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THE PROCEEDING

Grha ITS, December 21-22, 2010

2nd APTECS 2010

International Seminar on Applied Technology, Science, and Arts

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LPPM - ITS

PROCEEDING

2nd INTERNATIONAL SEMINAR ON APPLIED TECHNOLOGY, SCIENCE AND ARTS - APTECS 2010

THEME

EMPOWERING CREATIVITY THROUGH SCIENCE AND TECHNOLOGY TO ENHANCE NATIONS COMPETITIVENESS

GRAHA SEPULUH NOPEMBER, 21-22 December 2010

Organized by :
Institute of Research and Public Services (LPPM)
INSTITUT TEKNOLOGI SEPULUH NOPEMBER
2010

2nd INTERNATIONAL SEMINAR ON APPLIED TECHNOLOGY, SCIENCE, AND ARTS (APTECS 2010)

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OPENING SPEECH OF THE RECTOR OF ITS

Assalamu'alaikum Wr.Wb. Good Morning Ladies and Gentlemen, Let me, first, praise the Almighty God for the blessings and mercies that have made all we have today possible.

Distinguished guests, esteemed presenters and participants, I would like to extend the warmest welcome to all of you attending the 2nd ***Internasional Seminar on Applied Technology, Science and Arts*** **(APTECS)**. I would like to express my profound gratitude to Prof. KISHIDA Satoru for his willingness to join this seminar and to deliver his outstanding lecture on the Prospect of High-Tech Superconducting Oxides and their Surface Analysis Superconductivity, Surface Analysis, and Oxide as the Creative Industry for the Future. This speech would be very contributing to all attending this seminar.

Acknowledgement must also be given to all the attending plenary sessions, the Ministry of Marine Affairs and Fisheries Republic of Indonesia, Dr. Ir. H Fadel Muhammad Al-Haddar; the Chief Executive Officer, Mr. Dahlan Iskan; and Prof. Wayan Dibya who are willing to spend some of their time that I know they are quite compact in schedule**.** Thank you for featuring very inspiring experience and insightful notions that would be very contributing to all attending this seminar to build high comprehensive and up to date prior knowledge. Allow me to express my heartfelt gratitude to many sponsors for their generous financial support.

APTECS is an annual seminar hosted by the Institut Teknologi Sepuluh Nopember (ITS) as the forum of academic sharing focusing on various issues in science, technology and arts. As one of the reputable institutions in Indonesia, it is undeniable that active contributions of ITS would be one of the important considerations to deal with the Asean China Free Trade Agreement (ACFTA) that has been launched since the 1st January 2010. At the same time ceasing International competitions would become one of the agenda that must be done by enhancing as well as empowering the national competitiveness in all aspects including engineering, economy, social, and many others. In fact, regarless of the subsequently and surely diminished natural resources, people today need to be able to find brilliant ways to determine success in economy for the future of this beloved country, Indonesia. Dear Audience, the main point of my speech is that this country would take the global challenge only if we are able to develop dynamic cultures and traditions as a nation. And, ITS, in the Golden year anniversary, would become the leading institution to enliven the competition through the development of science, technology, and not to mention cultures and arts.

Now, dear audience, the seminar is all yours. I hope everyone will find the seminar inspiring and enriching, through presentations and discussions on empowering creativity through science and technology to enhance nation competitiveness. Finally, I wish to see you again in the coming 3rd APTECS seminar, December 2011. I wish great happiness, good health, and much success to each of you. Thank you.

Surabaya, 21 Desember 2010

Rector of ITS

Prof. Priyo Suprobo

OPENING SPEECH OF THE CHIEF OF INSTITUTE OF RESEARCH AND PUBLIC SERVICES

First of all, let us praise God whose blessings have enabled us to band together here in the 2nd International APTECS seminar that, this year, is hosted particularly to commemorate the golden year anniversary of the Institut Teknologi Sepuluh Nopember. It is a pleasure for LPPM to welcome you all the professional researchers either from abroad or all over Indonesia. This is the forum where we can meet colleagues from various specialty areas to develop knowledge, technology, and arts that would, of course, contribute to the lives of the mankind

In the attempt to foster the development of science and technology, basic and applied researches, and industrial researches as well are all the major activities need to be conducted to enhance industrial productivity and competitiveness and to advance our nations unchallenged supremacy; therefore, unless there were any publications and disseminations of research findings and discoveries, researches with high sophisticated findings and contributions would have completely no meaning.

In this global era, without ability to cope with advanced technology and to develop the creativity and innovation, industries would not be able to take part into rigorous competitions. For this reason, then APTECS raises the topic of *"**Empowering Creativity through Science and Technology to Enhance Nations Competitiveness".***

APTECS is forwarded to be one of the forums for researchers to disseminate and further discuss the results of researches; furthermore, this forum is promoted to enrich creative and innovative ideas that would be worth considering for further researches. Intensive communication as well as discussions in APTECS would continue the process of advancing science, technology, and arts as well. Moreover, further attempt of this form is to promote the implementation of the research finding to give positive contributions for our beloved country.

All researches and their findings are aimed to keep up and further develop our noble cultural values, arts, and human civilization so that, as a member of world societies, our nation would be much dignified among other nations on earth. By hosting this seminar LPPM-ITS is not only to gain the advancement of the science and technology throughout all the findings offered in this forum but at the same time, to encourage and to enhance the arts and cultural values of this country that would fruitfully signify our existence as a nation.

This academic forum meets annually at the end of the year, and next year we would welcome you to see us again in the 3rd APTECS International Seminar that would offer more laborious topics.

On behalf of LPPM-ITSI would like to express my deepest gratitude to all presenters and participants, and I wish a productive and inspiring seminar.

Surabaya, 21 Desember 2010

Prof. Ir. I Nyoman Sutantra MSc.PhD
The Chief of LPPM-ITS

OPENING SPEECH OF THE COMMITTEE CHAIRMAN

Rector of ITS,
Dr. Ir. H. Fadel Muhammad, Minister of the Ministry of Marine Affairs and Fisheries Ministry
Prof. KISHIDA Satoru from Tottory University Japan
Prof. Wayan Dibya fron Indonesian Arts Institute, Denpasar Bali
Mr. Dahlan Iskan, the Chief Executive Officer of PLN
Distinguished Presenters, all participants, and Colleagues

Assalamualaikum, Wr. Wb.

I am both honored and delighted to welcome you here in this remarkable conference hosted by Institut Teknologi Sepuluh Nopember (ITS) Surabaya in corporation with the Research Institute and Public Services (LPPM) ITS. The conference today takes the topic of "Empowering Creativity through Science and Technology to Enhance Nations Competitiveness".

On behalf of the committee, I would like to thank Prof. Priyo Suprobo, the Rector of ITS, whose full support has enabled all of this possible; Prof. I Nyoman Sutantra, M.Sc, PhD., the head of LPPM who has kept encouraging us in accomplishing all good preparation to welcome you here today until tomorrow; and the support of the board of committee of the golden year anniversary, whose financially support this event. Also, all the sponsors who keep rendering and make today's conference be more easily carried out.

Ladies and Gentlemen,

The interest of the international scientific community is clear, sharing enormous inspiring notions, research findings and innovations. This Conference has attracted 150 domestic and overseas presenters, it means that within two days we will hear 150 oral presentations. The subjects range from descriptions of recent technology, science both natural and social, and arts. So, it is marvelous, isn't it? Only in two days 150 brilliant ideas would have been disseminated and enriched our inventory of knowledge; furthermore, these 150 fresh and prolific ideas will enable this beloved country ready to face the challenge of ACFTA.

Ladies and Gentlemen,

In the middle of us, here we have four notable speakers who would overcome our desire for inputing the latest knowledge delivered in their presentations in the plenary sessions. Therefore, I would like to express my sincere gratitute and warm welcome to Prof. KISHIDA Satoru who comes far away from Tuttori University, Japan; I also feel grateful for the coming of important figures: our Minister, Dr. Ir. H Fadel Muhammad Al-Haddar; Prof. Wayan Dibya from Denpasar-Bali, and Mr. Dahlan Iskan who has been so popular among us, people of Surabaya.

Ladies and gentlemen,
Today's conference is born due to a hard work of all committee and staffs who have spent their time working day by day arranging every detail of the event, so allow me to congratulate their very keen and perfect job that makes me standing up here welcoming all the distinguished guests.

Last but not least, I would like to ask you all an apology for all incovenience that you might find prior, during, or after the conference; we are all just an ordinary man that won't be able to avoid making mistakes. Thank you and have extraordinarily inspiring seminar.

Wassalamu'alaikum Wr.Wb,

General Chairman of 2nd APTECS 2010
Dr. Bambang Sampurno

ACKNOWLEDGEMENTS

Special gratitude is extended to all of the followings:

RECTOR OF INSTITUT TEKNOLOGI SEPULUH NOPEMBER

INSTITUTE OF RESEARCH AND PUBLIC SERVICES – ITS

THE JOURNAL OF IPTEK ITS

MINISTRY OF MARINE AFFAIR AND FISHERIES

TOTTORI UNIVERSITY, JAPAN

PERUSAHAN LISTRIK NEGARA (PLN)

PT. TELEKOMUNIKASI INDONESIA, TBK

PT. TRUBA JAYA ENGINEERING

PT. NAHARADIA PRAKASA

HOUSE OF BEAUTY CLINIQUE

ELEKTRO BUDOYO – ITS

SMKN IX SURABAYA

for never ending supports that have made the 2nd APTECS 2010 held successfully

SCHEDULE
INTERNATIONAL SEMINAR ON APPLIED TECHNOLOGY, SCIENCE, AND ARTS
2nd APTECS 2010

Monday, 20 December 2010

Time	Activities
19.00 - 22.00	Welcome dinner for overseas participants, officially attended by the mayor, Ir. Tri Rismaharini, MT

Day I: Tuesday 21 December 2010

Time	Activities						
06.45 - 07.30	Registration						
07.30 - 07.40	Indonesian Traditional Musical Instruments- Elektro Budoyo : Ayak Talu						
07.40 - 07.50	Traditional Dancing : Jejer Gandrung Banyuwangi - SMKN 9 Surabaya						
07.50 - 08.00	Welcome to 2nd APTECS : Dr. Bambang Sampurno						
08.00 - 08.05	Ladrang APTECS : Elektro Budoyo						
08.05 - 08.15	Colossal Dancing Remo : Elektro Budoyo						
08.15 - 08.25	Speech from The Chief of Research and Public Services - ITS : Prof. I.N Sutantra						
08.25 - 08.30	Opening Term - Rector ITS : Prof. Priyo Suprobo						
	Theme I : The prospect of High - Superconducting Oxides and Their Surface Analysis Superconductivity, Surface Analysis, and Oxide and The Creative for The Future: by Prof. KISHIDA Satoru – Tottori University, Japan Theme II : Central Roles of The Electricity to Enhance the Quality of Nation Competitiveness: by Mr. Dahlan Iskan – PLN Moderator: Prof. Imam Robandi						
11.30 - 12.30	Break for Lunch and Pray						
	A	B	C	D	E	F	G
12.30 - 12.47	Eng-21	Art-1	Eng-65	Eng-87	Sci-1	Eng-51	Eng-105
12.47 - 13.04	Eng-22	Art-2	Eng-66	Eng-88	Sci-2	Eng-52	Eng-106
13.04 - 13.21	Eng-23	Art-3	Eng-67	Eng-89	Sci-3	Eng-53	Eng-107
13.21 - 13.38	Eng-24	Art-4	Eng-68	Eng-90	Sci-4	Eng-54	Eng-108
13.38 - 13.55	Eng-25	Art-5	Eng-69	Eng-91	Sci-5	Eng-55	Eng-109
13.55 - 14.12	Eng-26	Art-6	Eng-70	Eng-92	Eng-117	Eng-56	Eng-110
14.12 - 14.31	Eng-27	Gen-1	Eng-71	Eng-93	Eng-118	Eng-57	Eng-111
14.31 - 14.48	Eng-28	Gen-2	Eng-72	Eng-94	Eng-119	Eng-58	Eng-112
14.48 - 15.05	Eng-29	Gen-3	Eng-73	Eng-95	Eng-120	Eng-59	Eng-113
15.05 - 15.30	Break						
15.30 - 15.47	Eng-30	Gen-6	Eng-74	Eng-96	Gen-9	Eng-60	Eng-114
15.47 - 16.04	Eng-31	Gen-7	Eng-75	Eng-97	Gen-4	Eng-61	Eng-115
16.04 - 16.21	Eng-32	Gen-8	Eng-76	Eng-98	Gen-5	Eng-62	Eng-116

NOTE :

A : Room Argopuro 1
B : Room Argopuro 2
C : Room Kawi
D : Room Lawu
E : Room Semeru 1
F : Room Semeru 2
G : Room Utama

Day II: Wednesday, 22 December 2010

Time	Activities						
06.45 - 08.00	Registration						
08.00 - 08.10	Indonesian Traditional Musical Instrument- Elektro Budoyo : Ojo dipleroki & Kelinciku Ucul						
08.10 - 08.20	Traditional Dancing Pendet - TPKH ITS						
08.20 - 08.30	Indonesian Traditional Musical Instrument - Elektro Budoyo : Ketawang						
08.30 - 10.30	Keynote Speaker III and IV Panel : Theme III: Resilience of National Arts and Culture to Enhance Nation Competitiveness: By Prof. Wayan Dibia – Indonesian Arts Institute, Bali Theme IV : Empowering Marine Resources to Enhance Nation Competitiveness: Dr. Ir. H Fadel Muhammad Al-Haddar – Ministry of Marine Affairs and Fisheries Moderator: Prof. I Ketut Aria Pria Utama						
	A	B	C	D	E	F	G
10.30 - 10.47	Eng-1	Eng-9	Eng-17	Eng-46	Eng-39	Eng-78	Eng-33
10.47 - 11.04	Eng-2	Eng-10	Eng-18	Eng-47	Eng-40	Eng-79	Eng-34
11.04 - 11.21	Eng-3	Eng-11	Eng-19	Eng-48	Eng-41	Eng-80	Eng-50
11.21 - 11.38	Eng-4	Eng-12	Eng-20	Eng-49	Eng-63	Eng-81	Eng-100
11.38 - 11.55	Eng-5	Eng-13	Eng-42	Eng-35	Eng-64	Eng-82	Eng-101
11.55 - 12.12	Eng-6	Eng-14	Eng-43	Eng-36	Eng-85	Eng-83	Eng-102
12.12 - 12.39	Eng-7	Eng-15	Eng-44	Eng-37	Eng-86	Eng-84	Eng-103
12.39-12.58	Eng-8	Eng-16	Eng-45	Eng-38	Eng-77	Eng-99	Eng-104
12.58 - 13.45	Break for Lunch and pray						
13.45- 14.00	Closing Ceremony and Awarding Certificate						
14.00 - 14.30	Preparation for City Tour (Cancelled)						
14.30 - 17.30	City Tour (Cancelled)						
17.00 - ...	See you on 3rd APTECS						

NOTE :

A : Room Argopuro 1
B : Room Argopuro 2
C : Room Kawi
D : Room Lawu
E : Room Semeru 1
F : Room Semeru 2
G : Room Utama

Moderator Day I

A	Room : Argopuro 1	A: Prof. Ir. Noor Endah Mochtar, M.Sc., Ph.D.
B	Room : Argopuro II	B: Prof. Ir. Happy Ratna Sumartinah, M.Sc., Ph.D.
C	Room : Kawi	C: Prof. Dr. Ir. Mauridhi Hery Purnomo, M.Eng.
D	Room : Lawu	D: Prof. Ir. Gamantyo Hendrantono, M.Eng., Ph.D.
E	Room : Semeru 1	E: Prof. Dr. R. Y. Perry Burhan, M.Sc.
F	Room : Semeru 2	F: Prof. Dr. Ir. Suprapto, M.Sc.
G	Room : Utama	G: Dr. Maria Anityasari,ST.,ME.

Moderator Day II

A	Room : Argopuro 1	A: Dr. rer.nat Fredy Kurniawan, MSi
B	Room : Argopuro II	BDr. Ir. A. A. Masroeri, M.Eng.
C	Room : Kawi	C: Prof. Ir. Sutardi, M.Eng., Ph.D.
D	Room : Lawu	D: Prof. Ir. Djauhar Manfaat, M.Sc., Ph.D.
E	Room : Semeru 1	E: Prof. Dr. Ir. Adi Soeprijanto, M.T.
F	Room : Semeru 2	F: Prof. Dr. Ir. Dra. Danawati Hari Prajitno, SE,M.Pd.
G	Room : Utama	G: Dr. Ir. Ria Asih Soemitro, M.Eng., DEA.

Rules of Paper Presentation

1. The allotted time for presentation and question-answer session is 15 minutes for each presenter

2. To keep prompt presentation, bell would ring three times to remind the presenter's available time for presentation. It rings every eight minutes of the allotted time, ten minutes, and the last 15 minutes.

3. It is mandatory that the presenter promptly uses the time allotted.

4. The timekeeper would also strictly watch the time allotted to each presenter.

List of Abstracts:

State Feedback Controller Design of Power System Stabilizer (PSS) by using Fuzzy Model

TAMAJI[1] AND IMAM ROBANDI[1]

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Faculty of Industrial Technology, Institut Teknologi Sepuluh Nopember, Surabaya, 60111, Indonesia
email: tamajikayadi@yahoo.com

Abstract— **Power system stabilizer (PSS) is used to damp the mechanic electro oscillation that is the disturbance of PSS. Some methods of PSS control design are adaptive control, robust control. The other side of fuzzy logic is also influence by the performance increasing of PSS. The stability analysis and performance gain can be obtained by using the Linear Matrix Inequality (LMI). In this paper, we study how to build the Takagi-Sugeno fuzzy model, determine the LMI condition such that system stable, design state feedback controller and also simulate the performance of PSS. Here, we make program by using Matlab software.**

Keywords—**LMI, Takagi-Sugeno fuzzy model, state feedback**

I. INTRODUCTION

In power system generation, power system stabilizer (PSS) is use to damp the mechanic electro oscillation. This oscillation is a disturbance of system. Some disturbances are due to continuing variation of power, changing the set point and others. Some methods of PSS design controller are direct feedback linearization (Tamaji, 2009; Yadaiah & Ramana, 2006), adaptive control and robust control beside that fuzzy logic is influence to increase the performance of PSS. The stability analysis and performance gain of fuzzy model control system can be obtained by Linear Matrix Inequality (LMI) (Tanaka & Wang, 2001 in Soliman, 2009).

In this paper, we design the state feedback controller of single machine infinite bus (SMIB). The mathematical model of SIMB system is non linear system (Soliman, 2009; Yadaiah & Ramana, 2006). To design the controller of this PSS, at the first time, we change the mathematical model of SIMB into fuzzy model T-S, after that we define the fuzzy state feedback controller, we determine the LMI condition such that the system is stable, determine the feedback gain and finally we make simulation to analyze the performance of PSS.

II. SMIB FUZZY MODEL

Single machine infinite bus is a simple model of power system. This system consist of single power which connect with two line parallel transmission respect to large networking and approximate by infinite bus. This system is showed in Figure 1.

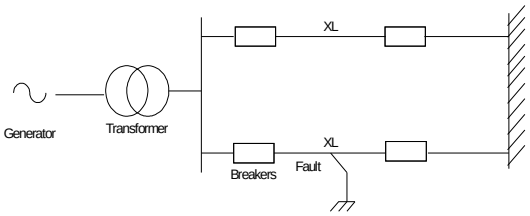

Figure 1. SMIB power system

The generating power system is a non linear system (Soliman, 2009; Tamaji, 2009) as follows:

$$\begin{aligned}
\dot{\delta} &= \omega_0 - \omega \\
\dot{\omega} &= (T_m - E_q^{'} I_q - (x_q - x_d^{'}) I_d I_q)/M \\
\dot{E}_q^{'} &= (-E_q^{'} - (x_q - x_d^{'}) I_d + E_{fd}^{'})/T_{d0}^{'} \\
\dot{E}_{fd}^{'} &= \frac{K_E}{T_E}(V_{ref} - V_T + u_{pss}) - \frac{1}{T_E} E_{fd}^{'}
\end{aligned} \tag{1}$$

The state variable $\delta, \omega, E_q^{'}, E_{fd}^{'}$ is angle, angular velocity, induced EMF proportional to field current and generator field voltages, respectively. From Yadaiah & Ramana, 2006, we know that

$$P_e = \frac{E_q^{'} V_s}{x_{d\varepsilon}^{'}} Sin\delta; \tag{2}$$

$$Q = \frac{E_q^{'} V_s}{x_{d\varepsilon}^{'}} Cos\delta - \frac{V_s^2}{x_{d\alpha}^{'}}; \tag{3}$$

$$V_T = \sqrt{V_d^2 + V_q^2};$$

$$V_d = -X_e I_q + V_s Sin\delta \tag{4}$$

$$V_q = X_e I_d + V_s Cos\delta \tag{5}$$

Such that by substituting equation (2) and (3) into equation (4) and (5) we obtain

$$V_d = -X_e I_q + \frac{P_e x'_{d\varepsilon}}{E'_q}; V_q = X_e I_d + \left(Q + \frac{V_s^2}{x'_{d\alpha}}\right)\frac{x'_{d\varepsilon}}{E'_q};$$

or $$I_q = \frac{P_e x'_{d\varepsilon}}{E'_q X_e} - \frac{V_d}{X_e},$$

There are some methods to design the controller of non linear system such that adaptive controller, robust control, linear direct feedback and by building the fuzzy model T-S. In this paper we use the building the fuzzy model T-S to design controller. At first the system in equation (1) we arrange into state space system

$$\begin{bmatrix} \dot{\delta} \\ \dot{\omega} \\ \dot{E}'_q \\ \dot{E}'_{fd} \end{bmatrix} = \begin{bmatrix} \frac{\omega_0}{\delta} & -1 & 0 & 0 \\ 0 & S_1 & \frac{P_e x'_{d\varepsilon}}{E'_q X_e M} - \frac{V_d}{X_e M} & 0 \\ 0 & 0 & -S_2 & \frac{1}{T'_0} \\ 0 & 0 & S_3 & -\frac{1}{T_E} \end{bmatrix} \begin{bmatrix} \delta \\ \omega \\ E'_q \\ E'_{fd} \end{bmatrix} \quad (6)$$

$$+ \begin{bmatrix} 0 \\ 0 \\ 0 \\ \frac{K_E}{T_E} \end{bmatrix} u_{pss}$$

where

$$S_1 = \frac{(T_m - (x_q - x'_d) I_d I_q)}{M\omega}; S_2 = \frac{-(x_q - x'_d) I_d}{T'_0 E_q};$$

$$S_3 = \frac{K_E}{T_E E_q}(V_{ref} - V_T)$$

In this problem we define the fuzzy variable are P, Q, X_e, where

$$P \in \begin{bmatrix} P^- & P^+ \end{bmatrix}; P \in \begin{bmatrix} Q^- & Q^+ \end{bmatrix}; P \in \begin{bmatrix} X_e^- & X_e^+ \end{bmatrix};$$

such that we can derive the fuzzy rules as follows:

Rule Model 1

$$IF.....P(t)..is..P^-..AND...Q(t)..is..Q^- AND$$
$$...X_e(t).is..X_e^- THEN.....\dot{x}(t) = A_1 x(t) + B\,u(t)$$
$$y(t) = C\,x(t)$$

Rule Model 2

$$IF.....P(t)..is..P^-..AND...Q(t)..is..Q^- AND...X_e(t).is..X_e^+$$
$$THEN.....\dot{x}(t) = A_2 x(t) + B\,u(t)$$
$$y(t) = C\,x(t)$$

.....

Rule Model 8

$$IF.....P(t)..is..P^+..AND...Q(t)..is..Q^+ AND...X_e(t).is..X_e^+$$
$$THEN.....\dot{x}(t) = A_8 x(t) + B\,u(t)$$
$$y(t) = C\,x(t)$$

Define the member functions of *P* are

$$L_1 = \frac{P - P^-}{P^+ - P^-}; L_2 = \frac{P^+ - P}{P^+ - P^-},$$

the member functions of *Q* are

$$M_1 = \frac{Q - Q^-}{Q^+ - Q^-}; M_2 = \frac{Q^+ - Q}{Q^+ - Q^-},$$

and the member functions of X_e are

$$N_1 = \frac{X_e - X_e^-}{X_e^+ - X_e^-}; N_2 = \frac{X_e^+ - X_e}{X_e^+ - X_e^-},$$

Suppose

$$h_1 = L_1 M_1 N_1; h_2 = L_1 M_1 N_2; h_3 = L_1 M_2 N_1; h_4 = L_1 M_2 N_2$$

and

$$h_5 = L_2 M_1 N_1; h_6 = L_2 M_1 N_2; h_7 = L_2 M_2 N_1; h_8 = L_2 M_2 N_2$$

If we define

$$\alpha_i = \frac{h_i}{\sum_{j=1}^{8} h_j}; i = 1,2,...,8 \quad (7)$$

Then the state space system in equation (6) can be written as model fuzzy

$$\dot{x} = \sum_{i=1}^{8} \alpha_i A_i x + Bu \quad (8)$$

and the output

$$y = Cx \quad (9)$$

After we build the state space fuzzy model, we design the state feedback controller based on equation (8) and it call Parallel Distributed Compensation (PDC).

III. Design Controller Fuzzy Model of SMIB

Parallel Distributed Compensation-PDC is a fuzzy design controller of fuzzy model Takagi-Sugeno (Fuzzy Model T-S). There are some designs controller such as state feedback controller $u = -Fx$, and output feedback controller $u = Fy$, where y is output such as equation (9). In this paper we design the controller by using the state feedback controller. State feedback fuzzy controller is constructed by PDC is

$$u(t) = -\sum_{i=1}^{8} \alpha_i F_i x(t) \qquad (10)$$

We substitute equation (10) into equation (8), we obtain

$$\dot{x} = \sum_{i=1}^{8} \alpha_i A_i x - B\sum_{i=1}^{8} \alpha_i F_i x$$

Or we can write as

$$\dot{x} = \sum_{i=1}^{8} \alpha_i (A_i - BF_i) x \qquad (11)$$

The design controller is to determine the matrix F_i such that the system in equation (11) is stable. One of methods to analyze the stability of system is by determining the eigen value of $\sum_{i=1}^{8} \alpha_i (A_i + BF_i)$ and the other is by defining the Lyapunov function. The system is stable if the real part of eigen value is negative or lay on the left half plane of complex space. The stability analyze by Lyapunov method is define the Lyapunov function

$$V(t) = x^T Q x \geq 0; \; Q \text{ positive definite} \qquad (12)$$

System (11) is stable if we can find positive definite matrix Q which satisfy equation (12) and

$$\dot{V}(t) = \dot{x}^T Q x + x^T Q \dot{x} \qquad (13)$$

is negative definite.

Substitute equation (11) into equation (13) we get

$$\dot{V}(t) = \dot{x}^T Q x + x^T Q \dot{x}$$

$$\dot{V}(t) = \left(\sum_{i=1}^{8} \alpha_i (A_i - BF_i) x\right)^T Q x + x^T Q \left(\sum_{i=1}^{8} \alpha_i (A_i - BF_i) x\right)$$

$$\dot{V}(t) = x^T \left(\sum_{i=1}^{8} \alpha_i (A_i - BF_i)\right)^T Q x + x^T Q \left(\sum_{i=1}^{8} \alpha_i (A_i - BF_i)\right) x$$

$$\dot{V}(t) = x^T \left[\left(\sum_{i=1}^{8} \alpha_i (A_i - BF_i)\right)^T Q + Q \left(\sum_{i=1}^{8} \alpha_i (A_i - BF_i)\right)\right] x$$

So $\dot{V}(t)$ is negative if

$$\left[\left(\sum_{i=1}^{8} \alpha_i (A_i - BF_i)\right)^T Q + Q \left(\sum_{i=1}^{8} \alpha_i (A_i - BF_i)\right)\right]$$

negative definite, or

$$\left[\left(\sum_{i=1}^{8} \alpha_i (A_i - BF_i)\right)^T Q + Q \left(\sum_{i=1}^{8} \alpha_i (A_i - BF_i)\right)\right] < 0 \qquad (14)$$

Inequality (13) is called linear matrix inequality (LMI). So, in the Lyapunov method is we must determine matrix $F_i, i = 1,2,...,8$ such that there is matrix positive definite Q which satisfy equation (14) (We solve the inequality (14)).

At this moment, we use the eigen value method to determine matrix $F_i, i = 1,2,...,8$.

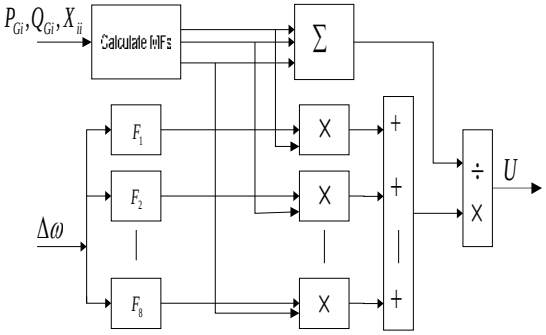

Figure 2. Schematic diagram for the proposed stabilizer on Gen # i

IV. Simulation and Result

We take the parameter value as follows: [Soliman, 2009]

$x_d = 1.8; x_d' = 0.3; x_q = 1.7; M = 13; T_{d0} = 8;$

$\omega_0 = 377; K_E = 200; T_E = 0.001; V_s = 1$

with fuzzy parameter

(P, Q, X_e)

$P \in [0.4 \quad 1]; Q \in [-0.2 \quad 0.5]; X_e \in [0.2 \quad 0.4]$

We make computer program for simulation by Matlab software. We use Matlab function "pole placement method" (place) to determine the feedback gain matrix $F_i, i = 1,2,...,8$. We desire the pole or eigen value of matrix

$\sum_{i=1}^{8} \alpha_i (A_i - BF_i)$ is $[-1 \quad -2 \quad -3 \quad -5]$.

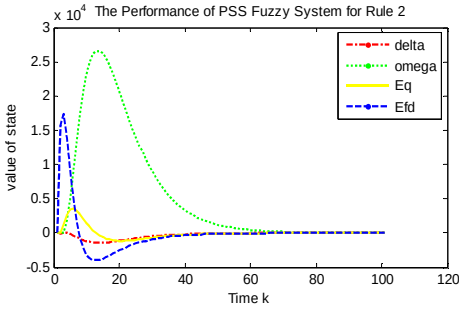

Figure 3. The Performance of PSS for rule 2 , pole $[-1 \quad -2 \quad -3 \quad -5]$

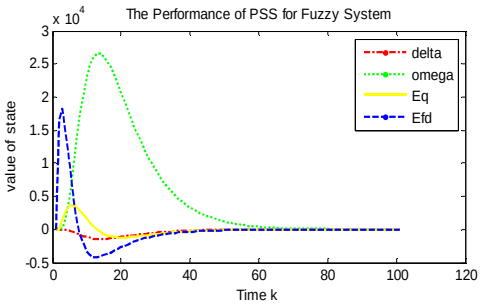

Figure 4. The Performance of PSS for Fuzzy System Pole $[-1 \quad -2 \quad -3 \quad -5]$

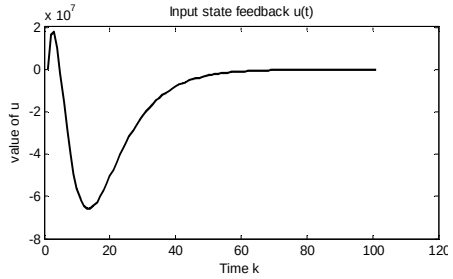

Figure 5. State Feedback Controller, Pole $[-1 \quad -2 \quad -3 \quad -5]$

From simulation we know that feedback gain for each rule F_i can be obtained by using pole placement technique, such as figure 3 and the all state variables converge to zero after 60 time step. Figure 4 shows that the performance of fuzzy system and the all variables also go to zero after 60 time step. The state feedback controller $u(t) = -\sum_{i=1}^{8} B\alpha_i x_i(t)$ is showed figure 5, after time set 60 the state feedback converge to zero.

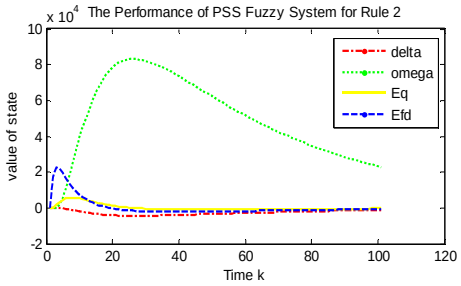

Figure 6. The Performance of PSS for rule 2 , Pole $[-1 \quad -0.2 \quad -3 \quad -5]$

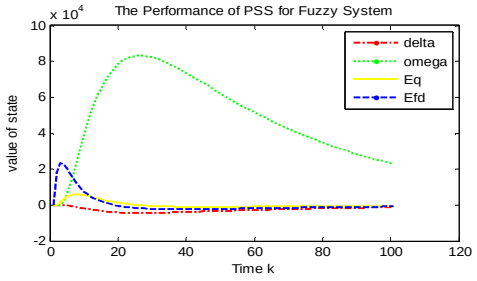

Figure 7. The Performance of PSS Fuzzy system, Pole $[-1 \quad -0.2 \quad -3 \quad -5]$

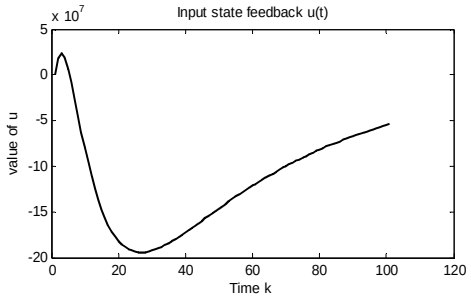

Figure 8. State Feedback Controller, Pole $[-1 \quad -0.2 \quad -3 \quad -5]$

The performance of PSS depends on pole which is taken. Figure (6) and (7) show the performance of PSS and state feedback controller if we take pole $[-1 \quad -0.2 \quad -3 \quad -5]$. Because the second pole (eigen value) is -0.2 then the state variable ω (the second state variable) need more time to converge to zero. Figure (8) show that the state feedback controller is not yet converge to zero after time 100.

V. CONCLUSION

Based on the discussion above and the simulation result, we conclude that

1. The fuzzy model system can be used to design the non linear PSS system
2. It is necessary to change the non linear system into the fuzzy state space system.
3. The state variable and the state feedback controller will converge to zero at the same time.
4. The speed of convergence of system depend on the choosing pole or eigen value

VI. FURTHER RESEARCH

The research will continue with solving the LMI to determine the feedback gain $F_i, i = 1, 2, ..., 8$. Beside that we can design the output feedback controller for fuzzy system of PSS either for SMIB or Multi-machine power system.

VII. REFERENCES

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