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Welcome to ICITDA, the Annual International Conference on Information Technology and Digital Applications 2016. On behalf of the committees, we are grateful to have your paper published in the 1st ICITDA. This International Conference is held by Department of Informatics, Faculty of Industrial Technology, Universitas Islam Indonesia, Yogyakarta, Indonesia in collaboration with Rajamangala University of Technology Thanyaburi, Thailand, and Youngsan University, South Korea.

ICITDA 2016 received 58 papers from 8 countries, and 30 papers were accepted in various topics.

Our conference will feature Prof. Wenny Rahayu, the Head of School of Engineering and Mathematical Sciences, La Trobe University, Australia and Prof. Dr. Lee Jin Ro, from the Department of Advertising and Public Relations, Youngsan University, South Korea as keynote speakers.

This year, ICITDA held in a city of tourism, Yogyakarta, Indonesia. We hope you enjoy your academics visit to this wonderful place. See you again in next ICITDA.

Best regards,

Taufiq Hidayat, ST., MCS
Conference Chair

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# Keynote Speeches

## Prof. Wenny Rahayu

**Head of School of Engineering and Mathematical Sciences, La Trobe University, Australia**

**Privacy Preservation in Big Databases**

*Advances in data collection techniques, from web application oriented through to automated sensor devices and crowd sourcing mechanisms, have significantly increased the volume and complexity of data storage and exchanges. As we move toward fully automated, seamless, and pervasive data gathering mechanisms, there is also an increase risk in personal privacy breach or disclosure of sensitive information. In this talk, well known and state-of the art studies in privacy protection for big databases will be discussed, along with new proposals in dealing with non-traditional and externally linked databases.*

## Prof. Jin Ro Lee

**Department of Advertising and Public Relations, Youngsan University, South Korea**

**Cyber Space and Digital Democracy in South Korea**

*Korea is a very interesting case. Korea shows rapid growth of the Internet users, and larger trade surplus in telecommunication industry with the help of government's successful information technology policy. And Koreans also made their country more democratic with active participation.*

*This paper analyzed the growth of the Internet and SNS in South Korea. The Internet and SNS created cyber space. They have several advantages as an effective means of communication. Cyber space is influenced by three subjects such as the government [state], the market [capital], and citizens [people].*

*There are two research questions. First question is how the Korean CMC industry can grow fast after its birth. Three main subjects were dealt with in this research. They are the State, the Market, and the Citizen. I divided the history of Korean CMC industry into three periods. The first formation stage is from the birth of CMC in Korea between from 1980 and 1990. The government initiated the monopolistic CMC market. Several conglomerates participated to co-operate the government. But the users are very small. The second growth stage is between from 1990 to 1995. The government also deregulated the Market with changing policy from 'appointment' to 'registration'. The companies increased investment for the possibility of wide diffusion of CMC use. The third prosperity stage is between 1995 and 2010. The government promoted the CMC market's competition with 'notice' policy. And citizens actively enjoy and apply CMC services. However, the fourth shift stage to smartphone faced several problems such as less democracy and one way communication which will weaken the creativity of the content.*

*Second question is what the roles of three subjects are. I examined the cyber space by the uses of digital media with three subjects. Even though the state and the*

*market have limits to promote democracy, the citizens are expected to make the digital society more democratic. If the state tries to monitor citizen by the use of digital media, that society is called 'surveillance society'. As the government is open and transparent, the citizens' democracy will increase. The market should limit to gather and accumulate peoples' information and profile for protecting their privacy.*

*Cyber space is a public sphere, which is two-way, economic, and open to every people. It has various positive sides. It promotes the communication by people of political information and opinion freely and actively. It makes people form groups against the wrong-doing of big companies and keeps people's privileges. People buy goods more cheaply via e-commerce, which also helps companies lessen the expenses.*

*However, the cyber space has several negative sides, too. The government and companies can accumulate people's information and use it for diverse purposes. If the government uses that information to monitor and control people, such a society may become a 'surveillance society' threatening democracy as in George Orwell's '1984'. As companies also take advantage of big data to sell more products for their profit increase, so people often feel they are captivated by a lot of commercial messages, including much advertising spam-mail. The more civil society depends on the cyber space, the more it can become fragile and risky.*

*The digital media guarantees neither democracy nor a surveillance society. It's true that new technology gives us the opportunity to expand democracy. However, if we don't use new media rightly and positively, we may find it negative or even harmless. Therefore, the positive use of the digital media and keeping our cyber space democratic is very important. With democracy, the Internet and SNS industry can be flourished by the cooperation of netizen, business managers, IT researchers, and politicians.*

# CONTENTS

# Simulation of the 6-DOF model of Discrete State Manipulators (DSMs) Based on Neuro-Fuzzy Architecture

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**Abstract**. This paper reports the simulation of neuro-fuzzy architecture of the discrete state manipulators (DSMs) with 6 degree of freedom (6-DOF) in Matlab environment. The DSMs are special kind of discrete manipulator with massive pneumatic actuators that can be switched among limited number of discrete states. We introduce three-state DSMs model, called as ternary DSMs (t-DSMs), which is driven by discrete forces and have continuous motions. The main problem of the DSMs are how to control such as the position of the manipulator by choosing the best combination of actuator's states which called as inverse static problem (ISP) of DSMs. This paper proposed an architecture which is based on the Neuro-Fuzzy Takagi Sugeno (NFTS) inference scheme with Gaussian membership functions as ISP solution of the proposed DSMs. The training algorithm needs at least one million iterations with different membership functions, employ 25.9% of the input-output correspondences dataset from the known input and output. For training database, the NFTS model generates 189 dataset from the 729 possible dataset. After one week training for searching optimized parameters within several membership function (M), the validation testing found the best error in 1.51% using M = 9.

## 1. Introduction

This paper proposes an effective way to control the ternary-Discrete State Manipulator (t-DSMs) through the real-time Neuro-Fuzzy controller as ISP solution of the t-DSMs. The t-DSMs generally are a special kind of mechanisms whose actuators can only be switched among three states (retract, null and extended, can be explained as 0, 0.5 and 1). Furthermore, the t-DSMs are a kind of manipulators in an effort to reduce the control procedure and complexity of computer interfacing.

Currently, t-DSMs can be hardly clustered into two categories depending on their actuators act as discrete generators for displacement or discrete generators for force. For instance, the first type of binary DSMs is the binary snake-like robots (SLRs). The SLRs are proposed by Chirikjian et al [1-4] and Dubowsky et al [5], which are kinematically constrained mechanisms employing a large number of discrete actuators in series-parallel configuration. The discrete SLRs can be configured either fully extended, just follow or fully contracted without consideration of the supplementary forces acting on them. In addition, the second type t-DSMs are the Massively Parallel Actuators (MPAs), or sometimes called as Massively Parallel Robots (MPRs). Here, the MPRs are dynamically constrained robots

exhausting a large number of binary pneumatic [6] or ternary pneumatic [7] actuators, which have constant forces.

For achieving accuracy in high position/force abilities, the SLRs or MPRs model practically needs a large number of discrete actuators (by experiment around 4-7 times larger than the number of desired DOF for the manipulator). The position of the actuators can be organized in a series-parallel formation [1, 5] or in parallel configuration [7].

Moreover, the ISP solution of t-DSM type MPRs model is usually very difficult to solve and needs unique solution. The optimal results or solutions practically require complicated processes in the terms of approximation and time computing. In the past, some significant research efforts have been devoted to address the ISP solutions, such as: proposing the combinatorial heuristics algorithms [5]; applying the probabilistic methods [3]; comprehensive brute-force search methods and optimized programming by genetic approach [6]; generating the Hopfield networks and Boltzmann machines algorithms [6-7]. Generally, most of the suggested schemes or solutions are formally very effective to reduce the complexity problem, but the results shown that the computation needs large computing time. On the other hand, the result of the ISP solutions still has numerous mathematic calculations, especially if the solutions are applied to the real-time control mechanism.

## 2. Neuro-Fuzzy Method for Real-Time ISP Solution

This paper introduces the efficient real-time mechanism to control the state of discrete manipulators via computational intelligence methods. Here, the potentialities of using computational intelligence algorithm such as neuro-fuzzy (NF) method as the real-time solution of the ISP of t-DSMs are investigated. The proposed of t-DSMs feature six degree of freedom actuated by six force generators with double action valve control. The positions of actuators are placed in parallel with symmetrical configuration which are extended version of massive parallel arrays in several applications, such as: one DOF MPRs and six DOF game simulator with 3D MPRs. Both applications are done by Pasila et al [7-8].

For more information, NF networks are hybrid networks between humans as rational fuzzy logic with the learning ability of neural networks. This idea is coming because of the main advantages of a NF system are: it interprets IF-THEN rules from input-output connections and focuses on reducing the generalization error in the training phase (off-line phase); In addition, it has efficient calculation time on the on-line phase. This idea was first proposed in ANFIS: adaptive-network-based fuzzy inference system by JSR. Jang [9]. ANFIS later developed as multi-input-multi-output problem (MIMO case) by Palit et al [10] and applied in electrical load forecasting application by Pasila et al [11].

In the next section, we proposed t-DSMs mechanism with real-time controlled. The control part uses Neuro-Fuzzy Takagi-Sugeno (NFTS) inference system with Gaussian membership functions (GMFs). Concerning the ISP, the proposed model can be applied in finding the optimal number of membership functions (M) that provide a strong link between the input values α with their output variables ternary number $u = [u_1, \ldots, u_6]$. In the design of the architecture of the NF, the membership function will be changed in the learning process using different M from 4 to 10.

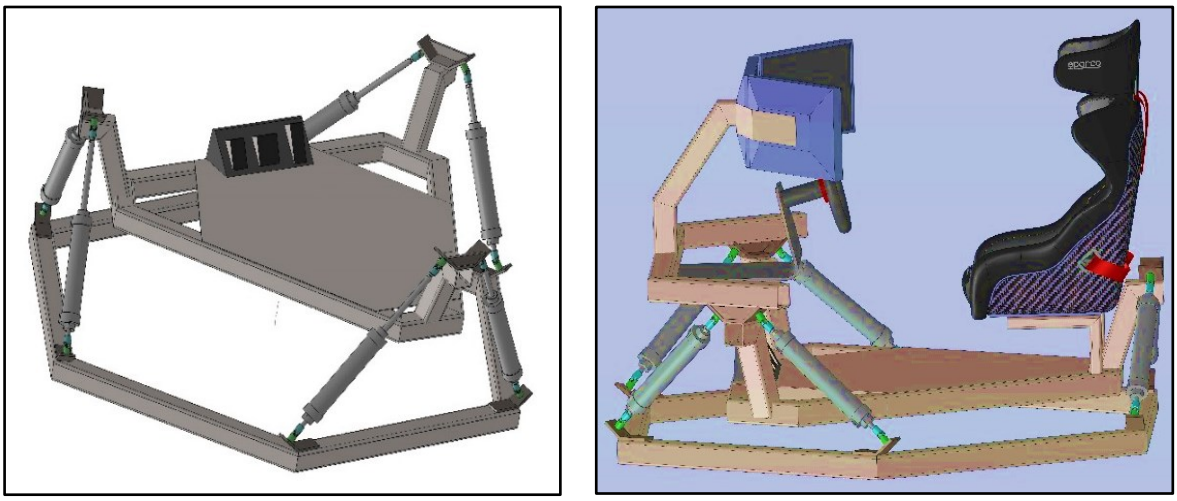
### *2.1. The Ternary-Discrete State Manipulators (t-DSMs)*

Moreover, figure 1 exploits the t-DSMs mechanism that is considered in this paper. It has 6 identical pneumatic actuators respectively 6-SPS-3D mechanism. The terms U, P and U are for universal, prismatic and universal joints respectively, sharing the same moveable platform (C) through their moving joint. The moveable platform is hinged to the platform at origin joints B (joints B are in the fixed platform), links to the six variable length Ci-Bi, where $i = 1, 2, \ldots, 6$. The moving platform are hinged at the points of the common platform based Bi and displacement of points of the Ci platform respectively, correspondingly relative to the XYZ axis along to the both platform. In order to neglect the twist of the moving platform while activating the actuators, additional crank and slotted-lever in the center of both platforms are applied. Moreover, the description about the t-DSMs mechanism can be

shown in table 1. The implementation mechanisms possibly will be achieved by using six double acting pneumatic cylinders with bi-directional control valves.

### *2.2. Neuro-Fuzzy type Takagi-Sugeno Model in Matlab*

This Section presents the architecture for the new model of ternary DSMs, like shown in figure 2. The architecture is called as feedforward Neuro-Fuzzy Takagi-Sugeno, type multi-input multi-output. The inputs are six set of coordinates XYZ and Forces in the related coordinate direction while the outputs consist of the states of the actuators ($u_{state}$). It also uses GMFs in the fuzzyfication phase.



(a) Manipulator with pneumatic actuators (b) Overall game simulator view

**Figure 1.** Design of DSMs with 6 pneumatic actuators (a) and simulator view (b)

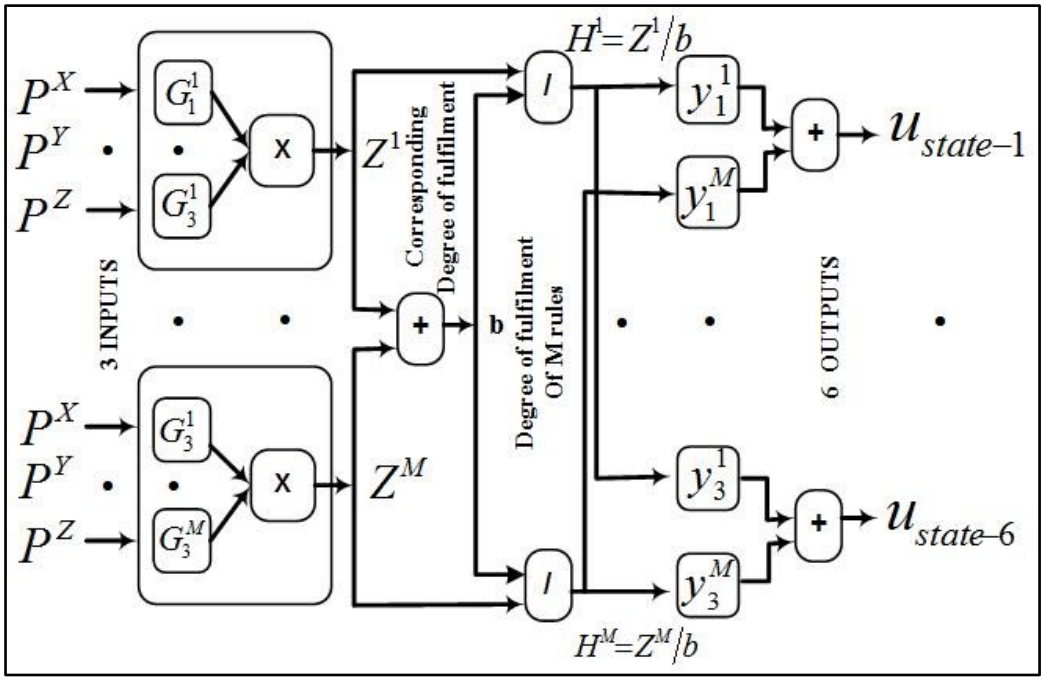



**Figure 2**. Feedforward Neuro-Fuzzy network type Takagi-Sugeno, 3 Inputs 6 Outputs, Learning method: LMA

**Table 1**. Description of t-DSMs simulator with 6 actuators

| Description | Measurement | Unit/Type |
|---|---|---|
| Simulator Weight | 391.6 | Kg |
| Moving Pneumatics Weight | 187.3 | Kg |
| Moving Platform Weight | 145,3 | Kg |
| Diameter Top Plate | 1329 | Mm |
| Diameter Bottom Plate | 1807 | Mm |
| Material Top Plate | aluminum | 6063-T6 |
| Material Bottom Plate | aluminum | 6063-T6 |
| Maximum declivity | 13 | Degrees |
| Actuator Strokes | 326 | Mm |
| Number of actuators | 6 | Unit |
| Type of Actuator Joints | Universal-Prismatic-Universal | Unit |

Moreover, we introduce the GMFs (1) as fuzzyfication functions to the NF methods $G_y^n$ ($y$ = 1, 2, 3; $n$ = *1*, …, *6*), for input pairs $\alpha^D = [P^X, P^Y, P^Z]$, where $\alpha^D$ are the input set of the positions (in X, Y and Z axis) with respect to the XYZ Euler coordinates.

$$G_y^n(\alpha_y) = exp\left(-\left[\left(\alpha_y - c_y^n\right)/\sigma_y^n\right]^2\right) \tag{1}$$

with parameters means $c_y^n$ and variance $\sigma_y^n$ together with the corresponding $n$-fuzzy rules ($FR^n$) can be written as:

$$\begin{aligned} FR^n: IF\ \alpha_1 is\ G_1^n\ AND\ \alpha_2 is\ G_2^n\ AND\ \alpha_3 is\ G_3^n\ AND\ \dots \\ THEN\ Y_i^n = w_{0i}^n + w_{1i}^n \cdot \alpha_1 + w_{2i}^n \cdot \alpha_2 + w_{3i}^n \cdot \alpha_3 + \cdots \end{aligned} \tag{2}$$

here $w_{0i}^n$, $w_{1i}^n$ being the Takagi-Sugeno weights (for $i$ = 1, …, *6*, and $n$ = 1, …, $M_{OPT}$, *where* $M_{OPT}$ is the number of optimized rules for the proposed model, will be found by search mechanism), the last part of the considered Neuro-Fuzzy model calculates the output vector $\bar{u}$.

$$\overline{u_{state}} = \sum_{n=1}^{M_{OPT}} Y_i^n \left( \frac{\prod_{y=1}^{3} G_y^n(\alpha_y)}{\sum_{n=1}^{M} \prod_{y=1}^{3} G_y^n(\alpha_y)} \right) \tag{3}$$

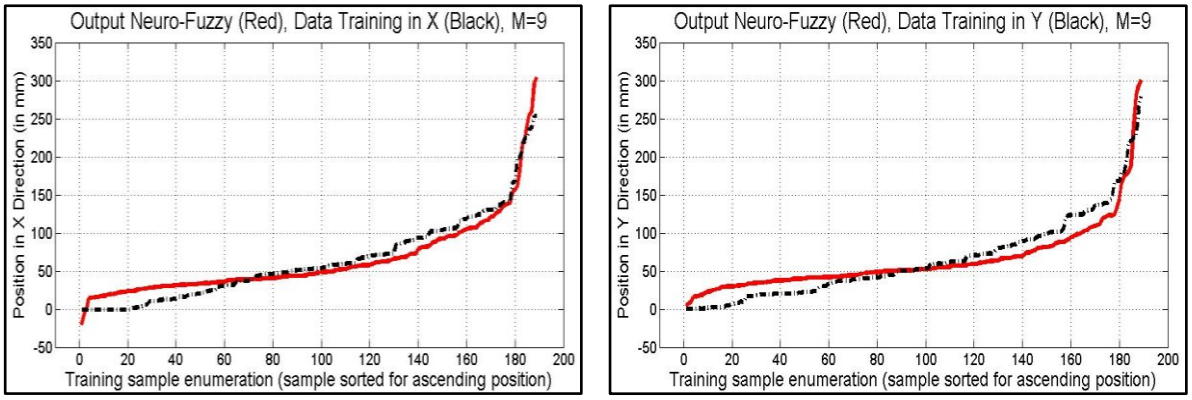
The NF output (3) consist of six outputs and still in the real form. Moreover, the outputs will be derived by alternatively approximating the activation states of actuators $u_{state}$ through the following threshold function:

$$u_{state} = 0.5 * round(2 * abs(\overline{u_{state}})) \tag{4}$$

where *round* indicates a process to change real form of vector $\overline{u_{state}}$ into the three state numbers which are 0, 0.5 and 1. In the process to find the predicted outputs, NFTS model requires the tuning of the parameters $c_y^n$, $\sigma_y^n$, $w_{0i}^n$, $w_{yi}^n$ (here $y$ = 1, 2, 3; $i$ = 1, 2,...,6; $n$ = 1, …, $M_{OPT}$;). The number of parameters for the considered architecture (with membership function optimal $M_{OPT}$ is 9) is 486 parameters from four tuned NFTS parameters. The values of these parameters are found by an optimized learning procedure via Levenberg Marquardt Algorithm, LMA [10]. The learning procedure employs 25.9% of the input-output correspondences known from 729 dataset for the 6 t-DSMs respectively.

## 3. Results and Discussion

The simple search procedure is needed in order to find the optimized number of rules *M* for the six t-DSMs mechanism. This procedure is a local search method that tries to find the best local minimum from one million iterations on the learning procedures. The procedure permits the best learning parameters that minimize the total error training ($e_t$) in every iteration and neglects the parameters that caused bigger $e_t$. The optimized membership function (*M*) is achieved after one week of searching time. As the results, the optimized model that give best performance is *M*= 9 for the 6-ternary MPRs, with model performances for the ISP solution shows off-line trained $t_{off}$ = 3218s, and *RMSE* model $e_t$ = 1.51 %. For the training purposes, the NTFS method uses 189 data training. The comparison between data and prediction of training performance of Neuro-Fuzzy method can be seen on figure 3 and table 2. The results in figure 3 also shown that model has ability to predict the forces accurately but with less ability in predicting the position in X and Y respectively.




(a) Training Performance of Position in X Direction (b) Training Performance of Position in Y Direction

**Figure 3**. Off-line training results of NFTS using 189 sample data in X (a) and Y (b) positions

**Table 2**. Performance Results of t-DSMs model with different Membership Function (*M*)

| No. of Membership Function M | Average RMSE Training (%) | Off-line Trained (sec) Using LMA |
|---|---|---|
| 4 | 2.05 | 2559 |
| 5 | 2.24 | 2668 |
| 6 | 1.85 | 2993 |
| 7 | 2.68 | 3046 |
| 8 | 1.92 | 3162 |
| **9** | **1.51** | **3218** |
| 10 | 1.89 | 3314 |

## 4. Conclusion

This paper presented six-DOF discrete state manipulators with 6 pneumatic actuators with three-state force generators, called as t-DSMs. An optimized model of Neuro-Fuzzy method type Takagi-Sugeno is found using the Levenberg-Marquardt algorithm (LMA) for the solution of inverse static problem of the considered t-DSMs. In addition, compared to the standard manipulator robot mechanism, the partitioned and parallel distributed actuator architecture proved that the considered manipulator features sufficient and accurate position generation abilities. The results show that NFTS with membership function (M) = 9 has better approximation ability compared to the other number of membership function between 4 to 10 during the off-line training phase.

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