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A SUGENO FUZZY INFERENCE SYSTEMS FOR INTELLIGENT TRANSPORT SYSTEM

Arockia Jaya J.[1*], Mahalakshmi K.[2] and Senthilkumar B.[3]

[1,2]Department of Computer Science and Engineering,
[3]Department of Electronics and Communication Engineering,
[1]Idhaya Engineering College for Women, India.
[2,3]Kalaignarkarunanidhi Institute of Technology, India.

***Corresponding Author: Arockia Jaya J.**
Department of Computer Science and Engineering, Idhaya Engineering College for Women, India.

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ABSTRACT
The Artificial intelligence plays very important role in solving the real-world problem. The optimization algorithm is sub part of Artificial Intelligence. The algorithm Inspired and developed using natural selection. We propose a Sugeno Fuzzy Inference Systems (SFIS) for Intelligent Transport System. The increasing of vehicle and traffic is very challenging for government. The researchers proposed many algorithms for solving transport issue. The smart city framework is require current technology, Modern infrastructure for smooth traffic. Due to Globalization and Urbanization, the cities are need to improve the transportation systems. To solve various traffic and transportation problems a detailed analysis of fuzzy logic systems is developed. This paper presents an analysis of the results achieved using Sugeno Fuzzy Inference System to model complex traffic processes. These results are verified using MATLAB simulation.

INTRODUCTION

Framework – Intelligent Transport System

The smart city project leads to develop the ITS and should be adopt the changes due to increasing the population and vehicle. Developing the ITS is very challenging task. Hence each city having different culture, Population and Infrastructure. ITS is contributing more on safety, secure, environment friendly and clean.[1] The ITS framework is made up of different layers: Data Layer, Application Layer, Communication layer and sensing layer. Each layer addresses the specific issue. the IoT plays the vital role in Transportation System.

Component of ITS Framework

The framework layer is shown in the Figure 1.

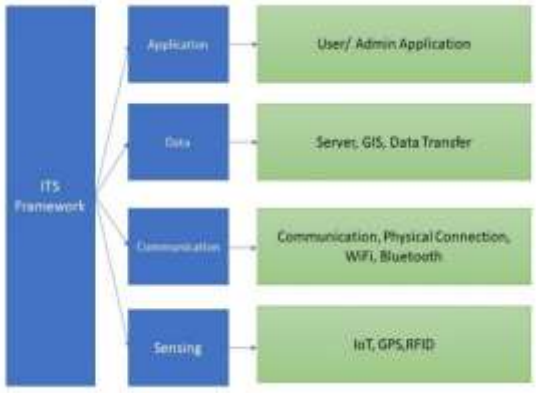

Fig 1: ITS Framework.

Application layer

The seventh layer in protocol hierarchy. The application layer used specify the shared communication protocols and communication interface methods. The application layer used to interact with the user. The FTP (File Transfer Protocol) and HTPPY (Hyper Text Transfer Protocol is based on application layer and also DNS, SMTP, MQTT Protocol. Highest level of open system and communicate to presentation layer.

Communication layer

The communication layer used to invoke the routing, connectivity and routing between the devices from the

cloud computing. The communication layer also manage the message transaction between the devices.

Data Layer
The most complicated layer in the networking infrastructure. The functionalities of the layer also difficult. This can be work between two host. The data layer is a point to point communication. Data link layer is responsible for converting data stream to signals bit by bit and to send that over the underlying hardware.[2]

Sensing layer
The IoT sensor are connected between each other and controlled by smart technology. The sensor gathered the information from environment and send to cloud for processing. The Sensor is very tiny device.

Application layer
The application layer ensure the effective communication between the any applications.
Intelligent Transport System: Overview of Architecture

The proposed ITS using Sugeno Fuzzy Inference Systems is used to show the vehicle information system regarding traffic flow, route modification and pollution. The present world is equipped with high digital and sophisticated technology. The modern technology is used to reduce the traffic flow in smart city. The mobile is a communication medium in modern world. Hence the mobilization is too high. The availability of GPS, Internet connection, easy mobility and processing capability the mobile is the only solution. The google map is predominant solution for tracking the traffic flow. Many analytical tools are available for managing the traffic flow. Moreover, specialised and more accurate sensors like accelerometer, Global Positioning System (GPS), and shock sensor etc. services are realised. Also, specific and more accurate sensors like accelerometer, global positioning system, and amaze sensor so on so forth are outlined and created on various stages and new technologies integrating with existing technologies in a single integrated system. The birds view of proposed architecture shown in the figure 1.

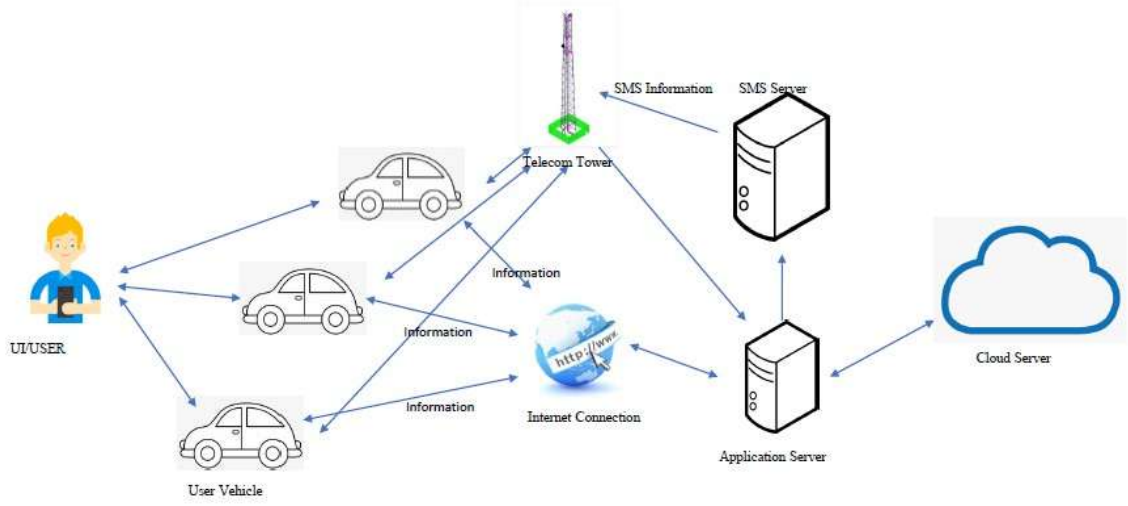

Fig 1: Birds View of Proposed Architecture.

The unknown person entering any big cities and find the shortest and less traffic ways is very difficult. In our proposed system, any user can easily find the alternative route very efficiently. The sugeno fuzzy inference system effectively reload the path. The figure 2 display the sample map of traffic. The following advantage using the Sugeno fuzzy system in ITS.

- The traveler receives the real time data about the traffic, Pollution and re-route.
- Real time data streaming.
- Environment monitoring system about the pollution status.
- Increase the individual mobility.
- Crash prevention and safety.
- Optimized data processing.
- Fastest response time about traffic.

Fig 2: Traffic map.

Sugeno fuzzy inference system Based Transport System

In this paper, we present sugeno fuzzy inference system (SFIS) based Intelligent Traffic Congestion control (ITCC) for Smart cities in India. The analysis process of traffic is based on sugeno fuzzy inference system. The Sugeno model was introduces in the year 1985.[1] Which is similar to Mamdani method in many views. The following two methods are same as Mamdani method: fuzzifying the input and applying the fuzzy operator. The output of Sugeno function is either constant or linear. This is the main difference between Sugeno and Mamdani. In this proposed method, we are considering the following factor: Speed of the vehicle (S), Distance between each signals (d), Vehicle capacity (V), Signals (t) and Riding Distance (r). We have considered the above-mentioned input to build the lookup table.

The mathematical representation is follows.

if input 1 = x and input 2 =y, then output is z=ax+by+c

The following are advantages of Sugeno method

- High computationally efficient.
- Outperforming well in linear techniques.
- Suitable for Adaptive and optimization techniques.
- Well suited to mathematical analysis.

The following variable used in proposed model for ITCC applications

Table 1: Step for Proposed method.

S.No	Description
1	Input: d → Distance between signal T→ Riding Distance V→ Vehicle capacity s→ Speed t→ Signals
2	Membership function are different for each variable listed in step 1.
3	The membership function used to build the fuzzy inference.

Intelligent Transport System – Structure Overview.

The proposed ITS structure of Communication between cluster shown in the figure 3. The smart cities are divided in to segmented based on the population, vehicle traffic and environment. In figure 3, each cluster can communicate between each other. The table 1 represents the proposed SFIS algorithm steps. The mathematical representation is follows.

μ_{CG} = SFIS [μ_{cs}, μ_{dt}, μ_{dts}, μ_{Td}]

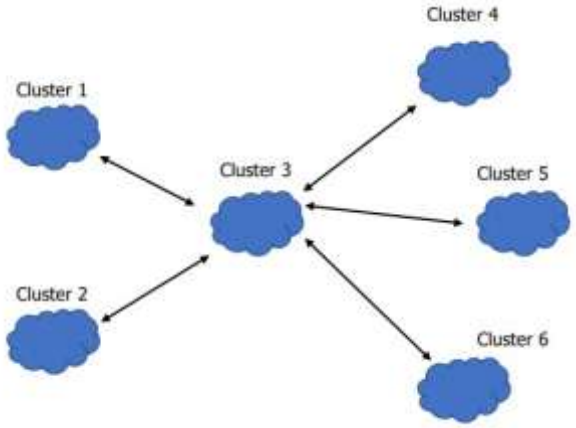

Fig 3: Communication between cluster

In our proposed system, the Intelligent Transport system (ITS) is developed using Sugeno Fuzzy Inference Systems. The figure 4 shows the input and output surface output of SFIS.

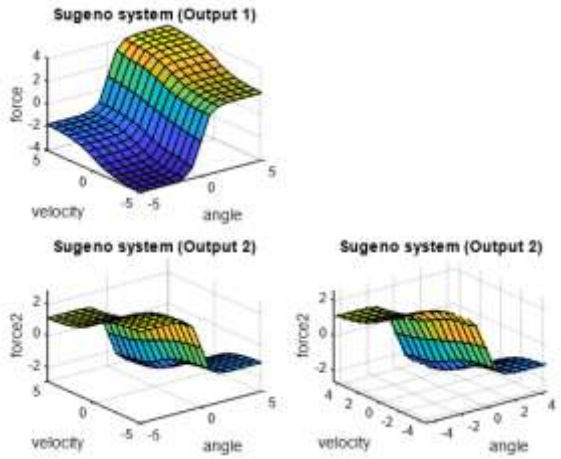

Fig 4: I/O surface of SFIS.

Input Variable Range

The detailed variable parameter value is shown in the table 2.

Table 2: Input variable.

S.No	Input Parameters	Ranges	Semantic Description
1	μ_{CG}	0-25 30-60 50-100	Slow Medium fast
2	μ_{cs}	0-30 25-55 60-105	Slow Average fast
3	μ_{dt}	0-15 5-10 10-25	Slow Average fast
4	μ_{dts}	4-8 3-9 5-20	Slow Average fast
5	μ_{Td}	0-15 8-22 15-34	Near Near far

Fuzzy sets
The fuzzy input set variable is used to calculate about the Traffic congestion in the city. Typically, fuzzy set based on statistical value.

Fuzzy output value
The fuzzy output value is used to display the result of fuzzy input. The output of fuzzy set is shown in the Table 3.

S.No	Output	Ranges	Semantic sign
1	Traffic Analysis	1-9 2-6 1-2	Delay Delay Delay

De-fuzzifier
The De-fuzzifier are used to represent a traffic surface in the figure 5.

From the figure 5:
vehicle speed- 0-120km/h
Traffic Signals: lies between 0-15
we can conclude, the congestion of the traffic is 70-80%.

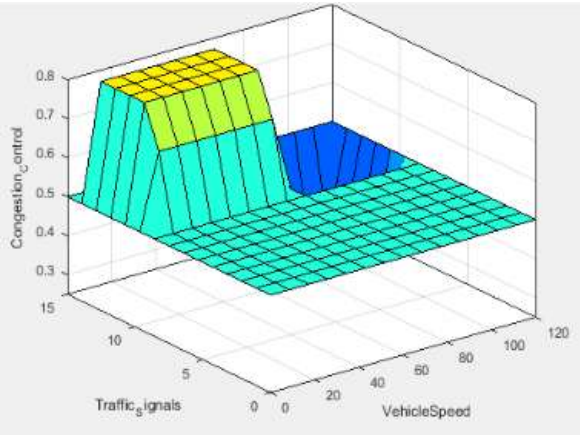

Fig 5: Defuzzifier for SFIS.

Simulation
For simulation result

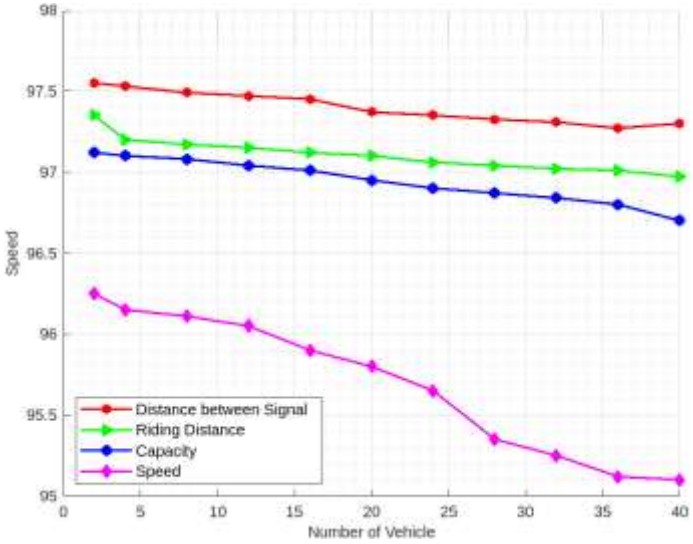

Fig 5: Lookup Simulation Result.

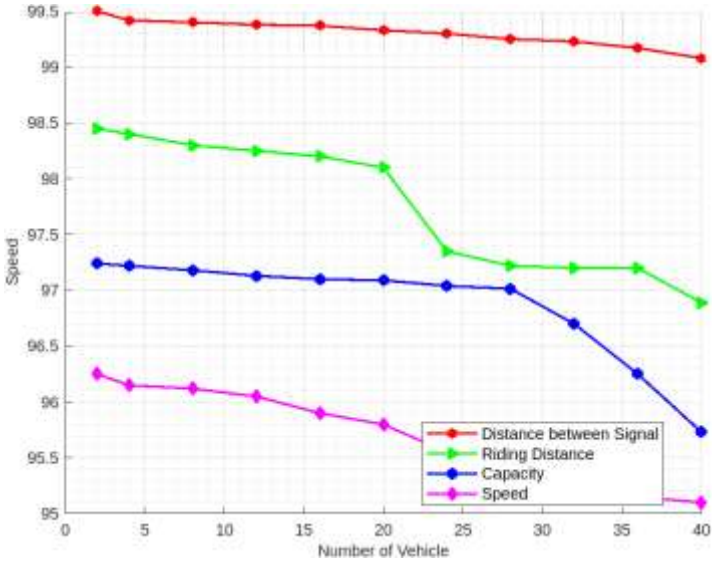

Fig 6: Lookup Simulation Result.

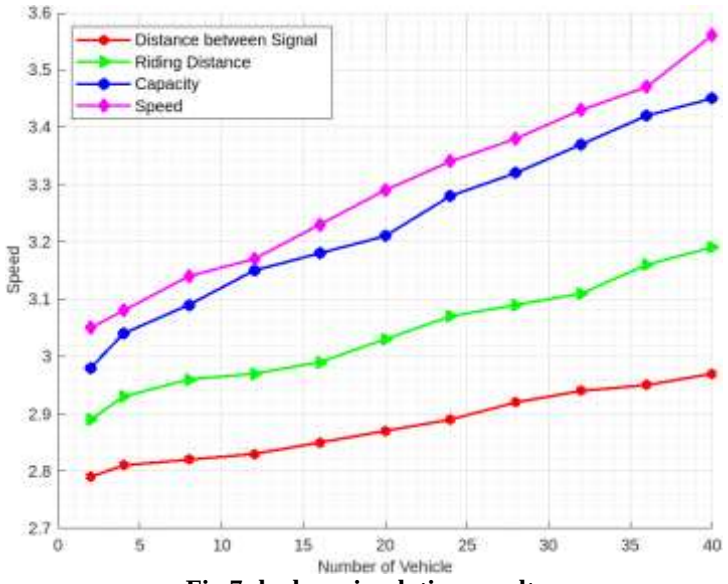

Fig 7: lookup simulation result.

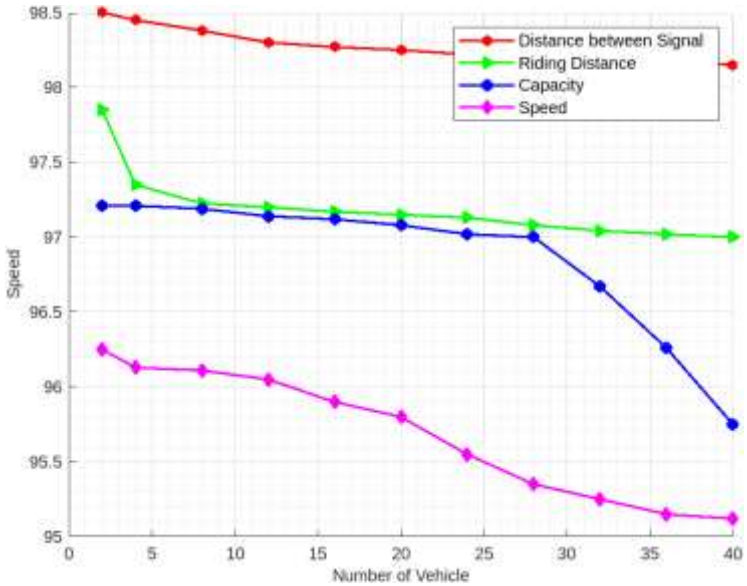

Fig 8: lookup simulation result.

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