Chapter 5
Design of Fuzzy Logic Controller for Up to 25MW Hydropower Plant

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ABSTRACT

In this chapter the emerging control techniques for 25 MW small hydropower (SHP) plants which utilize fuzzy logic are compared with conventional PID control for the speed control of hydraulic turbine in terms of rise time, smoothness of response, settling time, and overshoot in wicket gate opening with the response to change in turbine speed. In the case of the PID controller, gain adjustment (tuning) is required. The fuzzy controller algorithm is based on intuition, experience, and it incorporates a simple, rule-based IF X AND Y THEN Z approach. These controllers obtained don't require gain adjustment. The work done is a small step towards the automation of the hydropower plants.

INTRODUCTION

Hydropower is one of the prime resources of energy. Flowing water contained energy that can be converted into electricity. This is called hydropower. Hydropower is currently the world's largest renewable source of electricity, accounting for 6% of worldwide energy supply or about 15% of the world's electricity. Small hydropower can also be broadly categorized into three types as follows: (i) Run-of-River Schemes (ii) Canal Based Schemes (iii) Dam Toe Based Schemes. The following is an equation, which may be used to roughly determine the amount of electricity, which can be generated, by a potential hydroelectric power site: Power in kW (P) = 9.81x Q x H xη;Where Q: Discharge in cumecs/ m3/s; H: Head in meters;η: Overall efficiency of power conversion system.There is a lot of literature available on PID, Fuzzy, Neural as well as Hydropower Plant modeling. The basic concept of fuzzy logic paper by I.Horowitz and Englewood Cliffs has been used. The details of fuzzy controller design research have been taken from a paper by A.Katbab. The paper by Y.F.Liu and C.C.Lau in which the performance of Proportional-Integral-Derivative controllers and fuzzy controllers are compared in terms of steady-

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state error, settling time and response time is beneficial in laying the foundation for understanding the essential elements of fuzzy logic.

BACKGROUND

Hydroelectric power is a renewable resource form of energy. Hydropower provides about 96 percent of the United States ‘ renewable energy. Many sources of renewable energy include geothermal, earthquake, tidal, wind, and solar power. As other power plants can, hydroelectric power plants do not use energy to generate electricity or pollute the air, soil, or water. Hydroelectric power has played a significant role in the growth of the electric power industry of this country. In the early expansion of the electric power industry, both small and large advances during hydroelectric power were instrumental.

Hydroelectric power comes from mountain streams and deep ponds, floodwater, winter, and spring runoff. Water can be used to transform turbines and generators that produce electricity when it falls by the force of gravity. Hydroelectric power for our nation is critical. Growing populations and modern technologies require large quantities of electricity to produce, develop, and extend. Hydroelectric plants supplied up to 40% of the electricity produced in the 1920s. Although the amount of energy generated by this method has increased steadily, the amount produced by other types of power plants has increased at a faster rate, and currently supplies hydroelectric power about 10 percent of the electrical generating capacity of the United States. The capacity of hydropower to rapidly react to varied loads or system disruptions, which baseload plants can not handle with a combustion-powered steam system or nuclear operation, is necessary for the national electricity grid. Averaging 42 billion kWh (kilowatt-hours) per year, reclamation= 58 power stations in the West generate enough to meet the residential needs of over 14 million people.

That is about 72 million barrels of petroleum energy equivalent. The most powerful means of producing electricity are hydroelectric power stations. The new hydroelectric power station’s output is about 90%. Hydropower plants do not create air pollution, fuel drops do not consume water, long-life projects compare with other forms of power generation, and hydropower Generators react to device conditions that change rapidly. Such good qualities continue to make power sources for hydroelectric projects appealing.

Micro Hydro Power Plant (MHPP) provides power to a small rural area. On small streams, canals, and a branch of the river in the mountainous areas, Micro Hydro can be produced. The building of the dam, the reservoir, or water storage is not necessary for Micro Hydro Power engineering. This makes technological advantages for Micro Hydro Power. Only a power pipe from a river to a powerhouse prevents the running water. The water used for operating a turbine is drawn without loss from the same flow. It does not require gas fuel ignition. Only water that is the natural source of Ethiopia’s land is used to sustain the parameters of power plant energy within its allowable limits by the generation of electricity from the Micro Hydro Power Plant.

For the appropriate performance and practical use, it is essential to maintain the parameters of output power. The mechanical controller regulates water flow through the turbine in an extensive hydraulic system to suit the electricity generated from the grid to the demand.

However, mechanical control systems are complicated to reduce, and smaller accounts tend to be as costly as larger ones, because costs per kW increase rapidly, as their size decreases.

Hydropower comes from running water, moving water. The sun enhances the hydrological cycle that gives earth its water can be seen as a solar energy form. The air-water reaches the surface of the Earth