Simulation of ARMAX model for Forecast of Power Output of a Photo-Voltaic Grid

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***Abstract*—This work is devoted to the simulation of an ARMAX model proposed in the literature for better forecasting of power output of a Photo-Voltaic (PV) grid; the model includes information of environmental inputs (average temperature, precipitation amount, insolation duration, humidity) that classical time series approaches did not include. The simulation is performed using three different noise distributions in order to establish a comparison of the time series.**

***Index Terms*—ARMAX, Photo-Voltaic grid, simulation, random noise, outliers, environmental inputs, time series.**

I. Introduction

Photo-Voltaic (PV) systems, nowadays, are growing relevant due to the increasing obligation to global warming and production of renewable energies. It is often desired to forecast the amount energy that can be obtained through these systems, in order plan its distribution and usage.

II. Problem Formulation

As previously mentioned, the output of the PV system is an stochastic process. The standard approach to forecasting the behavior of this system has been modelled using ARIMA models, using only information of the past of the same system, but it does not take into consideration the external environmental factors that may affect the power output [1]; as for the problem of this particular work, the main objective is to simulate the ARMAX model proposed in [1] with different noise distributions, particularly with outlier behavior and show that it is not always adequate to assume normality of some random processes.

III. Theoretical Approach

A. General ARMAX model

This work uses an ARMAX model presented in the literature; hereby, let the general ARMAX model be presented:

$$z_{t+1} = \sum_{i=0}^{h_1} a_i z_{t-i} + \sum_{i=1}^{m}\sum_{j=0}^{h_2} b_{ij} u_{i,t-j} + \sum_{i=0}^{h_3} c_i \xi_{t-i} \tag{1}$$

for $t = 0, 1, 2, \ldots$; $u_{l,k}$ are external inputs (type l and lag k), and ξ_k are random noises of lag k.

B. Rössler System

The Rössler system is a set of ordinary differential equations:

$$\begin{cases} \dot{x} = -y - z \\ \dot{y} = x + ay \\ \dot{z} = b + z(x - c). \end{cases} \tag{2}$$

These equations originally proposed by O. Rössler in [2]; it is well-known that, under certain parameters, the output of the state variable z presents peaks in a aperiodic (stochastic) manner [3]. This model is used to emulate the behavior of one of the inputs for the ARMAX model, since it presents quite an unusual behavior and this method gives a decent representation.

C. Normal Distribution

Let ξ be a random variable. We say $\xi \sim N(\mu, \sigma)$ if the probability density function is given by

$$f(x) = \frac{1}{\sqrt{2\pi}\sigma} e^{-\frac{1}{2}\left(\frac{x-\mu}{\sigma}\right)^2} \tag{3}$$

with mean μ and standard deviation σ.

D. Cauchy Distribution

Let ξ be a random variable. We say that ξ has a Cauchy distribution if the probability density function is given by

$$f(x) = \frac{1}{\pi\gamma}\left[\frac{\gamma^2}{(x-x_0)^2 + \gamma^2}\right] \tag{4}$$

with location parameter x_0 and scale γ.

IV. Numerical Aspects

A. ARMAX Model

In this particular case, the model obtained in [1] is:

$$\begin{aligned} z_t =& 237.565 + 0.426 z_{t-1} + \xi_t - 0.153\xi_{t-1} + 8.9087 u_{1,t} \\ &- 1.557 u_{7,t} + 31.919 u_{8,t} - 2.045 u_{9,t} \end{aligned} \tag{5}$$

where z_t is the power output of the PV grid in Watts (W); $u_{1,t}$ is the daily average temperature, $u_{7,t}$ is the precipitation amount, $u_{8,t}$ is the insolation duration and $u_{9,t}$ is the humidity.

V. Numerical Results

In the following figures, the simulations of the model for different distributions can be found.

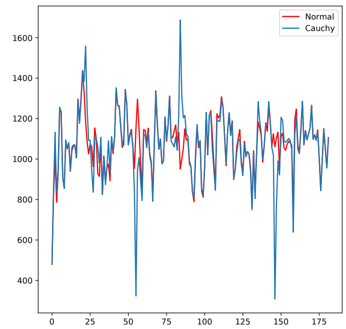

Figure 1: Results using Normal and Cauchy distribution.

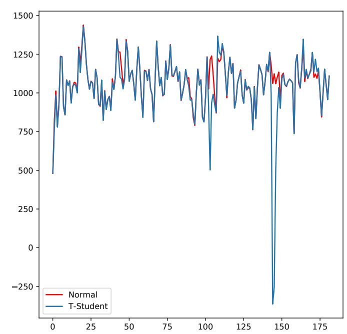

Figure 2: Results using Normal and T-Student distribution.

VI. Conclusions

References

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