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Someone appreciated *Alberuni*:

“You Did Well In The Field Of Research”

The great Researcher replied:

“I Actually Did Nothing Rather Than Explaining

The *Ahadiths_e_Karima* of My Holy Prophet

upon whom may be peace and solidarity”

DEDICATION

This smallest piece of effort is sincerely, humbly and affectionately dedicated to the greatest personality of the last Prophet of Allah Azzawajal (the Holy Prophet Mayupon whom be peace, solidarity and blessings of Allah), from whom flourished the oceans of knowledge and wisdom, the one who enlightens the world, whose students are the teachers of all and whose teacher is the Greatest and the Superior Lord of all.

After him the dedication is rendered to his sincere and honorable friends and companions:

- *The great Hazrat Abu Bakar Siddique (with whom Allah Azzawajal is pleased)*
- *The great Hazrat Omer Farooq.e.Azam (with whom Allah Azzawajal is pleased)*
- *The great Hazrat Usman.e.Ghani (with whom Allah Azzawajal is pleased)*
- *The great Hazrat Ali.ul.Murtaza (with whom Allah Azzawajal is pleased)*

Afterwards it is rendered to his sons and to his famous devotees and lovers who taught the manners of affection for the blessed Holy Prophet, (Mayupon whom be peace, solidarity and blessings of Allah Azzawajal), to his followers:

- *The great Hazrat Hassan Mujtaba (with whom Allah Azzawajal is pleased)*
- *The great Hazrat Imam Hussain (with whom Allah Azzawajal is pleased)*
- *The great Hazrat Ameer Hamza (with whom Allah Azzawajal is pleased)*
- *The great Hazrat Bilal Habashi (with whom Allah Azzawajal is pleased)*
- *The great Hazrat Owais Qarani (with whom Allah Azzawajal is pleased)*

And to His Daughters (with whom Allah Azzawajal is pleased), Wives (with whom Allah Azzawajal is pleased), Companions and the Reformers of His ummah, those sincere and kind people whose guide and prays have ever been enlightening.

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PREFACE

The thesis thrashes out one of the emerging control scheme of “Fuzzy model based Generalized Predictive control” in the domain of controlling a well known class of nonlinear systems i.e. the Hammerstein model. It is usually a challenging task in practical considerations that the engineers have to identify nonlinear systems before applying any control scheme. This work therefore carries out both these domain under study i.e. at first the unknown system is identified using Fuzzy Hammerstein model and then generalized predictive controller alongwith an adaptive inverse model controller is used to control the system.

System identification is carried out through *constrained recursive least squares algorithm*. This algorithm determines both the linear and nonlinear plant parameters at once. The systems under study are delayed but the delay is not identified during the identification process. This is done to display the amazing property of *Generalized predictive control algorithm* that it has the ability that along with the known delayed systems, it can also control the systems without having any information about system delay.

Generalized predictive control algorithm works on plant parameters. After identifying the system parameters as fuzzy Hammerstein model, linear plant parameters are applied to the GPC algorithm that generates optimized *virtual control action*. This virtual control action is generated by keeping the system constraints in mind. By system constraints here we mean the static nonlinearity of the system which restricts a linear Generalized Predictive control algorithm to generate an actual control action for the Hammerstein model. The optimization of virtual control action is ensured by single layer convex optimization.

Finally to transform the virtual control action into actual control action, an adaptive inverse controller is defined using TS fuzzy model. This inverse model controller is made capable to cancel out the effect of any sort of nonlinearity by making use of feedback.

To test the scheme, simulations are carried out for different systems which possess different static nonlinearities and different linear dynamics. It is observed that proposed control algorithm is capable enough to control all these systems satisfactorily.