Analysis of relevant variables to monitor a photovoltaic charging station through FDM

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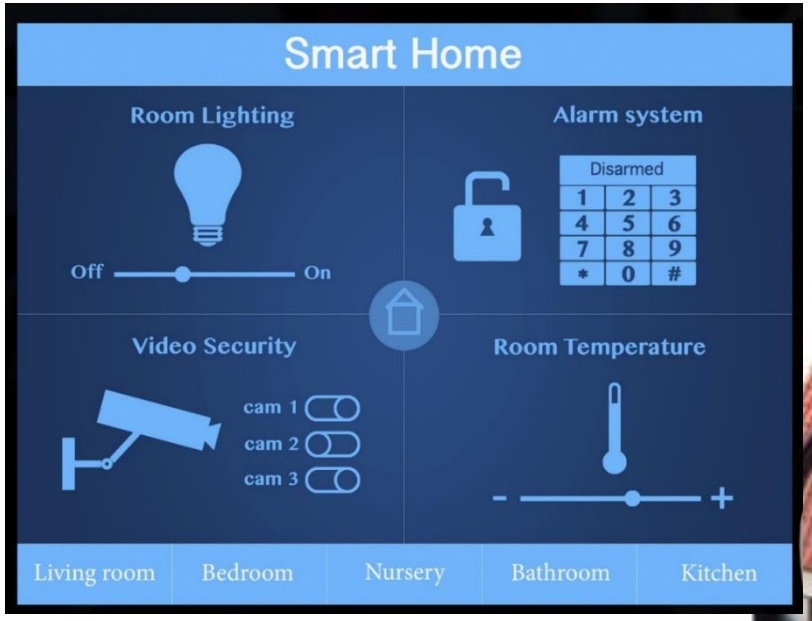

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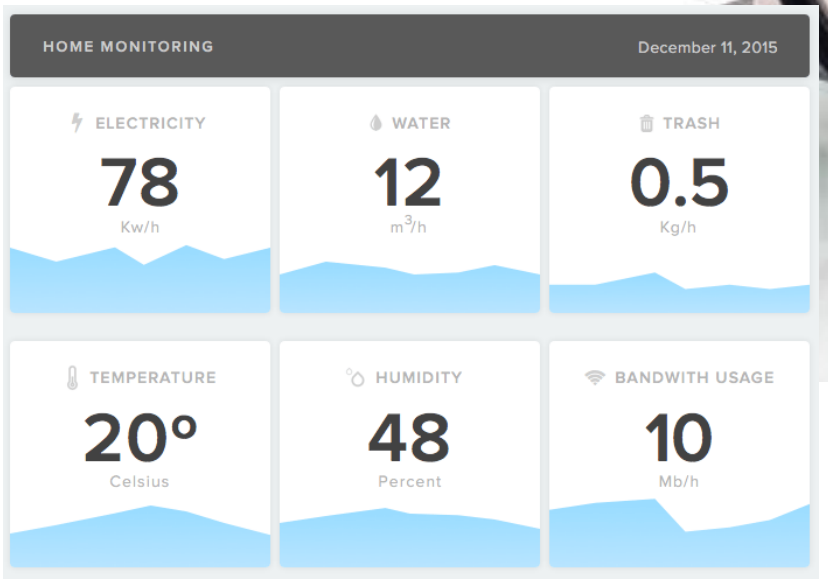

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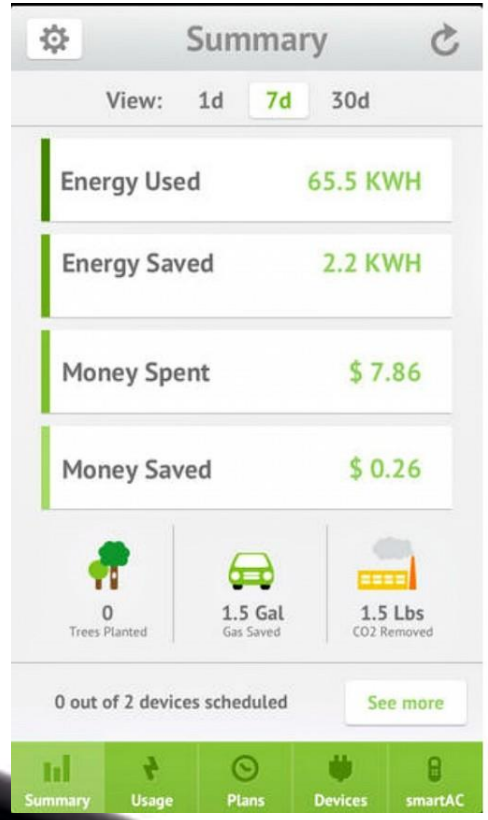

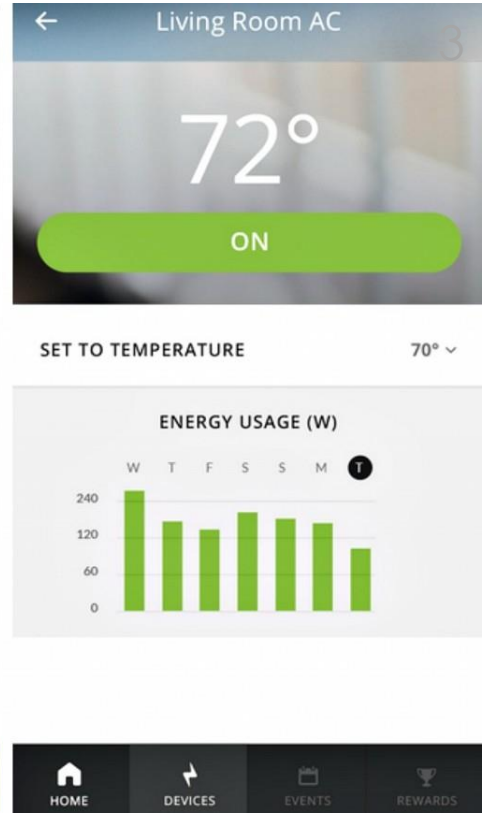

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1. Introduction

Monitoring and Control

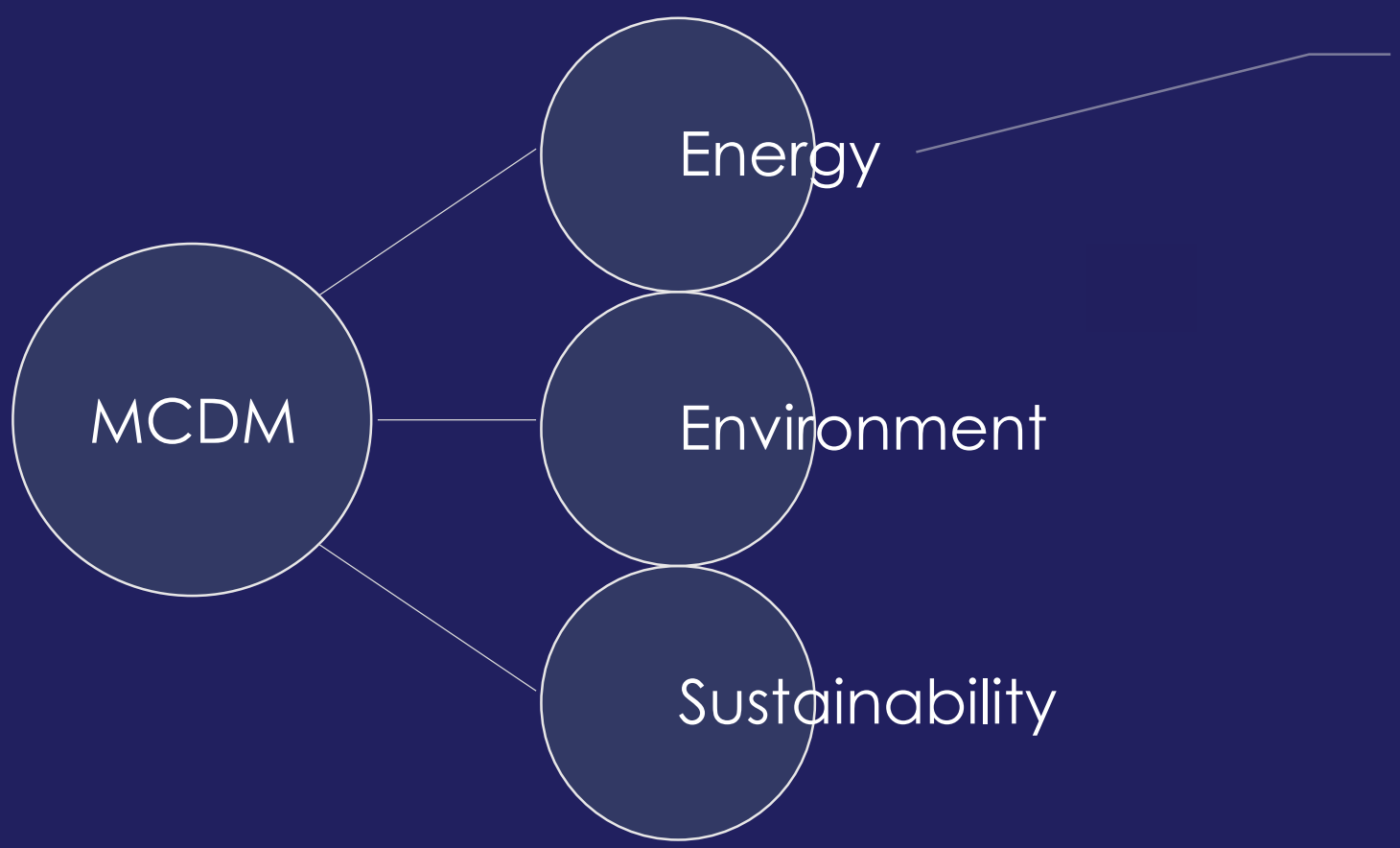
- Permanent operation
- Errors detection
- Possible improvements
- Historical data

Monitoring and Control

Big datasets = High computational time + High computational cost

(Kim, 2006)

Monitoring and Control



(Mardani et al, 2015)

"electrical sensors and smart meters to monitor and exchange information with a control center" (Su et Al, 2012)

Optimization
Improvement

Selection of devices involves multiple factors

"the wireless communication technology to be employed depends on the distance between communicating hot spots and the amount of data to be transmitted" (Mwasilu et Al, 2014)

Function to Data Matrix (FDM)

- Seeks the relationship of variables with the main functions of a system considering its operational states.

(Fernández-Montoya, 2017)

- Used for the control of the Racing Solar Vehicle *Primavera1,* obtaining, from 168 initial variables, 30 relevant variables.

- Includes objectives, success criteria, basic functions and restrictions.

(Fernández-Montoya et al, 2017)

2. Case study - **Ceiba** Solar EAFIT

Ceiba is the name of a tree, native to tropical and subtropical areas of the Americas

FDM applied to the "Ceiba Solar"

Tracking subsystem

- Linear actuator
- Tilt sensor
- PLC

Collection subsystem

- Solar panels
- MPPT

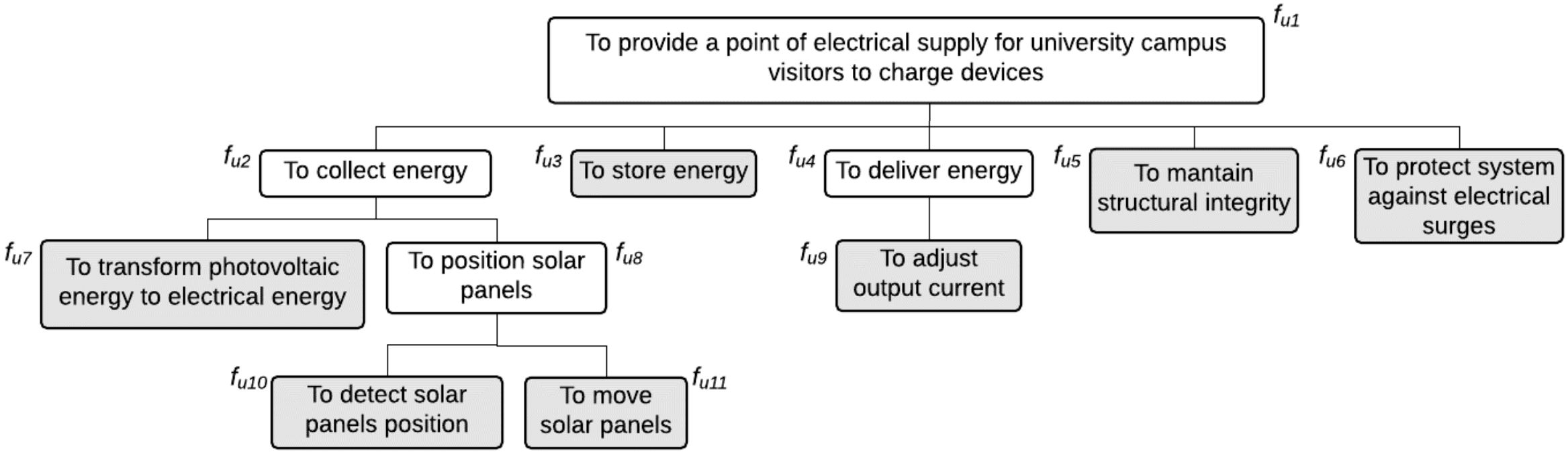
Storage subsystem

- Battery system

Deliver subsystem

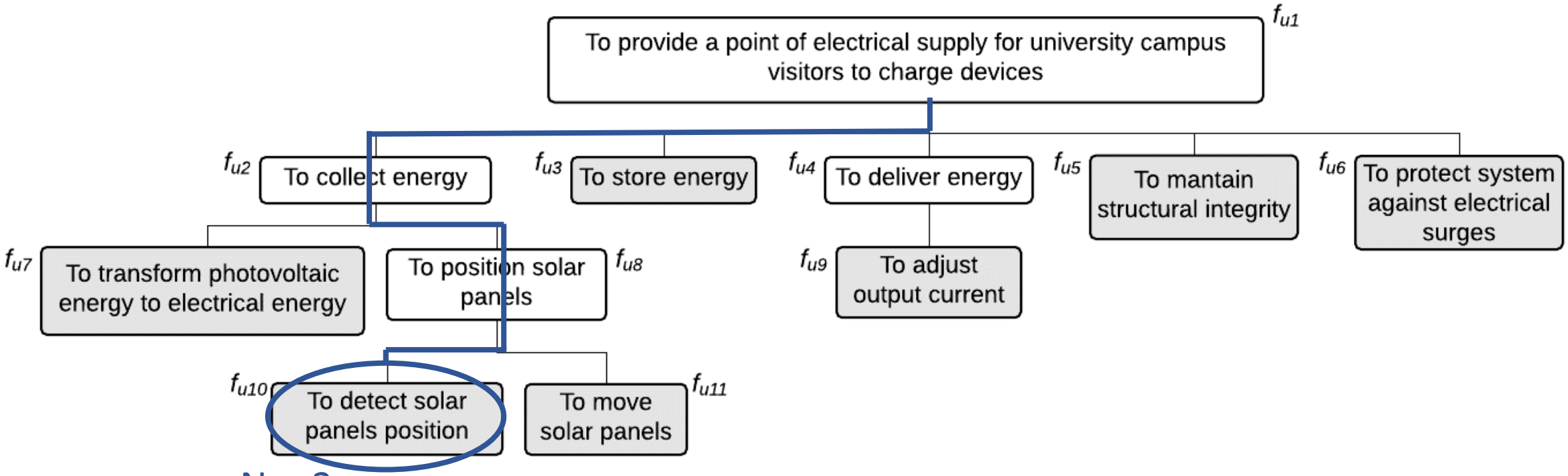
- DC/AC power inverters

2. Basic Functional Analysis



$$F_u = (fu_3, fu_5, fu_6, fu_7, fu_9, fu_{10}, fu_{11})$$

2. Basic Functions Analysis



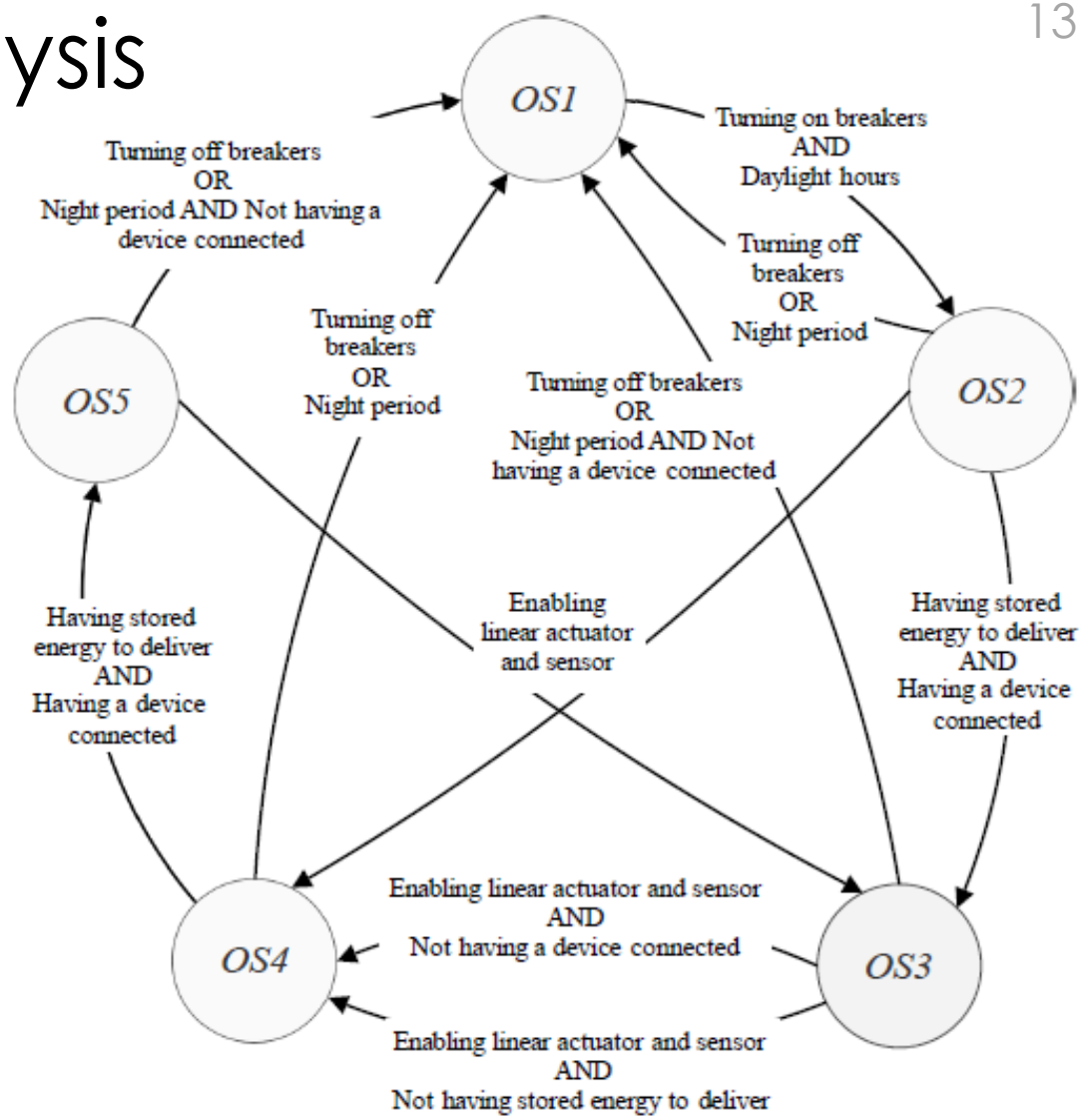
Nn=2

Kv=1/2=0.5

$$W_u = (0.2, 0.2, 0.2, 0.1, 0.2, 0.05, 0.05)$$

3. Operational Stages Analysis

Description Operative States				OS
Not Tracking	Not Collecting	Not Storing	Not Delivering	OS_1
Not Tracking	Collecting	Storing	Not Delivering	OS_2
Not Tracking	Collecting	Storing	Delivering	OS_3
Tracking	Collecting	Storing	Not Delivering	OS_4
Tracking	Collecting	Storing	Delivering	OS_5



3. Operational Stages Analysis

OS	fu_3	fu_5	fu_6	fu_7	fu_9	fu_{10}	fu_{11}
OS_1	0	1	0	0	0	0	0
OS_2	1	1	1	1	0	0	0
OS_3	1	1	1	1	1	0	0
OS_4	1	1	1	1	0	1	1
OS_5	1	1	1	1	1	1	1

4. Functional Structure Analysis

v_1	Radiation	v_7	MPPT output current
v_2	Ambient temperature	v_8	Battery state of charge (SoC)
v_3	Solar panel temperature	v_9	Battery voltage
v_4	MPPT input voltage	v_{10}	Battery output current
v_5	MPPT output voltage	v_{11}	System output voltage
v_6	MPPT input current	v_{12}	Solar panel orientation

Variable Relationship Descriptor (VRD) =
- 0, null
- 1, weak
- 3, medium
- 9, strong

5. Variable Relevance Indicator

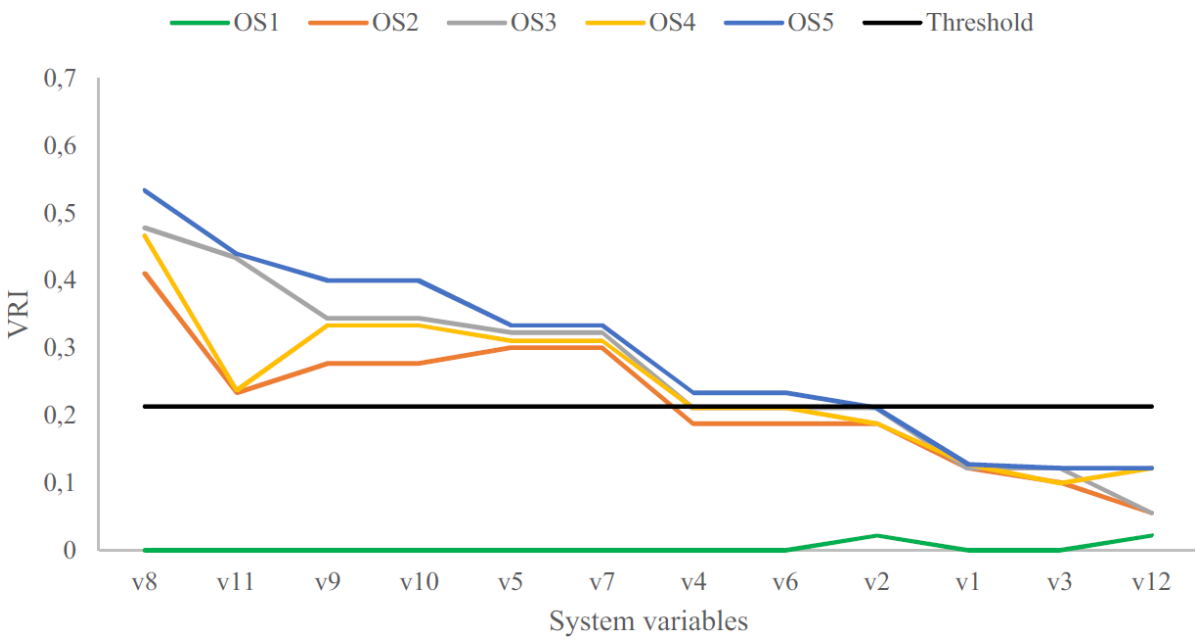
$$VRI = \frac{1}{9}\sum_{j=1}^{n} kf_j v_i \; S_{fu_j} \; W u_j$$

VRD

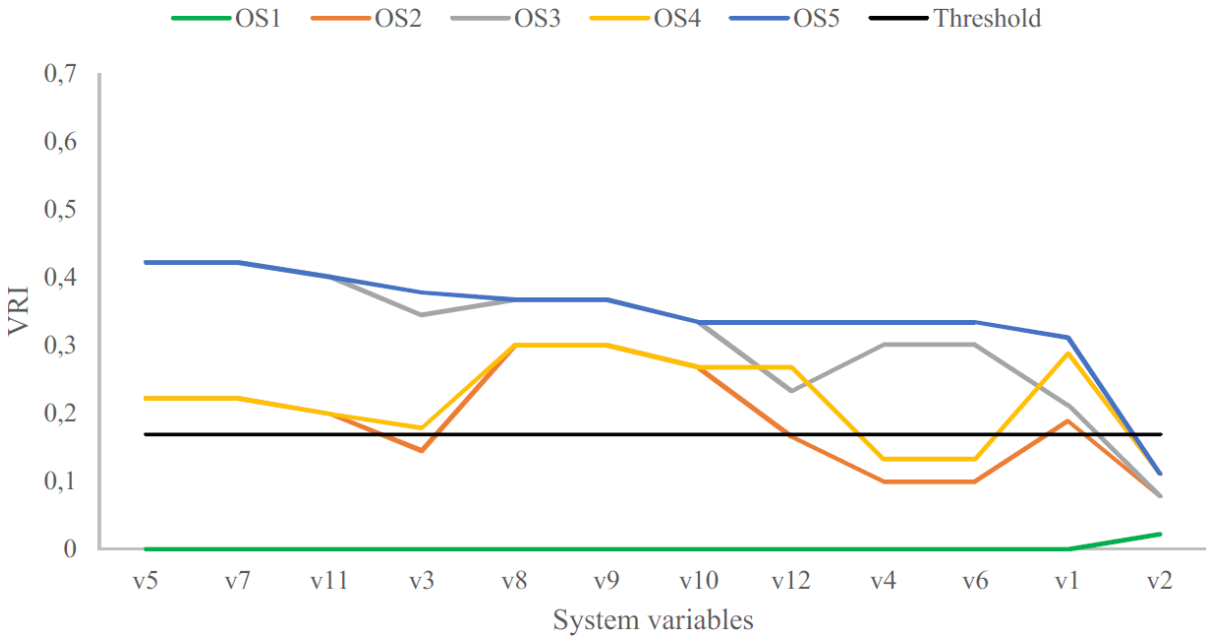
Variable operation mode(0,1)

Weight

Analysis of results



Expert1: experience working with maximizing energy storage



Expert2: experience working with photovoltaic energy collection

Conclusions

- Expert1 gives more weight to energy storage and how to maximize this subsystem performance.
- For Expert2 there was a not so marked preference, considering also the importance of the collection system.

v_1	Radiation	v_7	MPPT output current
v_2	Ambient temperature	v_8	Battery state of charge (SoC)
v_3	Solar panel temperature	v_9	Battery voltage
v_4	MPPT input voltage	v_{10}	Battery output current
v_5	MPPT output voltage	v_{11}	System output voltage
v_6	MPPT input current	v_{12}	Solar panel orientation

- It is valuable to consider the implementation of a monitoring interface with the option to display various screens according to the variables of interest.
- Evaluate more disciplines/experts to have other weightings involving different perspectives.

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