i) above. The probabilities of any targeted utterance *U* is given as simulated in the Baye's rule of equation (ii).

The neural model threshold logic for unipolar input $x \in \{0,1\}^n$ such that the input feature vectors $x_1, x_2, ...x_n \in \{0,1\}^n$ is perfectly mapped into a single two-valued output $y \in \{0,1\}^n$ on the application of a weighted sum function $f(x) = \sum w_i x_i$ on the binary inputs [5].

Mathematically, the sigmoid function is expressed as

$$S(x) = \frac{1}{1+e^{-x}} \qquad \text{.....(iii)}$$

and this sigmoid function performs the basic thresholding algorithm, which produces a value of one when $x > 0$, and a value of zero when $x < 0$ [7, 9].

$$S = \begin{cases} 1, x > 0 \\ \\ 0, x < 0 \end{cases} \qquad \text{.....(iv)}$$

The vocabulary was constructed using the facts of the identified problems and storing each of the required knowledge inferred as integers. This is an implementation of the knowledge base. This knowledge base is intelligent, dynamic and can be expanded. The knowledge base provides the training required by the neural network. The enlisted food menus, various service definitions and other customer-related interaction/dialogue styles commonly found with food industries (especially in hotel setups) were enumerated for easy computation and searching. Enumerated services include registration, choice menus, room service, billing among others.

C. Training the network

Measurements as search algorithms were implemented for training the neural network using the weighted sums (of the input and weight vectors) equipped with thresholding function to achieve supervised learning.

D. Designing the User Interface (UI)

To facilitate the conversation between any customer (dumb and deaf), a user-friendly interface (menu) was created in the algorithm to enable customers communicate naturally and efficiently. Using the exception handling capability of the system tool used, flexibility and mixed initiative style dialogue mechanism is provided via the keyboard of the computer system, where the expert system is installed.

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III. IMPLEMENTATION OF THE DDSI

To work out the logical consequence of all the rules in the knowledge base, a platform independent tool, C++ was adopted. Because the NN-modelled ES requires little information and can retrain itself with any current situation to take further decisions, an algorithm was developed to concentrate menus or services into requests or responses and display them as speech made by our targeted customers.

As remarked in [8], since neural networks do not require any thinking pattern to be specified, explicitly only two sets of data are required from the ideal customer – service relationship exhibited in any food joint. These are all the inputs to the system and the correct output corresponding to the input values.

IV. RESULTS AND DISCUSSIONS

The design under consideration showed the following results:

(i) A communicating model using a training data set to achieve supervised learning was developed. The network evaluates menus and associated services. These parameters are expandable.
(ii) The lexical tree search embedded in the learning algorithm finds the current menu or service requested using two or more previously menu/service searched, providing more efficiency in classifying.
(iii) The vocabulary of the training set designed using the *enumerated* data structure features made the developed ES flexible and adaptable, and the adopted platform enhances portability. This is shown in appendices I, II and III.
(iv) Any out of vocabulary menu or service is mapped to an out-of-vocabulary inputs/output as equally shown in appendix IV.

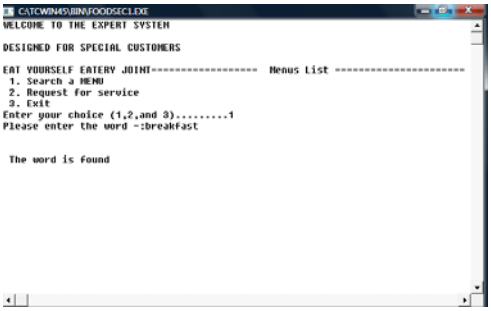
V. CONCLUSION, IMPLICATION AND FUTURE RESEARCH

The software expert system was implemented to assist in actualising an effective communication between customers and service points in food industries where non-audible communication is practically impossible. Therefore, required information for services, including request for choice menus, room services, billing etc is communicated in manners that such special requests are free from all attacks of eavesdropping and tapping. This expert system provides improved services to the handicaps and other guests of the food industry and it could be enhanced to accommodate customer registrations for hotel bookings, lodgements and payments even by able-bodied men.

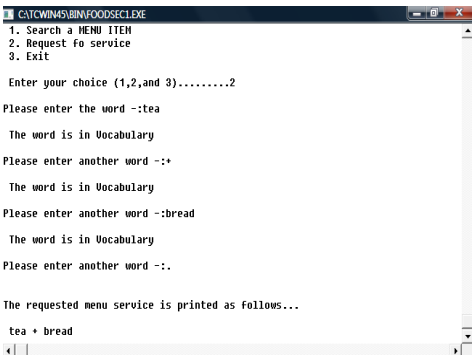
APPENDIX

Appendix I: Opening screen of DDSI

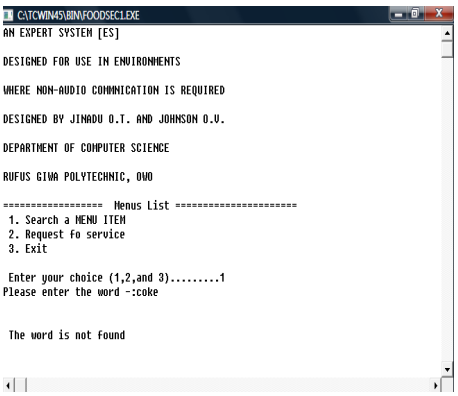
Appendix II: Request for a service of breakfast



Appendix III: Request for a menu of tea plus bread



Appendix IV: Request not granted due to out-of-vocabulary service and menu



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REFERENCES

[1] Akinyokun O.C. (2002), "Neuro-Fuzzy Expert System for Evaluation of Human Resource Performance". First Bank of Nigeria Plc Endowment Fund Lecture Series I, delivered at Federal University of Technology, Akure, Nigeria.

[2] Bar-Yam Y. (2005), "Making Things Work" available at http://necsi.org/publications/mtw.

[3] Ihekoronye A. I. and Ngoddy P. O.(1985) "Integrated Food Science Technology for the Tropics" pp 261-263.

[4] Kim L. (2001), "Dough Processing and Bread faults" Campden and Chorleywood Food Research Association, pp. 344.

[5] Madan M., Liang J. and Noriyasu H. (2003), "Static and Dynamic Neural Networks". IEEE Press, John Wiley & Sons Inc Publication, New Jersey, 1st ed.

[6] Schalkoff R. (1997), "Artificial Neural Networks", New York, McGraw Hill.

[7] Steven W. (1999), "The Scientist and Engineer's Guide to Digital Signal Processing" California Technical Publishing. San Diego, California, 2nd ed.

[8] Valluru R. and Hayagriva R. (2005), "C++ Neural Networks and Fuzzy Logic". BPB Publications, New York, pp 4-6.

[9] Wulfram G. and Werner K. (2006), "Spiking Neuron Models: Single Neuron, Populations, Plasticity". Cambridge University, University Press.

[10] Yuk D. (1999), "A Neural Network system for robust speech recognition in variable acoustic environments" Technical Report, CAIP Center, Rutgers University, January, 1999.

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