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Development of speech control for robotic hand using neural network and stream processing method

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Abstract

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Abstract

The purpose of this paper is to develop speech control for robotic hand using voice input. The voice signal acquired by microphone is processed in real time using stream processing for handling large amounts of data. The processed signal is recognized using Neural Network with tansig and softmax transfer function in hidden layer and output layer. The Network consists of 20 neurons in hidden layer. Eight frequency domain and five time domain features are employed in speech recognition system. The recognition results from ANN are sent to Arduino Uno to drive the robotic hand motion. Based on the experiment results, ANN can recognize the voice command with 95.9% in offline recognition and 90 %. in online real time recognition. The proposed of speech control system was also tested in noisy environment. The overall accuracy of speech control decreases 10 % in noisy environment. Speech control for robotic hand using stream processing method has been successfully developed. © 2017 IIJ.

Author keywords

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Development of Speech Control for Robotic Hand Using Neural Network and Stream Processing Method

Ismoyo Haryanto, Mochammad Ariyanto, Wahyu Caesarendra and Hadianto K. Dewoto

***Abstract*— The purpose of this paper is to develop speech control for robotic hand using voice input. The voice signal acquired by microphone is processed in real time using stream processing for handling large amounts of data. The processed signal is recognized using Neural Network with *tansig* and *softmax* transfer function in hidden layer and output layer. The Network consists of 20 neurons in hidden layer. Eight frequency domain and five time domain features are employed in speech recognition system. The recognition results from ANN are sent to Arduino Uno to drive the robotic hand motion. Based on the experiment results, ANN can recognize the voice command with 95.9% in offline recognition and 90 %. in online real time recognition. The proposed of speech control system was also tested in noisy environment. The overall accuracy of speech control decreases 10 % in noisy environment. Speech control for robotic hand using stream processing method has been successfully developed.**

***Index Terms*—Robotic hand, Speech, Neural Network, Feature calculation, Stream processing.**

I. Introduction

ARTIFICIAL neural network have been widely used in pattern recognition, nonlinear regression, and control system due to its performance result. In this study, the research will develop speech control of robotic hand using stream processing method based on artificial neural network (ANN). The neural network has been successfully implemented in speech recognition as studied in literatures [1,2]. ANN can recognize the speech recognition with good performance. The other common classification methods are Hidden Markov models as in [3], support vector machines [4], and dynamic time warping [5].

Feature extraction is one of the most important steps in speech recognition system. It extracts useful features from the raw data which can help the classifier to make decisions. The common features that are commonly used in speech recognition are Mel Frequency Cepstral Coefficients (MFCC) and Linear Predictive Coding Coefficients (LPCC). In this paper, thirteen features that have been widely used due to its performance in Electromyography (EMG) analysis are employed in this speech control of robotic hand.

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This paper will focus on developing a speech control of robotic hand using stream processing method. Stream processing is employed to handle large data that comes from acquired speech command. One of common challenges in speech recognition is the noise. In order to reduce the effect of noise, the sound from noisy room is recorded and added in data input for training data in neural network. The robustness of proposed speech system will be tested in quiet and noisy room.

II. Feature Calculations

In this paper, thirteen features which comprises of eight frequency domain and five time domain features is selected and utilized in this study. These features have been found in many literatures giving the maximum classification performance in EMG analysis [6-8]. The frequency domain features are MNF, MDF, PKF, MNP, TTP, SM1, SM2, SM3. The time domain features are LOG, DASDV, MN, WL, ZC. The features can be summarized in Table 1. In frequency domain, f_j is spectrum frequency at frequency bin j, P_j is the signal power spectrum at frequency bin j, and M is length of the frequency bin. In time domain, x_i denotes the voice signal in a segment i and N represent the length of input signal Final Stage.

III. Neural Network

Artificial Neural Network (ANN) is utilized in speech recognition system to recognize speech command from user. The general structure of ANN can be depicted in Figure 1. The structure of feed-forward ANN model comprises of three-layers of nodes. ANN is widely used to perform complex tasks such as control systems, pattern recognition, forecasting, identification, speech, and computer vision.

The first output neuron in hidden layer can calculated using equation (1) and the first output neuron in the output layer is defined in (2).

$$a^1 = f^1(IWp + b^1) \tag{1}$$

$$a^2 = f^2(LW(f^1(IWp + b^1)) + b^2) \tag{2}$$

Accelerating IIOT Adoption with OPC UA

Saju Eruvankai, Murugesan Muthukrishnan and Anantharamaiah Kumar Mysore

Abstract— In this new era of pervasive computing and anytime, anywhere information, manufacturing industry has rightfully evinced lot of interest in adopting internet of things in significant measure. Industrial IoT adoption offers immense value for manufacturing across the value chain for many functions like material tracking, production performance, in-line quality inspection, asset maintenance, and to churn out new innovative service models. The OPC UA standard provides interoperability in industrial automation by creating and maintaining open specifications that standardize communication of acquired process data, alarm and event records, historical data, and batch data to multi-vendor enterprise systems and between production devices. This paper details out the challenges faced during IIOT adoption in a typical Automation industry and provides an OPC UA based framework to resolve these challenges and demonstrates the application of this concept in a proof of concept implementation of an OPC UA adapter. The results indicated better performance, superior integration capabilities as compared to a traditional industrial protocol gateway.

***Index Terms*—OPC UA, IIOT, IT/OT Convergence, Data Analytics with OPC UA**

I. Introduction

Manufacturing industry is witnessing tremendous progress across the automation layers right from sensors to machines, controllers to machine systems, due to advancements in smart sensing, integrated electronics, communication technologies and development of micro/nano-electromechanical systems (MEMS/NEMS). This has led to Industrial Internet of Things (IIoT) initiative being a major component of Industrial 4.0 and Smart Manufacturing drive. Needless to mention these advancements will influence every industrial manufacturing domain be it process or discrete and calls for their calibrated adoption for creating and sustaining competitive market leadership.

The number of cellular machine-to-machine (M2M) connections in industrial automation applications is predicted to grow at a compound annual rate of 23.2 percent—from 2.5 million connections at the end of 2013 to about 7.1 million connections by 2018 [1]. With IoT devices projected to increase to about 3 devices per person in next five years, this domination of connected machines and sensor networks would only create more volume and veracity of data and the real challenge would be made to ensure accurate, real time visibility of the information for decision making and redefinition of the ecosystem. The information flows in industrial systems is increasing across all levels of the plant and the need is accommodate plant information for vertical, horizontal as well as across the lifecycle of production equipment [2]. It is indeed compelling the market players to acquire and create new business models to realize and tap the vast opportunities opened up by IOT.

However, there are significant concerns for adopting Industrial IoT solutions primarily around data security, reliability of data communication, interoperability and scalability. The concerns are primarily due to the fact that the hitherto employed proprietary interfaces for machine data collection, process systems, communication protocols with SCADA or their implementation might be exposed to vulnerabilities in an IIoT deployment scenario. Further the emergence of IT-OT convergence necessitates interoperability between Industrial devices. Devices also need to be programmed for firmware updates across its lifecycle and its access might need to be restricted based on the end user role and responsibility. Additionally the communication network should be able to handle requirements for reliable data connection even in case of temporary link failures. Many industrial IOT gateways provide the necessary bridge between shop floor sensor networks and traditional communication networks for connecting to the internet [3]. Messaging protocols like MQTT, CoAP, AMQP, XMPP, and JMS are being adopted for connectivity. The IoT gateway functionalities have moved from the traditional technological interoperability to include aspects of remote configuration, dynamic provisioning, on the air software updates to information model based integration. OPC-UA facilitate industrial IOT through its scalable and secure service oriented architecture. The idea of RESTful extension of OPC-UA is also being mooted [4].

Infosys offers a versatile OPC UA based IIoT solution framework which has scalability right from individual sensor devices to sensor systems and connectivity across the automation network with applications in the enterprise. Furthermore, it offers valuable benefits with unique security safeguards along with standard based communication and interoperability. This article provides details about the Infosys solution for secure and reliable communication to address these problems faced by the industry.

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Management of Laboratory Work for Designing Manufacturing Phases via the Ethernet Connection

Anna Antonyová, *Member, IEEE,* Peter Antony, and Endra Joelianto, *Member, IEEE*

***Abstract*—Management of pre-labelling phases in production the boxes, which are used as packages, requires office with the suitable environment for dealing with customers as well as the laboratory for the prototype production. To meet the requirements of the customers taking into account the possibilities of material, it is necessary to manage the testing the quality of corrugated paper, which is mostly used for production the boxes as well as testing the designed sample as prototype. Ethernet network can provide the suitable connection for transmission the data between office and laboratory. The connection includes especially plotter to design boxes and measurement devices to control the boxes quality. The devices as well as their connections were originally designed and constructed under the leadership of Peter Antony, as one of the coauthors.**

***Index Terms*—Computer network management, Ethernet networks, Instrumentation and measurement, Testing**

I. Introduction

INTERNET and in specific cases Ethernet applications have become an integral part of the present development. Also, the service sector is more widely available, for example through mobile applications [1]. Cloud computing plays an important role not only for services but also for global business in general [4]. Interactive Internet multimedia applications require also real-time communication including synchronization [3]. Professor Robert Štefko with his colleagues [5] stresses importance in setting the proper ways to manage the communication for detecting and solving demanding situations.

Embedded systems in connection with multimedia computing [5] are included in particular industrial applications. Managing proper connections especially between control and production parts of industrial processes may influence the resulting efficiency and safety of the manufacturing process [6]. In our previous work [7], we used Internet connection to set the parameters for the proper function of the water cleaner. It not only increased operational reliability but also security of the service.

Our new research aims to managing the modern laboratory with full functioning regarding the designing the prototypes of boxes with the Ethernet connection to the central office. Reliable data transfer is conditioned by several factors: the optical connection, the selected data system control as well as double data backup. However, each laboratory device has its own control system. The reliability of data transmission is superior to other parameters such as bit rate.

II. Materials and Methods Used in Laboratory Work

The company, where we realized our research, has its own laboratory to construct the prototypes of boxes as packages. The constructed boxes are subsequently tested regarding the quality of the used material as well as the finished product. The finished product is measured for their strength and quality parameters.

Figure 1 shows a plotter. Plotter is used for drawing, cutting and pre-labeling the samples for bending. All those operations are necessary to produce prototypes of boxes. Plotter was designed and constructed with Ing. Peter Antony, the coauthor, in such a way that it can be managed from the laboratory through a central computer with Linux operating system. For adjusting a typical process, a control via an infrared remote controller can be used. This feature is mainly used when setting the depth of cut, the initial operating point within the area of material and the depth of the bend. Draft drawings for prototyping boxes takes place in another part of the company's buildings, at the office.

The office is equipped especially for a better customer contact. The prototype of the box can be made as follows on the basis of specific customer requirements, in accordance with the appropriate choice of process flow as well as the possibilities of a certain material. Customer requirements influence the choice for a specific type of corrugated board which is usually used for the boxes production. Prototype testing is important also for the specific requirements such as wet environment for storage of goods in boxes, suitability of

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