Universidad Pontificia Bolivariana
SECCIONAL BUCARAMANGA

SIIDI 2017
International Week of Research Development and Innovation

CIIMCA 2017
CICTS 2017
RIIVI net

Design of one DOF solar tracking for PV system using fuzzy logic controller

MSc(c) Rafael Núñez R.

MSc. Fabio Gonzalez

Ing. Elkin Velasco

Ing. Edisson Rueda

uts Unidades Tecnológicas de Santander

Vigilada Mineducación

UNIVERSIDAD NACIONAL DE COLOMBIA
ICETEX
CDT AgroIN Centro de desarrollo tecnológico para el agro y la industria
Fellows Colombia
GiDeTechMa Grupo de investigación en Desarrollo Tecnológico, Mecatrónica y Agroindustria

1. Introduction

- Techniques for supervisory control of two axes solar tracker, have led to increased efficiency in PV system, since the driver needs only executed when an event has occurred, reducing energy consumption of the actuator.
- Efficiency increased close to 10%, with the implementation of a two-axis solar tracker low cost for a PV system with a strategy On-Off
- Mechanical structures based on parallel manipulator are implemented using robust control techniques in adaptive sliding mode, allowing validate such structures for tracking solar radiation to a PV system.
- A variant to the conventional PID control systems applied to solar trackers, have been proposed intelligent control techniques based on a PI structure to parametric variations in the mechanical structure of the follower, with an easy tuning methodology.

Vigilada Mineducación

1. Introduction

- This work describes the implementation of a system based on fuzzy logic for monitoring solar radiation of a structure of one DOF and a PD controller is proposed. The modeling of the solar tracker is proposed; the design PD Fuzzy controller and the design parameters described. The performance about efficiency of the generator in a mobile structure of one DOF, is shown.

Vigilada Mineducación

2. Modeling

Vigilada Mineducación

2. Modeling

Shadow Line detectors relative position.

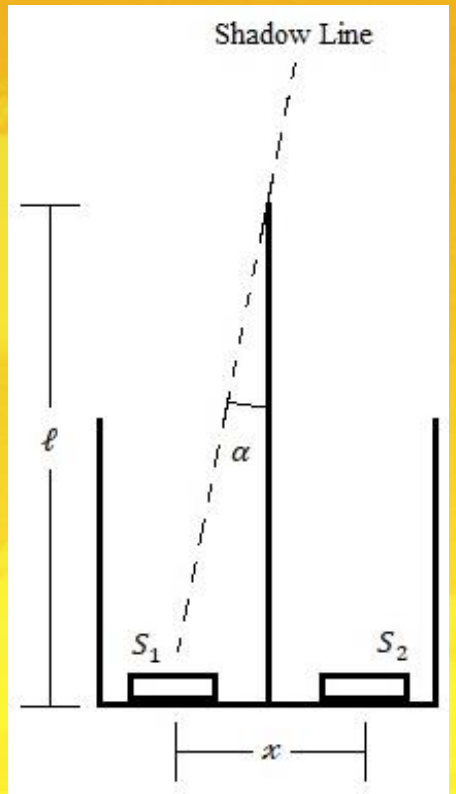


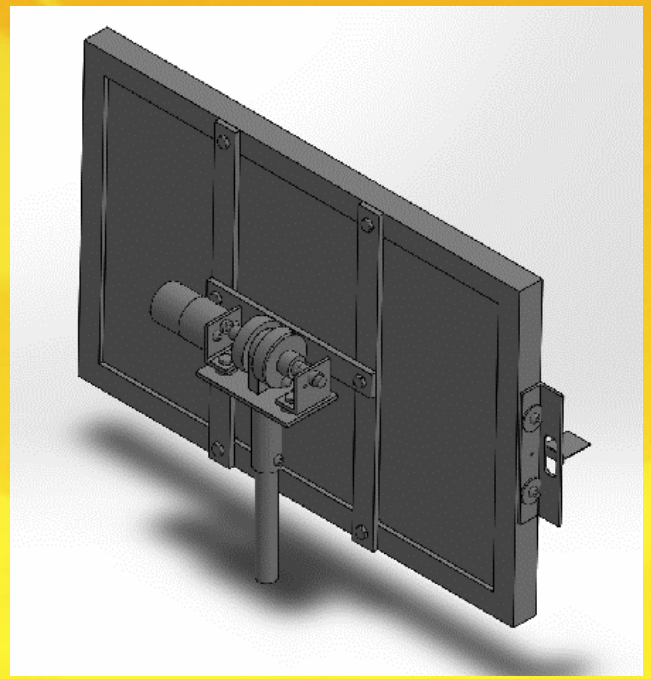
Table 1. Detector algorithm of relative position sun

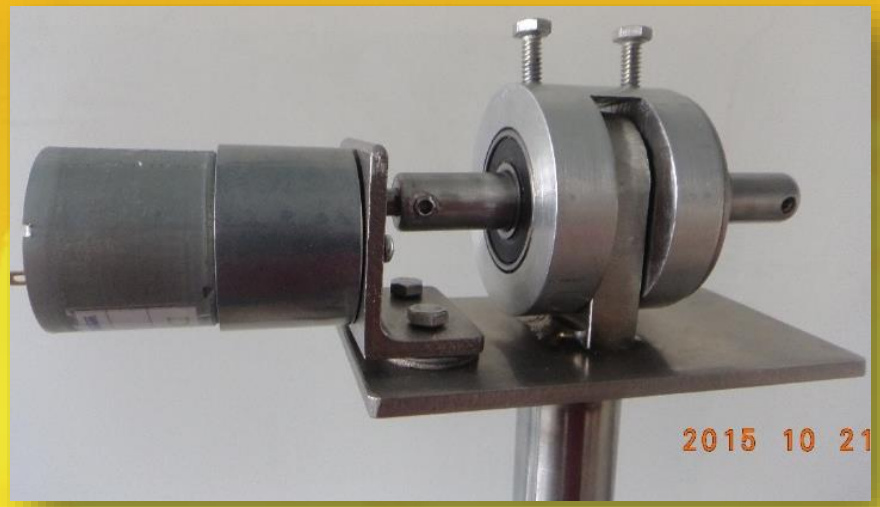
$Read\ analog\ signal\ LDR_1\ and\ LDR_2$
$Disf_{LDR}{=}LDR_1 - LDR_2$
$If \quad Disf_{LDR} > 0$
$Position\_sun = Position\_sun - 7.5°$
$Elseif \quad Disf_{LDR} < 0$
$Position\_Sun = Position\_sun + 7.5°$
end
$Referencia\_Control = Position\_sun$
End

Vigilada Mineducación

2. Modeling

Mechanical structure 20Wp solar panel.

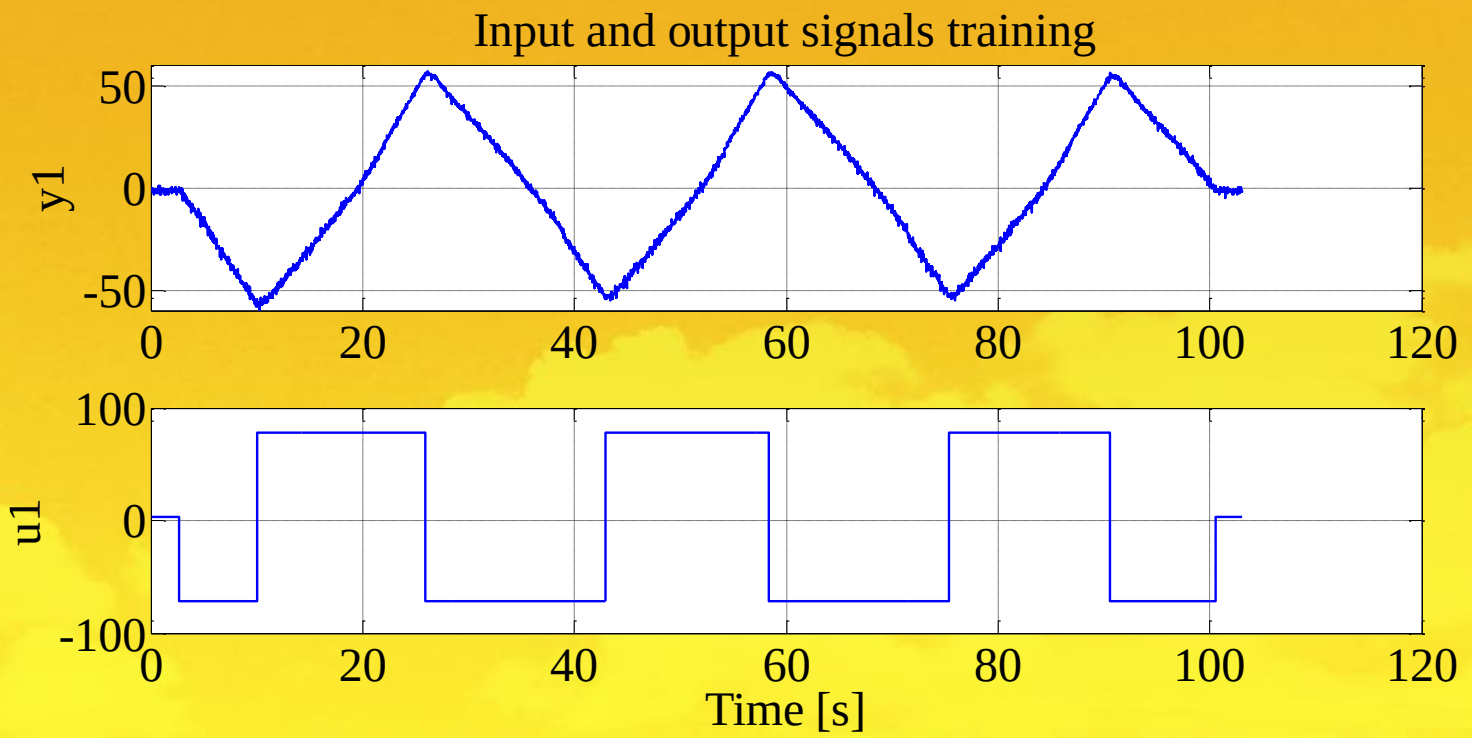




Universidad Pontificia Bolivariana
SECCIONAL BUCARAMANGA
SIIDI 2017
CIIMCA 2017
CICTS 2017
RIIVI net
Vigilada Mineducación

2. Modeling

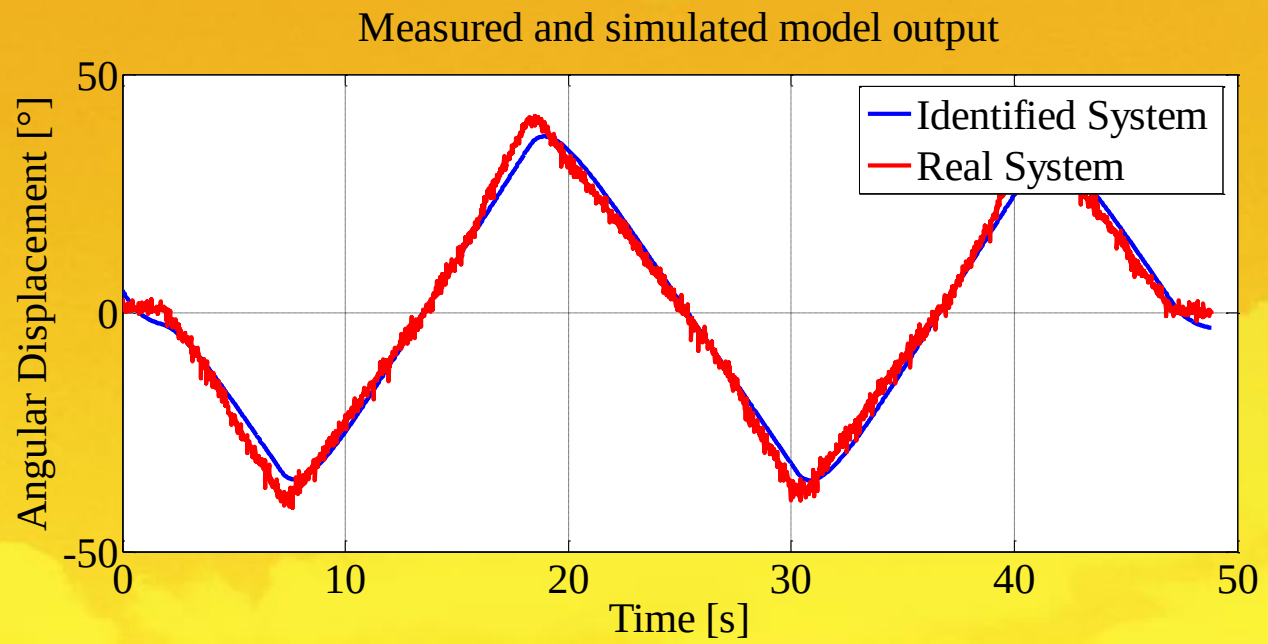
Input-output data for identification.



Vigilada Mineducación

2. Modeling

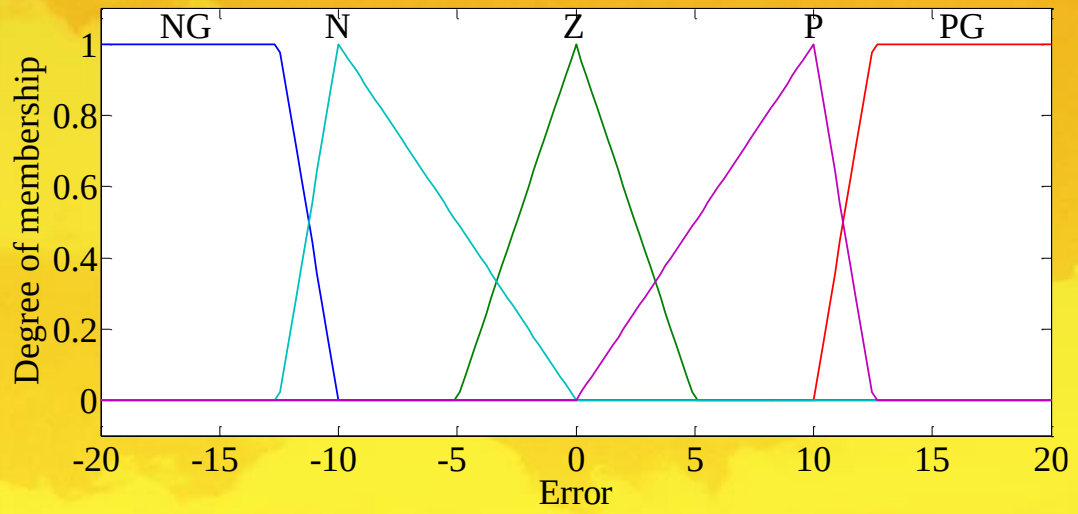
Validation of the mathematical model of the system

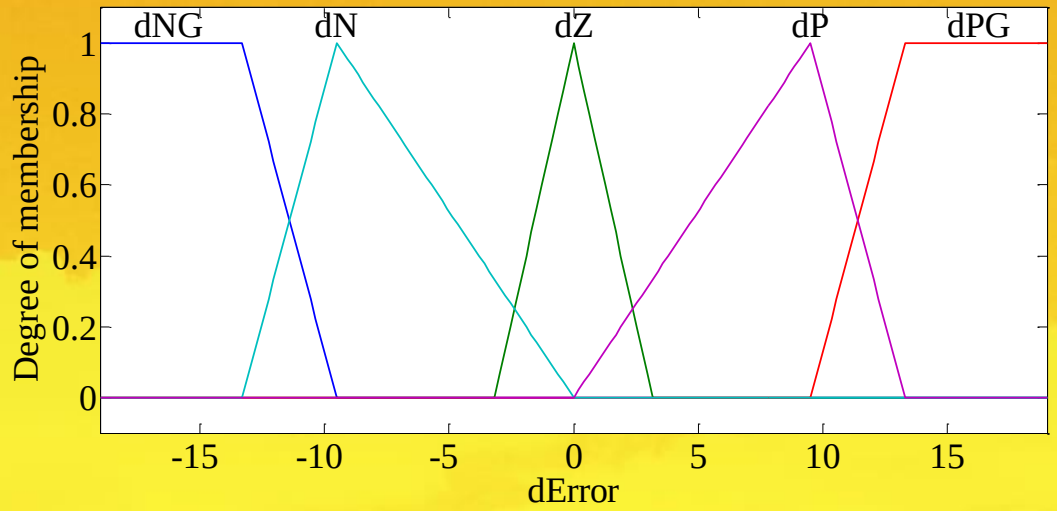


$$G(s) = \frac{0.095}{s(1 + 0.996s)} \qquad (1)$$

3. Fuzzy Logic controller

Set belonged input variable Error and dError





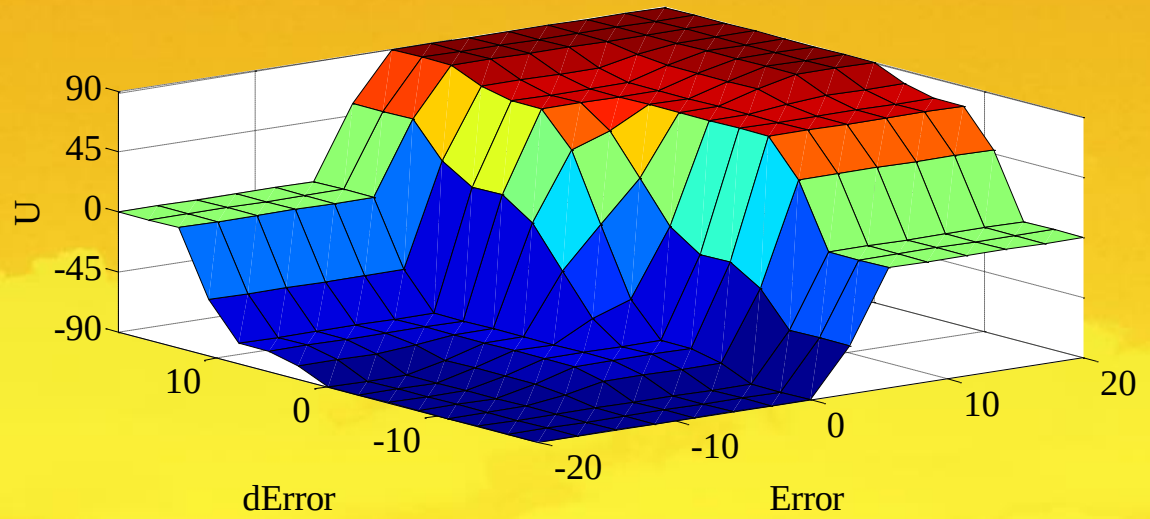
Universidad Pontificia Bolivariana
SECCIONAL BUCARAMANGA
SIIDI 2017
CIIMCA 2017
CICTS 2017
RIIVI net
Vigilada Mineducación
Formación integral para la transformación social y humana
www.upb.edu.co

3. Fuzzy Logic controller

Surface Takagi-Sugeno Fuzzy Control

Table 2. Fuzzy rules based controller

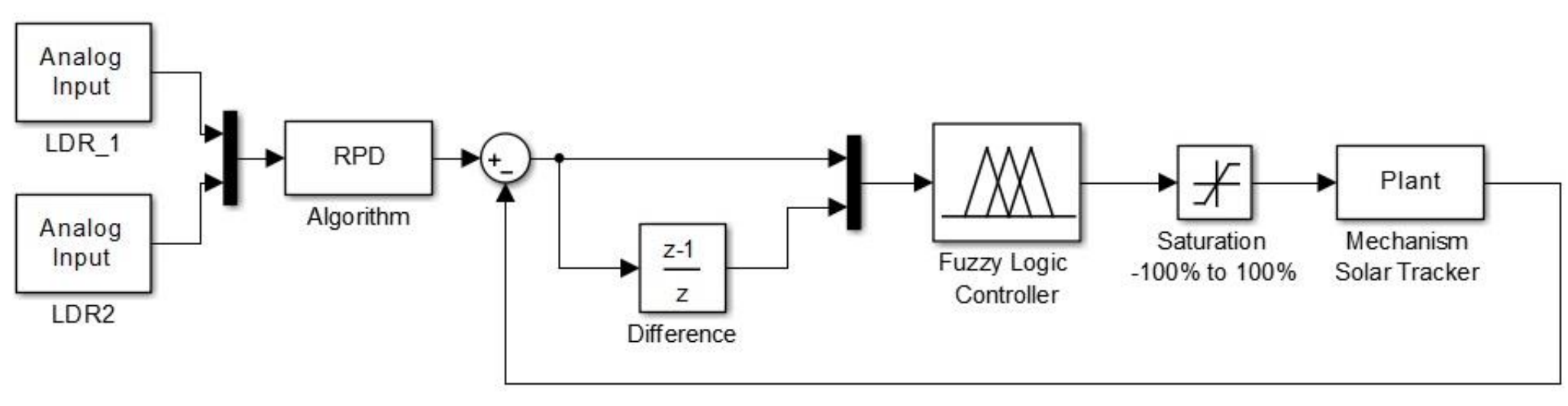
Error	Error				
Δ	**NE**	**N**	**Z**	**P**	**PG**
DNG	NG	NG	NG	Z	Z
dN	NG	N	N	P	P
dZ	NG	N	CZ	P	PG
dP	N	N	P	P	PG
DPG	Z	Z	PG	PG	PG



Vigilada Mineducación

3. Fuzzy Logic controller

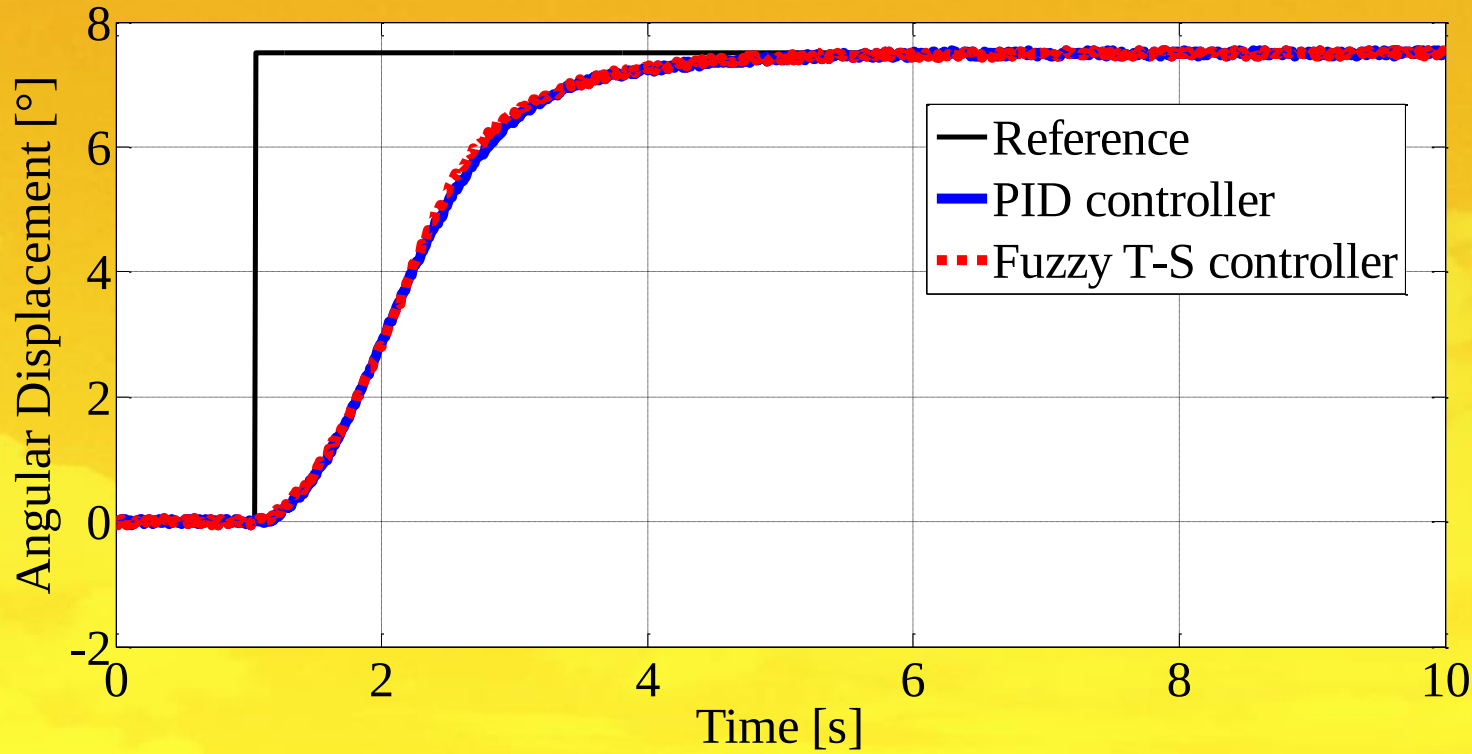
Fuzzy controller block diagram Position



Vigilada Mineducación

4. Result

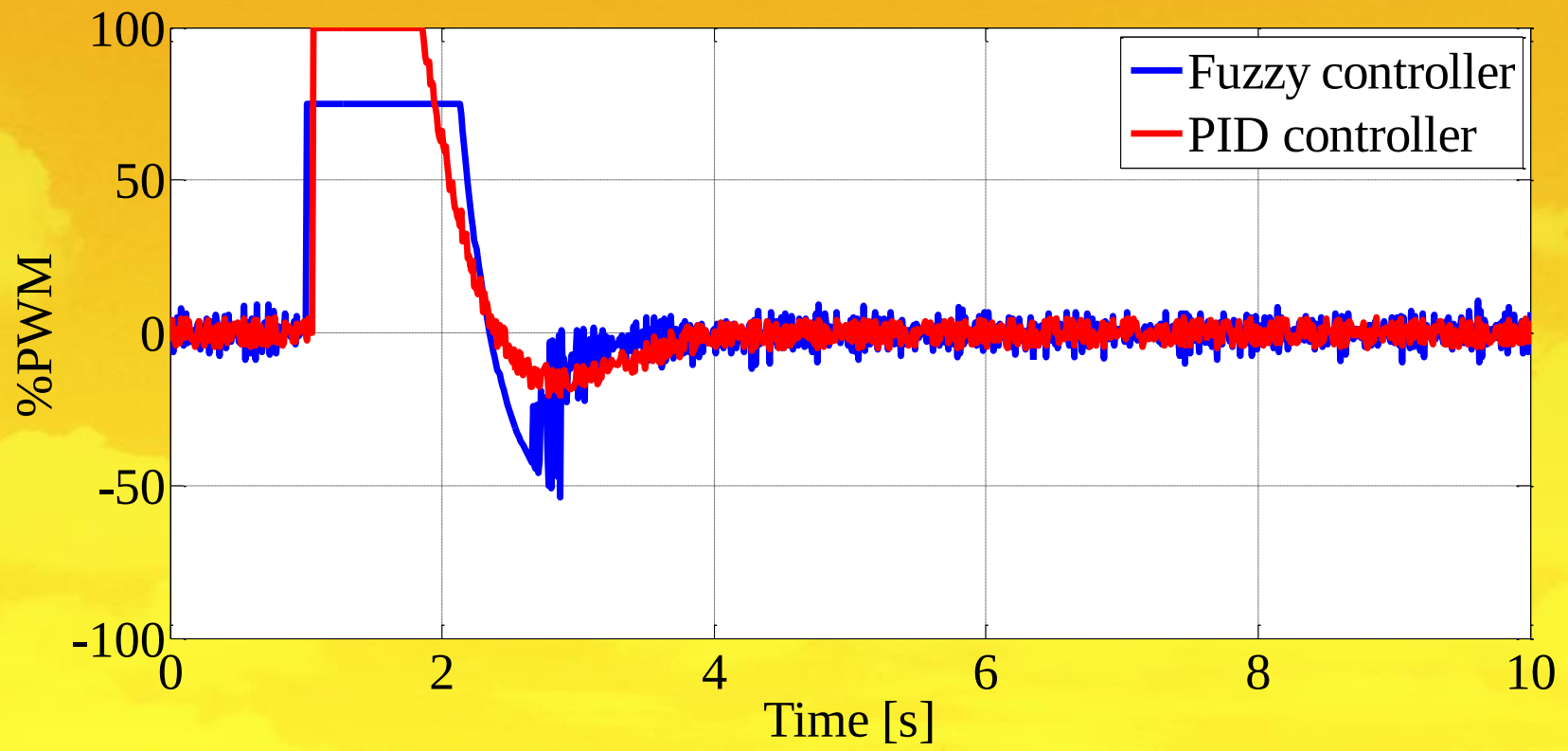
Fuzzy controller TS response regarding PD controller



Vigilada Mineducación

4. Result

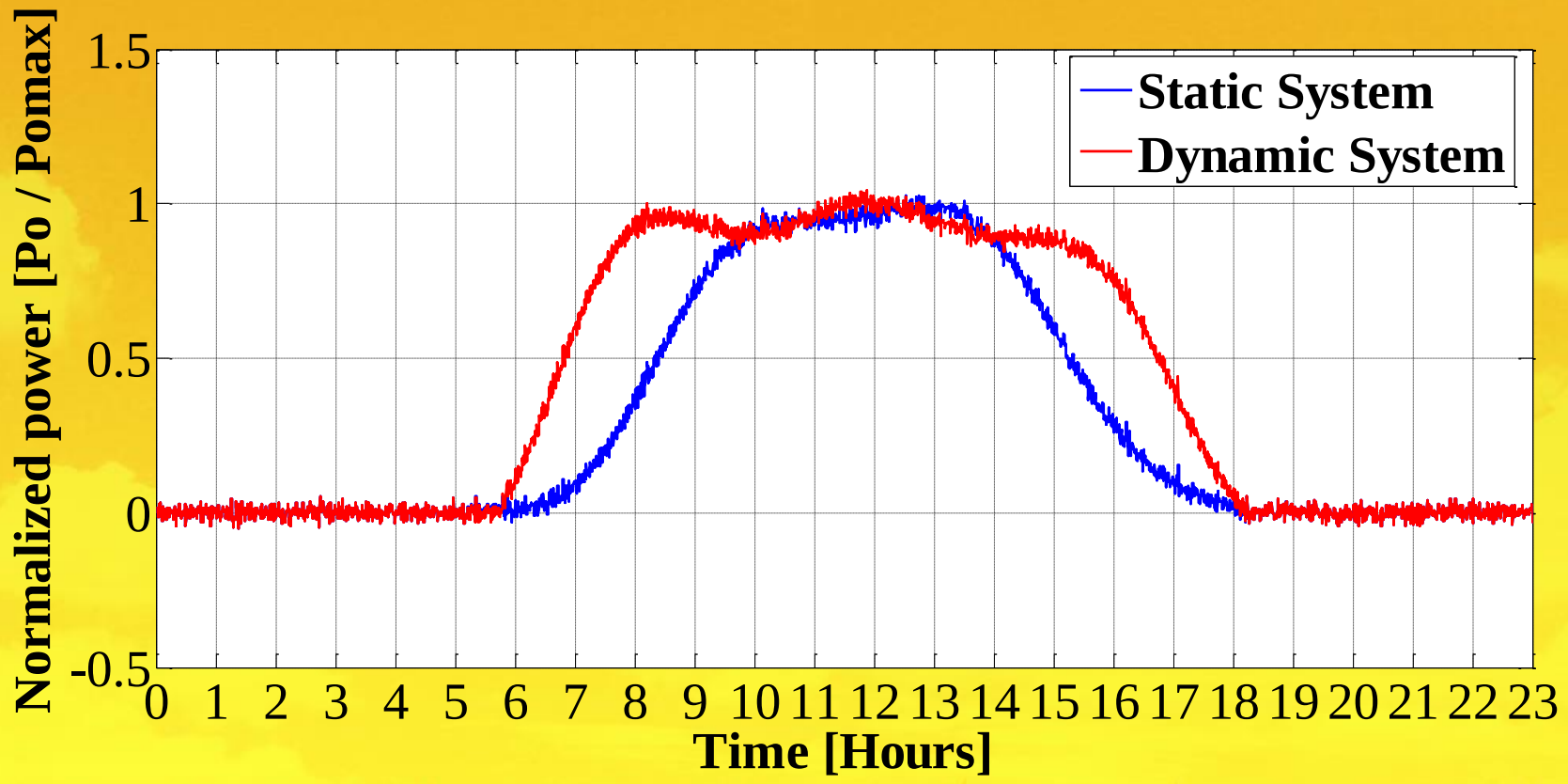
Fuzzy control signal TS about controller PD controller.



Universidad Pontificia Bolivariana
SECCIONAL BUCARAMANGA
SIIDI 2017
CIIMCA 2017
CICTS 2017
RIIVI net
Vigilada Mineducación
Formación integral para la transformación social y humana
www.upb.edu.co

4. Result

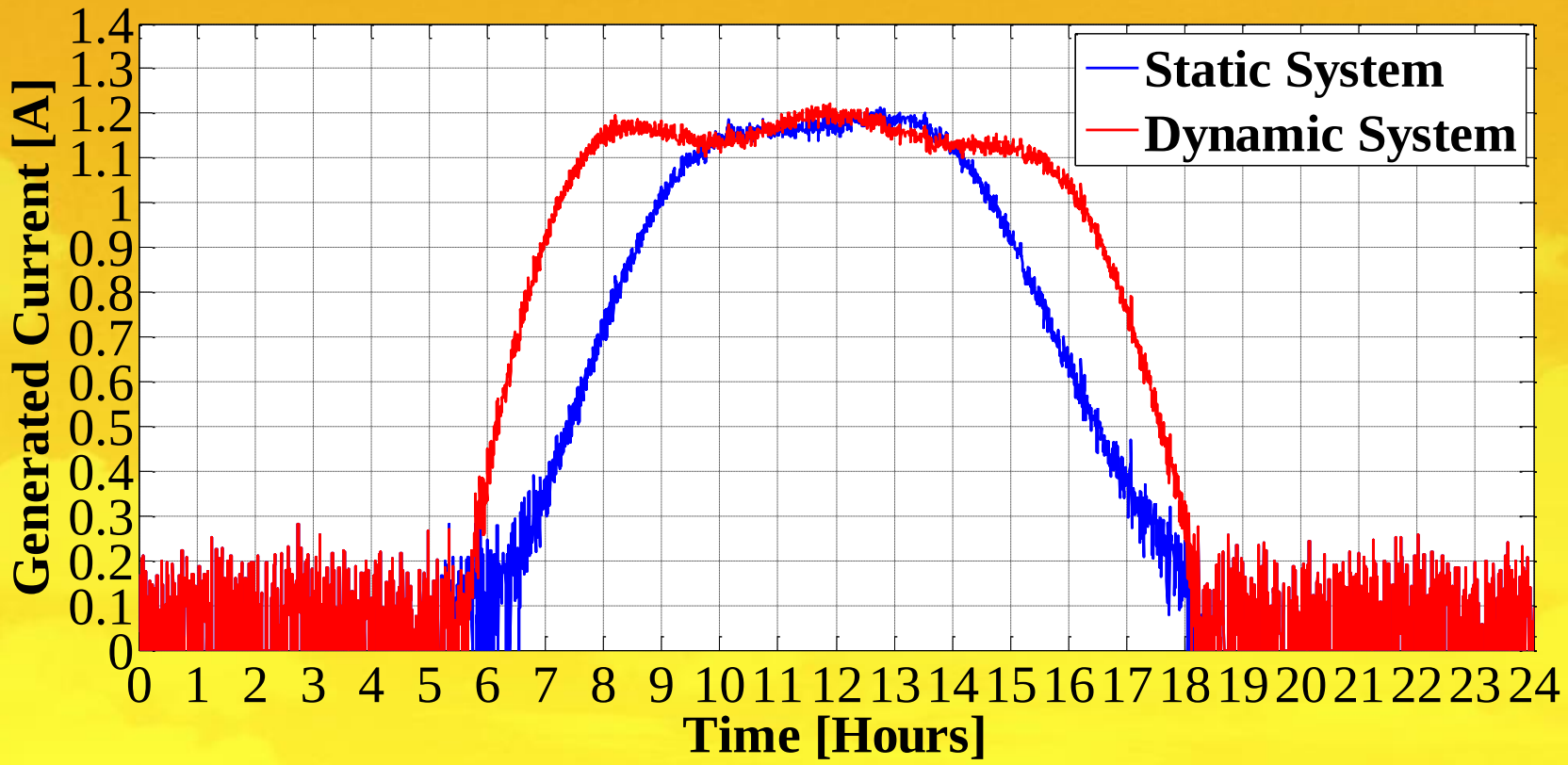
Normalized power tracking PV system regarding fixed system.



Universidad Pontificia Bolivariana
SECCIONAL BUCARAMANGA
SIIDI 2017
CIIMCA 2017
CICTS 2017
RIIVI net
Vigilada Mineducación
Formación integral para la transformación social y humana
www.upb.edu.co

4. Result

Current generated tracking PV system regarding fixed system



Universidad Pontificia Bolivariana
SECCIONAL BUCARAMANGA
SIIDI 2017
CIIMCA 2017
CICTS 2017
RIIVI net
Vigilada Mineducación
Formación integral para la transformación social y humana
www.upb.edu.co

5. Conclusions

- The Fuzzy controller obtains a dynamic response similar to that exhibited by a conventional PD controller: without overshoot, with a settling time close to 4 S, and steady-state error close to zero. However, the PD controller saturates the actuator to get a response with the same temporal characteristics that TS the Fuzzy controller, since the high signal PD control for the system to reach a reference of 7.5 ° is 100% PWM duty cycle. The Fuzzy controller for a similar response signal applies a maximum 75% duty cycle and PWM.

Vigilada Mineducación

5. Conclusions

- The average power generated by the fixed system is near to 90 Wh, while the tracking PV system produces 160 Wh, so that this sytem produces 56% more energy compared to fixed system.
- The PV tracking system is more efficient, since the energy generated by is prolonged for more time, approximately about 8 hours exceeding the estimated time of a solar day, which in Bucaramanga is around 4.5 Hours

Vigilada Mineducación

Thanks!
Any questions?

Universidad Pontificia Bolivariana
SECCIONAL BUCARAMANGA

SIIDI 2017

CIIMCA 2017

CICTS 2017

RIIVI net

Vigilada Mineducación