FPGA Based Meteorological Monitoring Station

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FPGA Based Meteorological Monitoring Station

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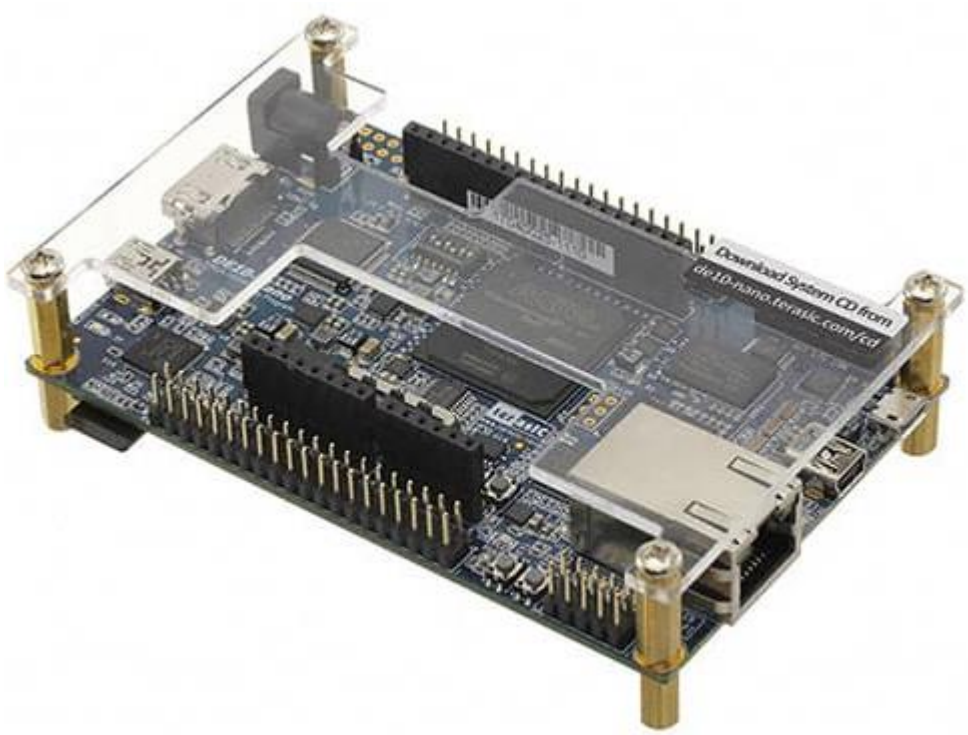
FPGA Based Meteorological Monitoring Station

Topics

- Introduction
- Related Work
- High-resolution Data Acquisition
- Methodology and System Model
- Numerical Results
- Conclusions

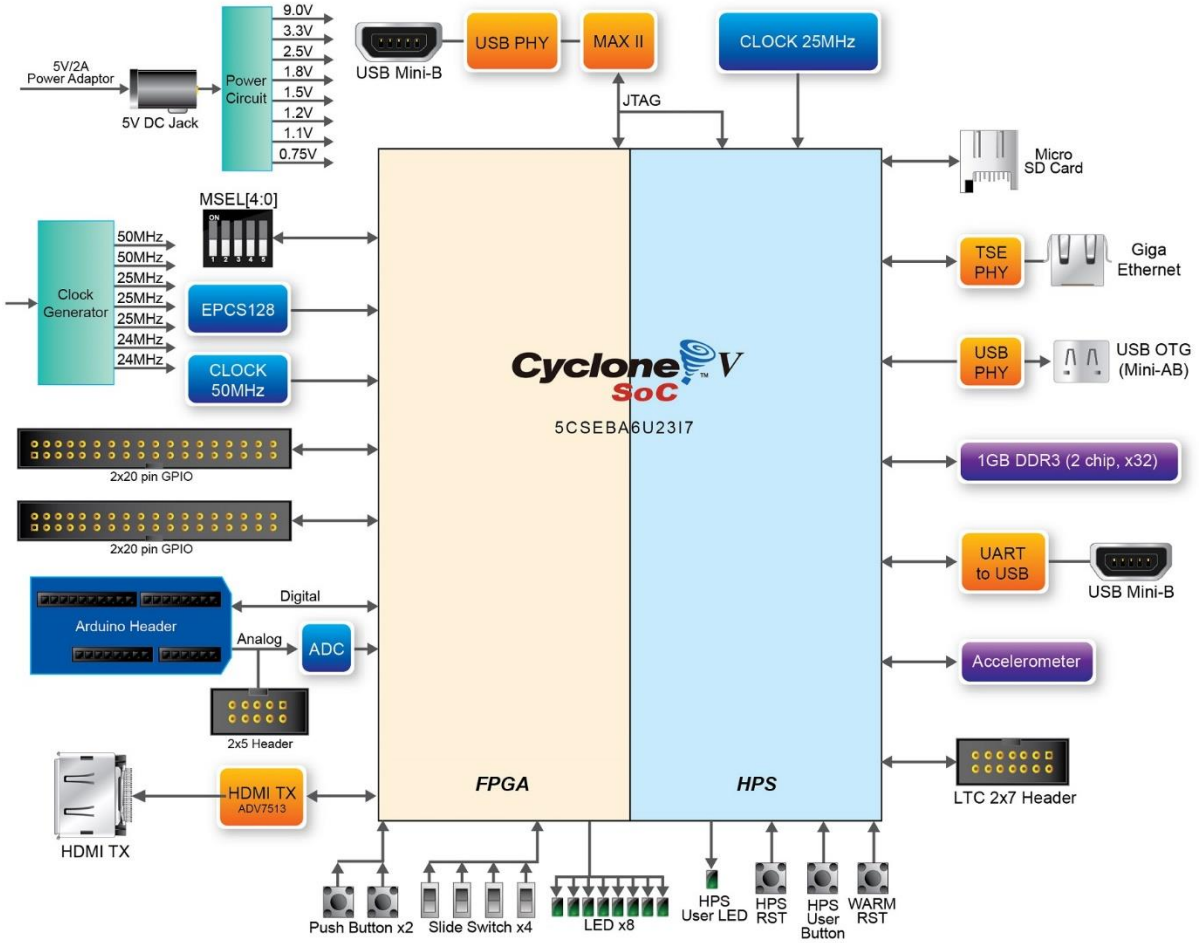
Introduction

- Field Programmable Gate Array (FPGA)
  - System on Chip (SoC)
    - Nios II Processor
  - Hard Processor System (HPS)
    - Advanced RISC Machine (ARM)



Related Work

- M. Haefke et al. proposed a weather station based on ZigBee, to monitor variables such as temperature, pressure, sunlight intensity, and humidity [6].
- Aziz et Al. proposed similar system based on FPGA considering humidity and light intensity to determine when to water the plants, using neural networks [8].
- Shaari et Al. proposed a Artificial Neural Network (ANN) based on FPGA for the prediction of Solar Radiation using Data from sunlight duration and average temperature [10].



High-resolution Data Acquisition

TABLE I. DATASET

Variable	Description	Range
Relative Humidity	Sensor (DHT11) is used to measure the environment humidity using oneWire.communication.	[42 – 69]
Environment Temperature	Sensor (DHT11) is used to measure the environment temperature using oneWire.communication.	[27.1 - 32.9]
Soil moisture	Sensor (FC28) generates an analog signal as a function of the soil moister. Sampled signal is digitized with 10 bits.	[434 – 1000]
Light intensity	Light dependent resistor (LDR) generates an analog signal proportional to the intensity of incident light. Sampled signal is digitized with 10 bits.	[119.76-9582]
Rain Occurrence	Digital sensor (FC-37) detects if there is rain (0), drizzle (1) and no rain (2).	[0 - 2]

Dataset Citation:
Juan Cadena, Steven Santillan, Víctor Asanza, Rebeca Estrada, July 11, 2021, "Weather Monitoring Station For Farms And Agriculture", IEEE Dataport, doi: https://dx.doi.org/10.21227/mdfs-ya42.

* Values are sampled each 30 seconds and saved as CSV.

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Methodology and System Model

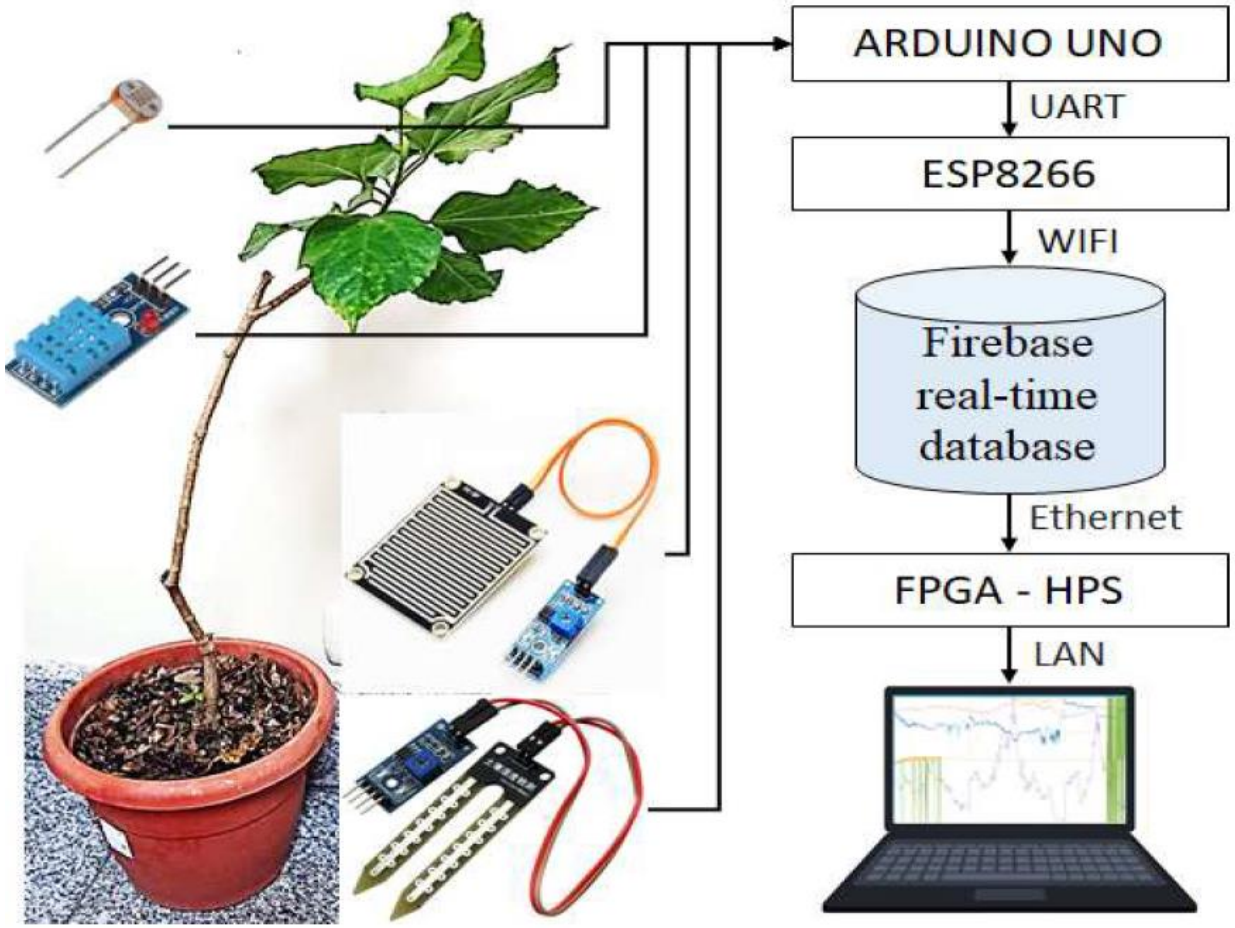

Fig. 1: Architecture of embedded system.

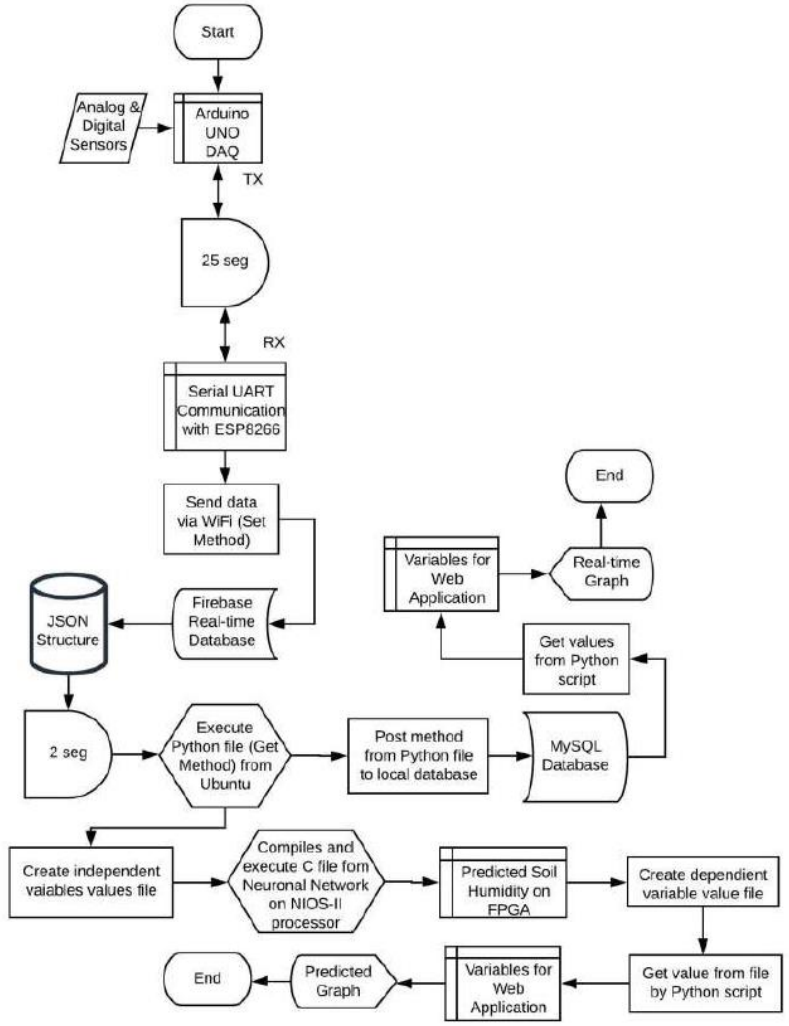

Fig. 2: System flowchart.

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Methodology and System Model

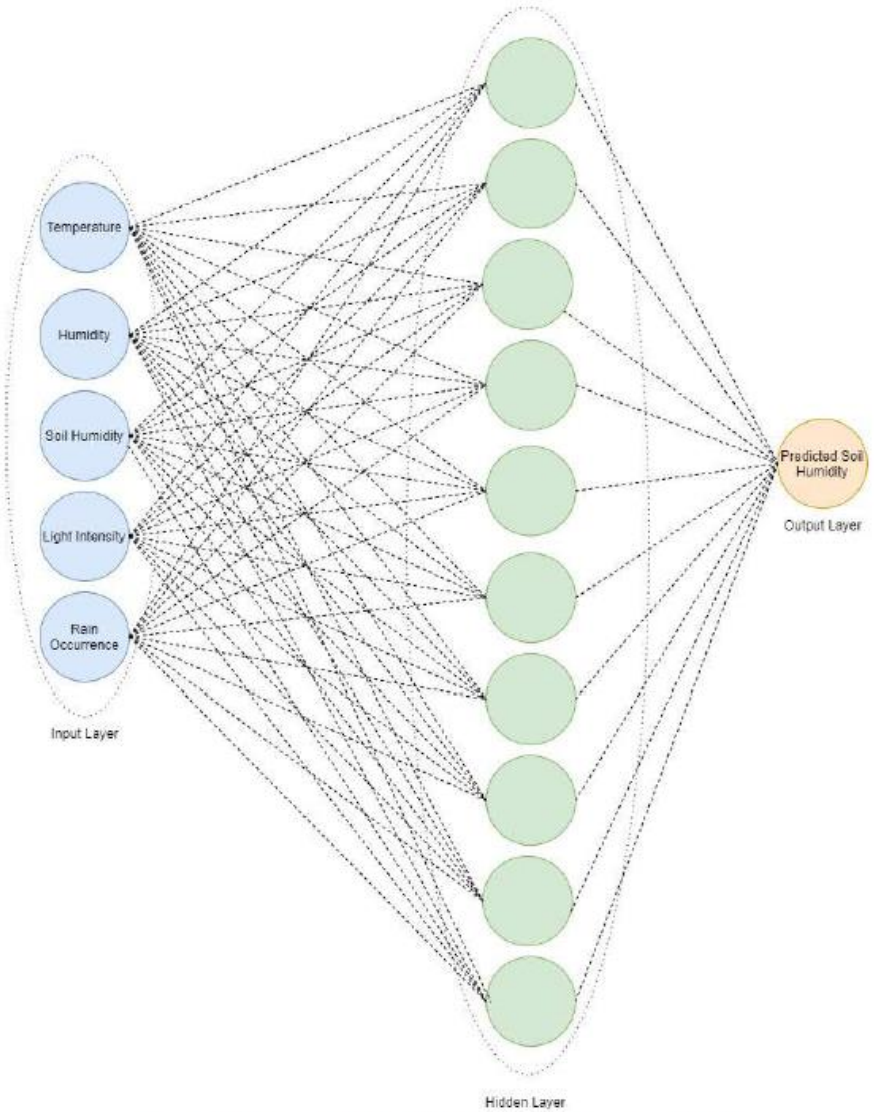

Fig. 3: Diagram of the neural net pattern recognition.

Numerical Results

TABLE IV. CORRELATION VALUES

Correlation Matrix	Soil Moisture
Relative Humidity	-0.3068
Ambient Temperature	0.1850
Light Intensity	0.2130
Rain Occurrence	0.0489
Soil Moisture	1

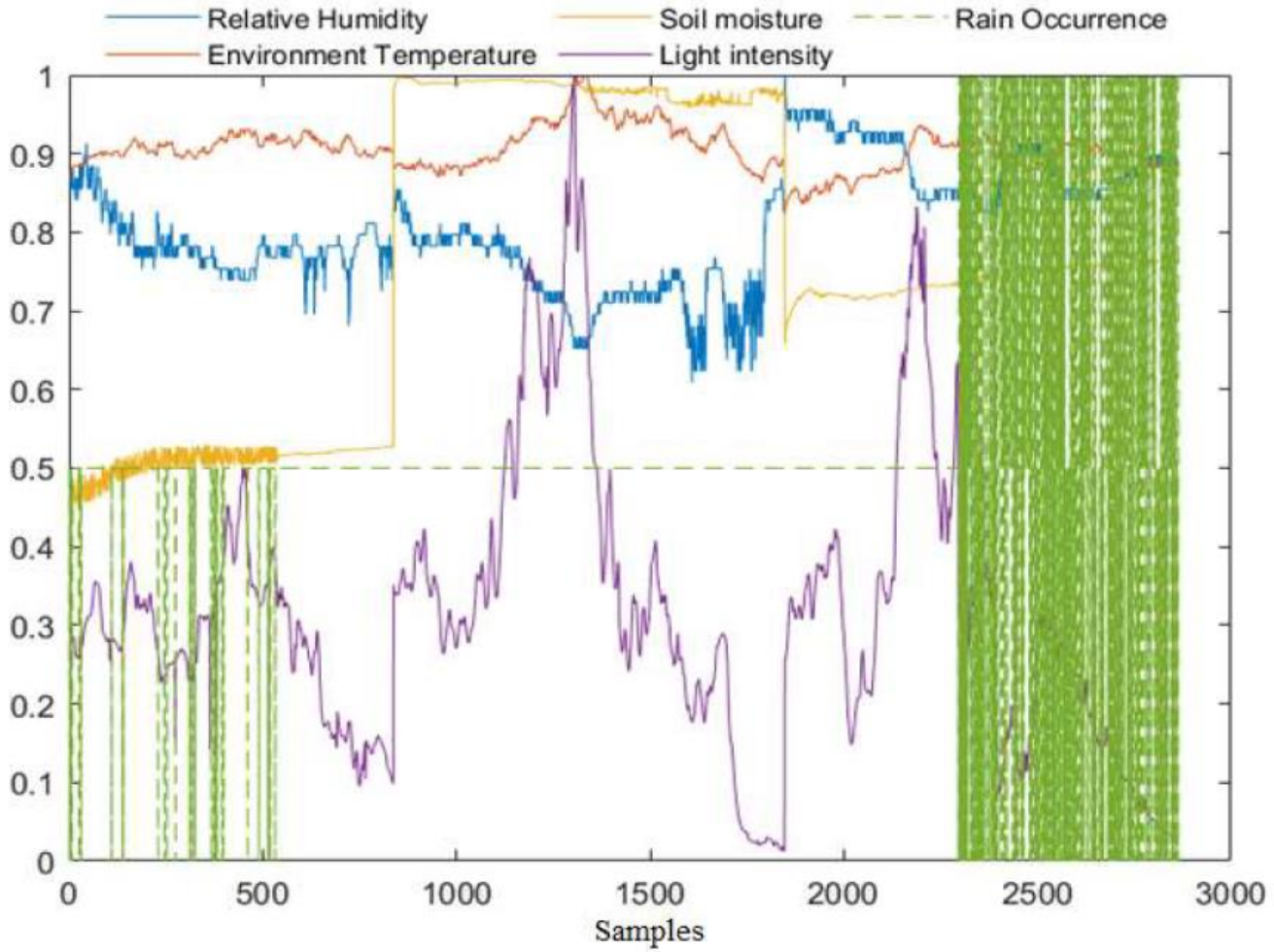

Fig. 4. The five variables measured during the weekend from 9am-6pm.

Numerical Results

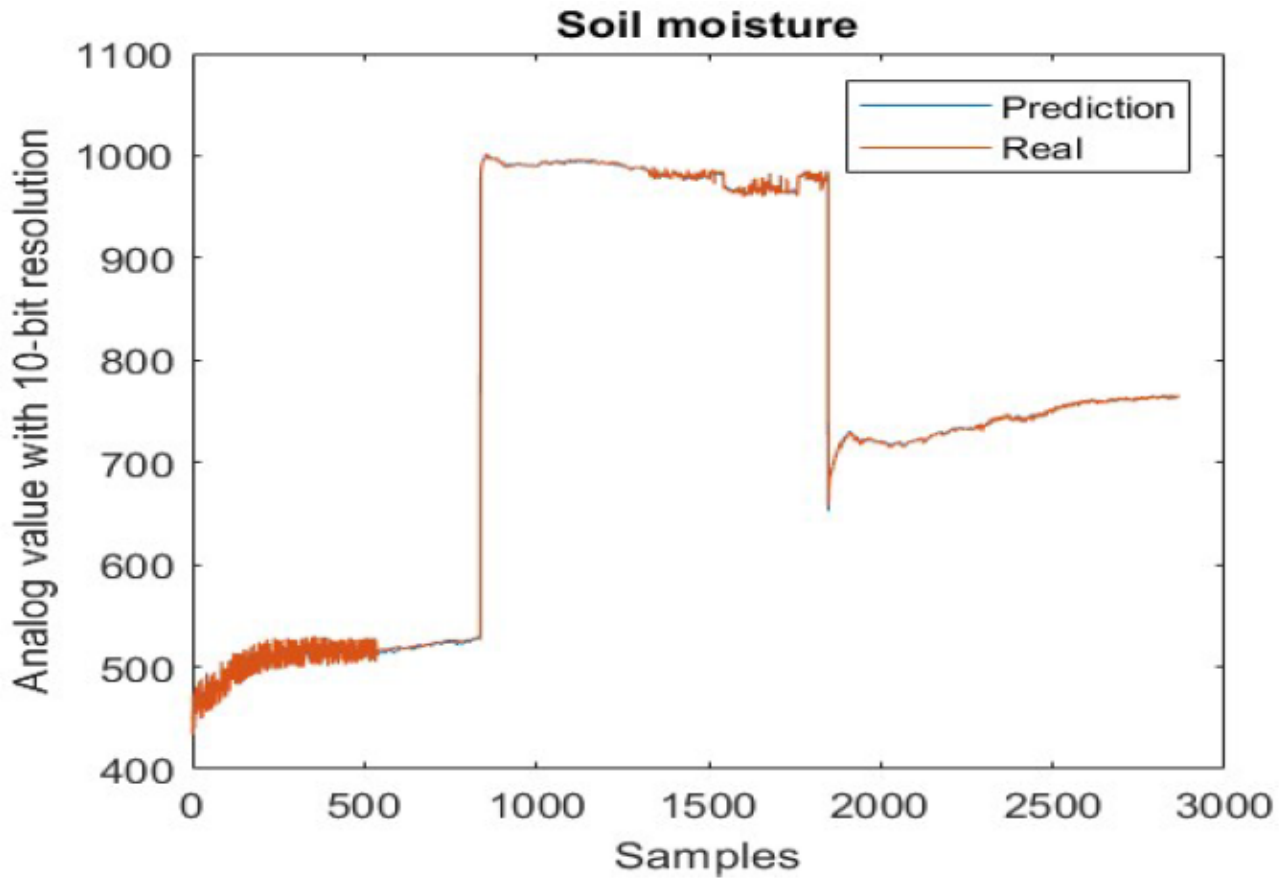

Fig. 5. Prediction of the next value of soil moisture.

Conclusions

TABLE V. USED RESOURCES

Processes	% CPU	% MEM
My SQL	2.30	7.50
Network Manager	0.01	1.40
N GIN X	0.01	1.70
Python	4.70	0.80
PHP	0.01	2.30
Total	7.03	13.70

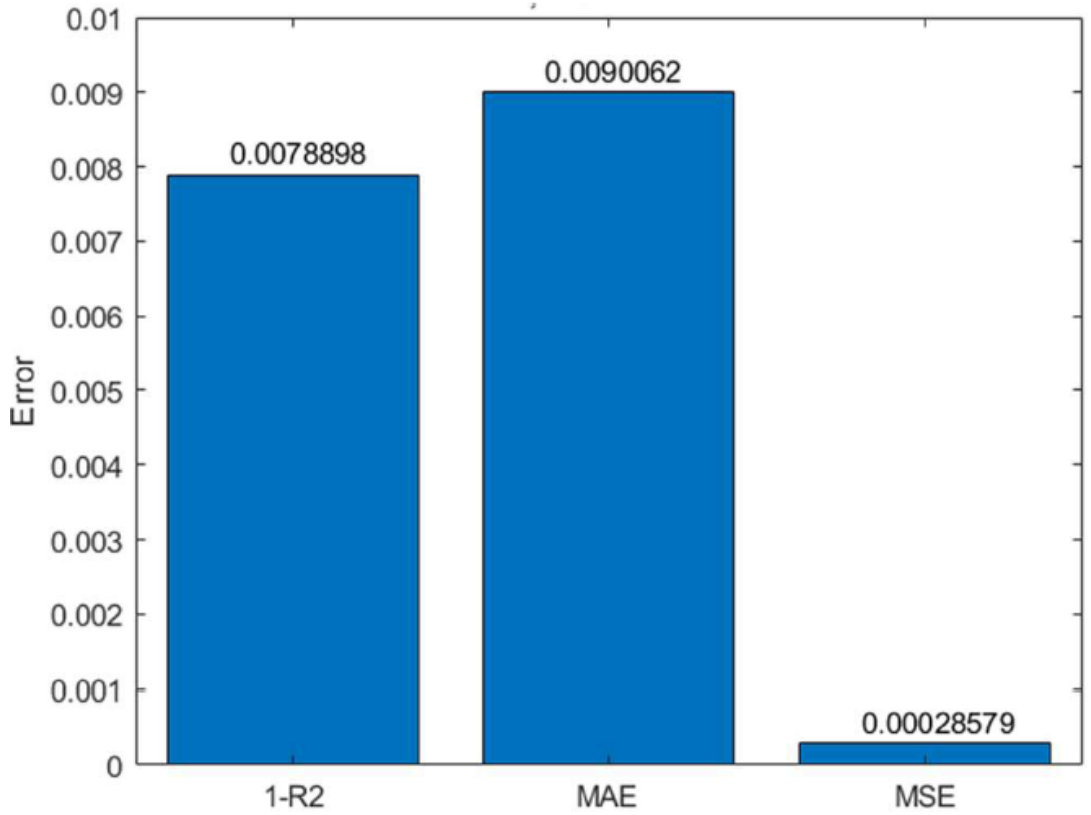

Fig. 7 Performance Metrics for the model evaluation in regression.

For more information

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Thank you!