Design Laboratory

Weather station

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Description:

Building a simple "weather station" to measure basic parameters such as temperature, humidity, light intensity and the occurrence of rainfall. The device will be based on a microprocessor and sensors. Current data can be viewed using a smartphone application using Bluetooth communication or using USB connection and computer software like "putty". Data can also be saved to non-volatile memory and read at a later date.

Pictures of the device
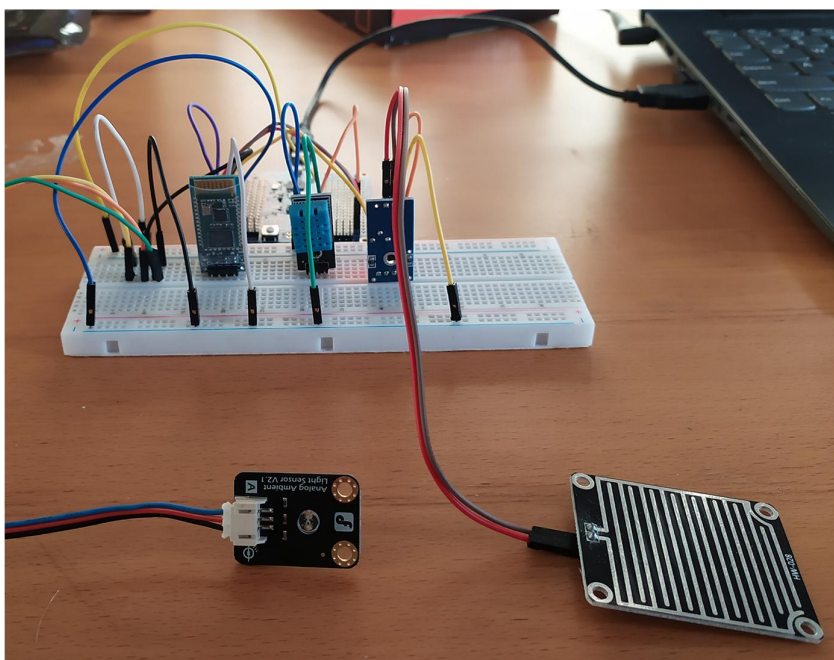
Picture no. 1 - front view
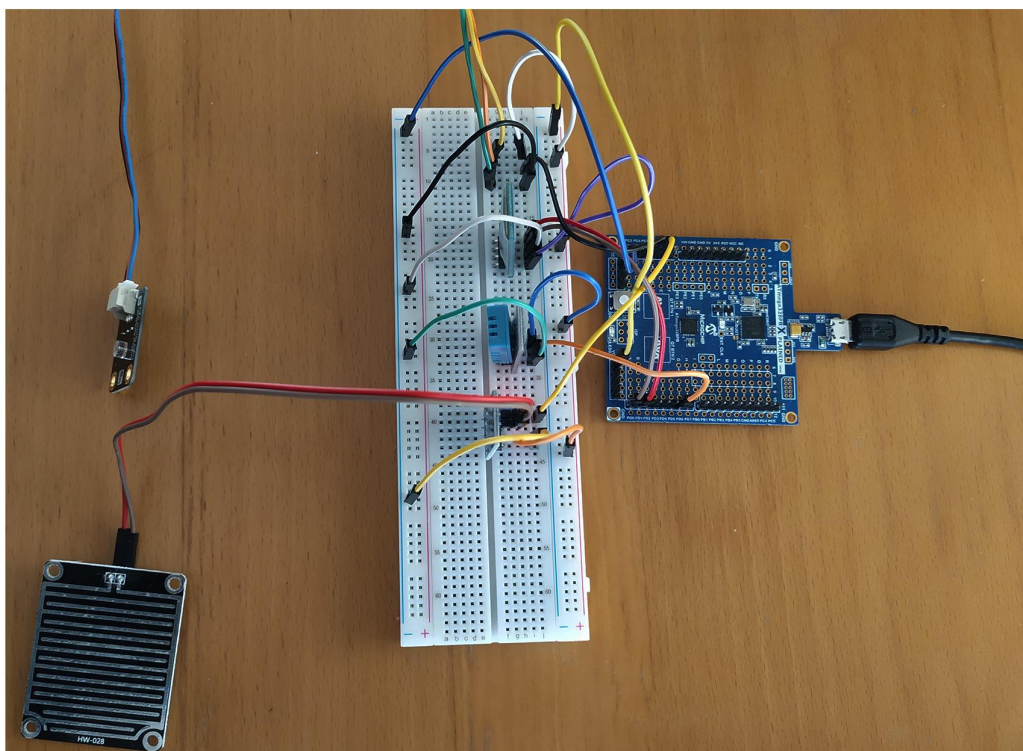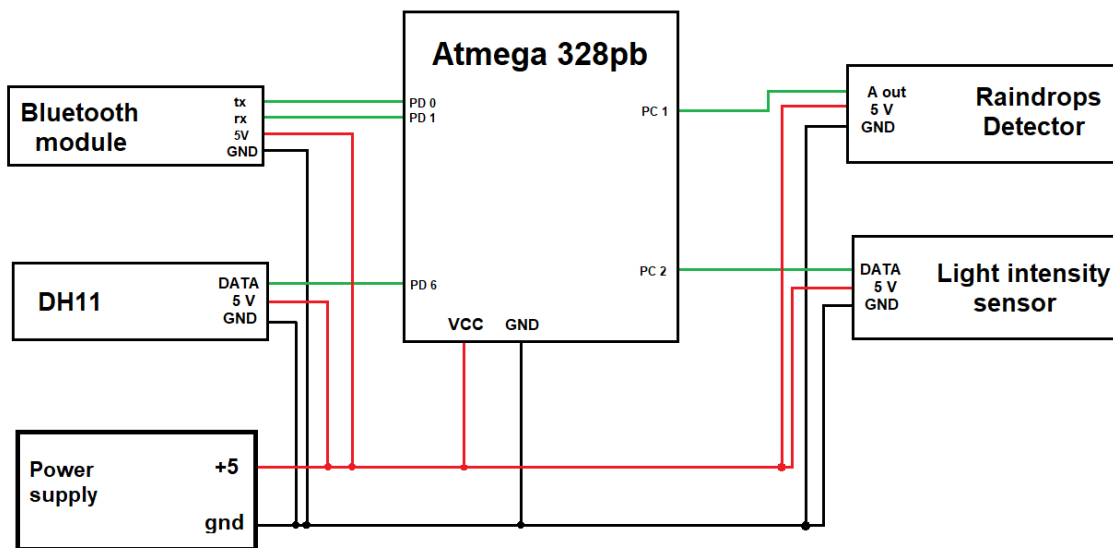

Picture no. 2 - upper view

Measure range:

	measure range		accuracy	
	minimum	maximum	minimum	maximum

Temperature	0℃	50℃	1℃	2℃
Humidity	(0℃) 30% (25℃) 20% (50℃) 20%	90% 90% 80%	1%	5%
Raindrop	5V	0V	0.005 V	0.01 V
Light sensitivity	0V	5V	0.005 V	0.01 V

Table no. 1 - measure rang of all sensors

Electric scheme:

Used components:

Test an evaluation board - ATmega328PB XPLAINED mini
- High Performance, Low Power AVR® 8-Bit Microcontroller Family
- Advanced RISC Architecture
- 32KBytes of In-System Self-Programmable Flash program memory
- 1 KBytes EEPROM
- 2KBytes Internal SRAM
- By default, the ATmega328PB device and mEDBG (debugger) on Xplained MINI kit uses on-board **16MHz** crystal as the clock source.
1. Humidity and temperature sensor - DHT11
   - DHT11's power supply is 3-5.5V DC
   - Single-bus data format is used for communication and synchronization between MCU and DHT11 sensor. One communication process is about 4ms
2. Light intensity sensor ALS-PT19
   - Wide supply voltage range, 2.5V to 5.5V
   - Guaranteed temperature performance, -40℃ to 85℃
   - Low sensitivity variation across various light sources
3. Raindrops Detection Sensor Module

- The output in the form: digital switching outputs (0 and 1) and analog voltage output
- Operating voltage: 3.3V-5V
4. Bluetooth module HC-06
    - Has a built-in 2.4GHz antenna; user needn't test the antenna.
    - Has the external 8Mbit FLASH
    - Can work at the low voltage (3.1V~4.2V). The current in pairing is in the range of 30～40mA. The current in communication is 8mA.
    - Standard HCI Port (UART or USB)

Implementation:

DHT11 communicates with the MCU using a one-wire serial transmission. We can divide transmission into five stages:
1. 8 bit - integral humidity data
2. 8 bit - decimal humidity data
3. 8 bit - integral temperature data
4. 8 bit - decimal humidity data
5. 8 bit - checksum

At the beginning we have the initialization phase, then the sensor sends data, MCU decides whether it is logic "1" or "0" based on the pulse length.

Other sensors are connected with an analog-digital converter built in board. After the raw conversion, the result is divided by 1024 (10-bit ADC resolution) and separated into integer parts and decimal parts.

Then all information is saved in structure and can be saved or printed on a terminal or Bluetooth application.

Validation

Labview implementation

The four graphs below show the measurement characteristics of our sensors. It was done in the LabVIEW environment, the LabVIEW project is included in the files.
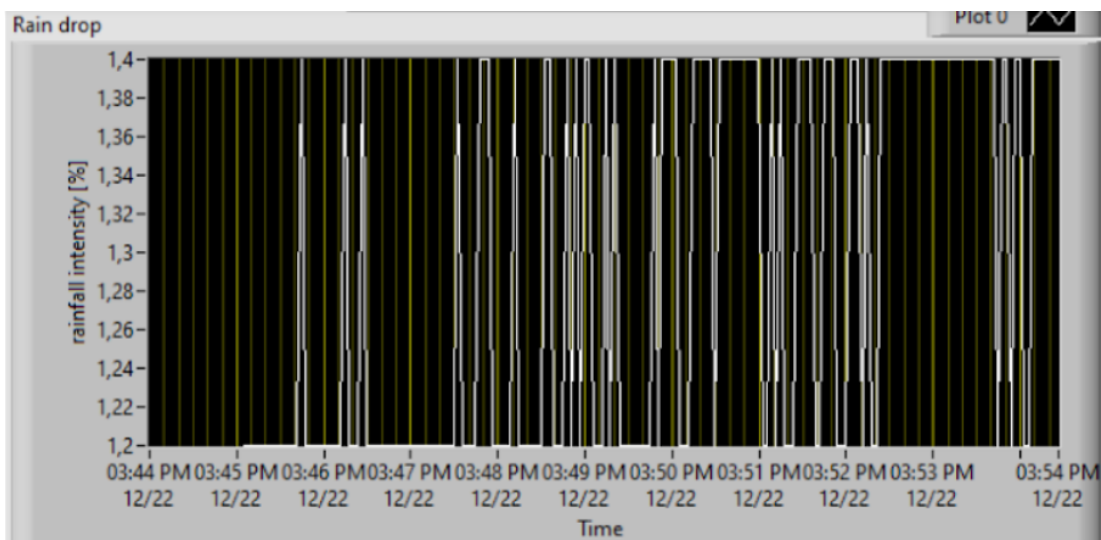
Photo no. 1 - Graph of raindrop intensivist displayed on Labview program.
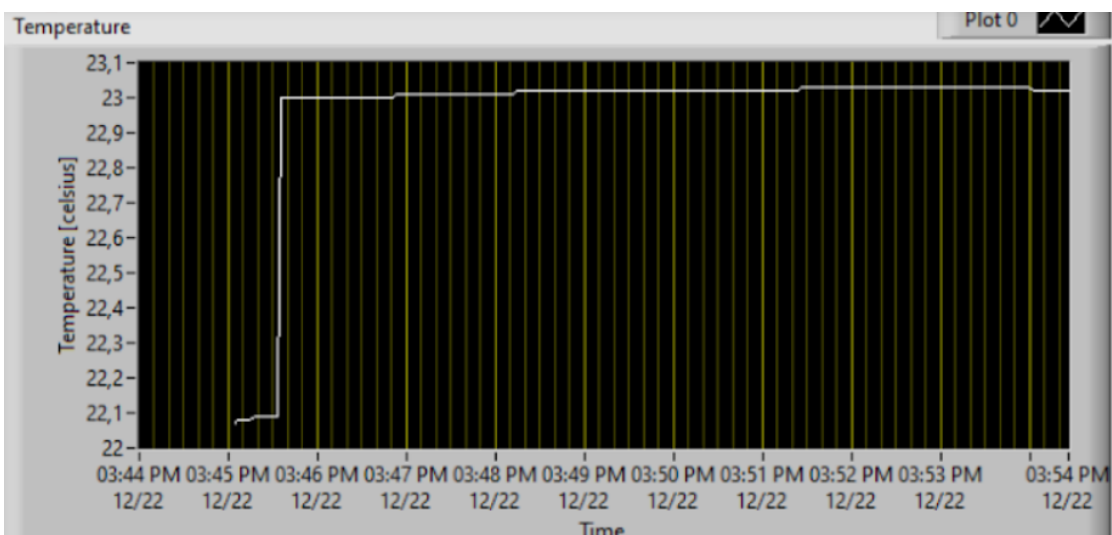

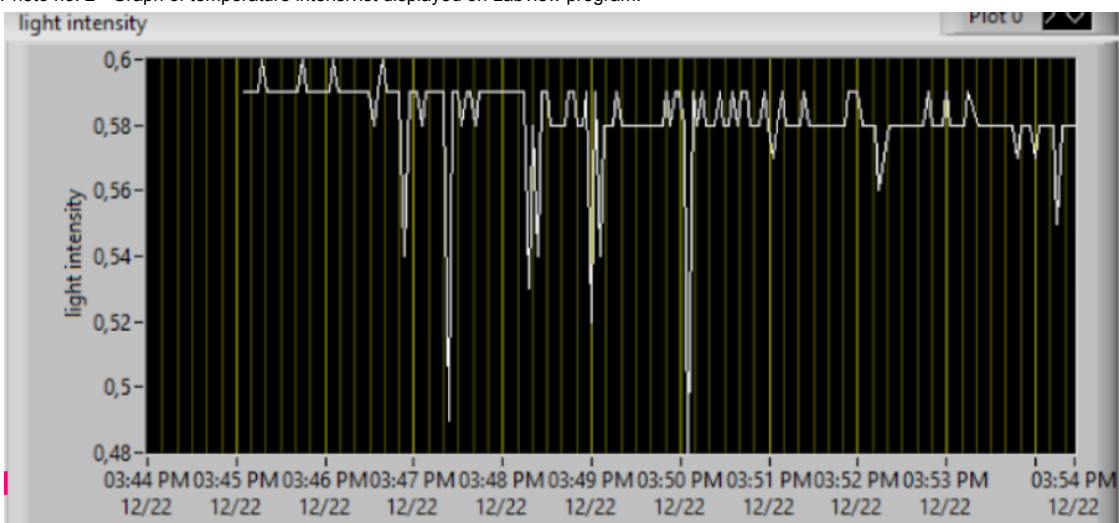Photo no. 2 - Graph of temperature intensivist displayed on Labview program.

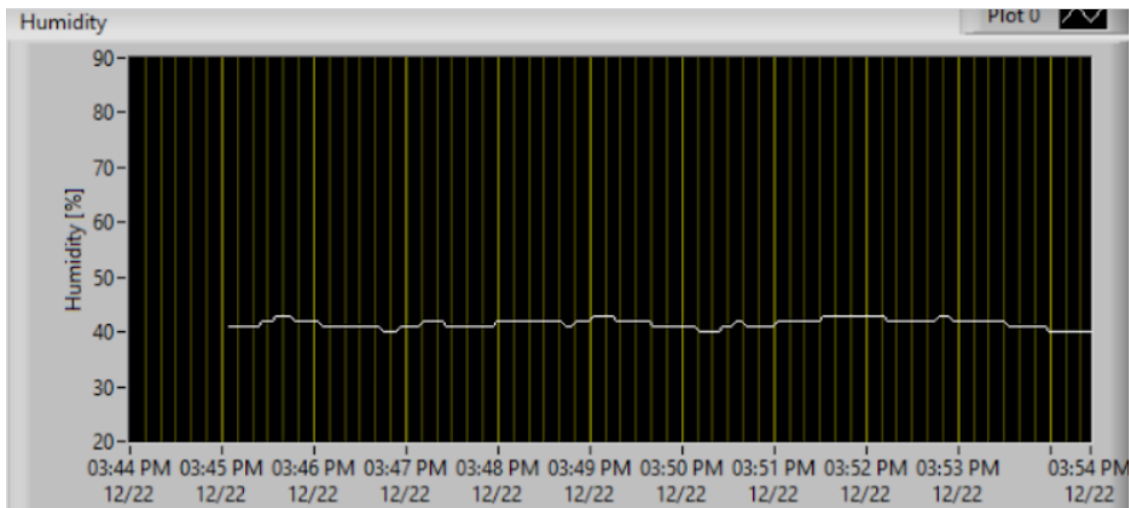Photo no. 3 - Graph of light intensivist displayed on Labview program.

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Photo no. 4 - Graph of humidity intensivist displayed on Labview program.

Terminal

Below is a screenshot of the measurement test for our sensors. Use putty to connect to the appropriate COM port.

The putty program should be configured as follows: Connection type: Serial, Serial line on which the evacuation board is connected (check in the device manager), Speed: 9600 and Window-> Translation-> Remote character set: Win1250

n	Humidity [%]	Temperature [°]	RAIN_VOLTAGE [V]	LIGHT_VOLTAGE [V]
1	46.0	23.1	4.34	0.36
2	46.0	23.1	3.71	0.35
3	46.0	23.1	4.26	1.84
4	46.0	23.1	1.48	4.83
5	46.0	23.2	2.66	0.53
6	46.0	23.2	2.95	1.6
7	46.0	23.4	3.33	1.21
8	46.0	23.4	3.66	0.30

Photo no. 5 - display all information in table format using computer program "putty"

Bluetooth module

Below is a screenshot of the Bluetooth communication test. We download a free terminal application to display data on the terminal.

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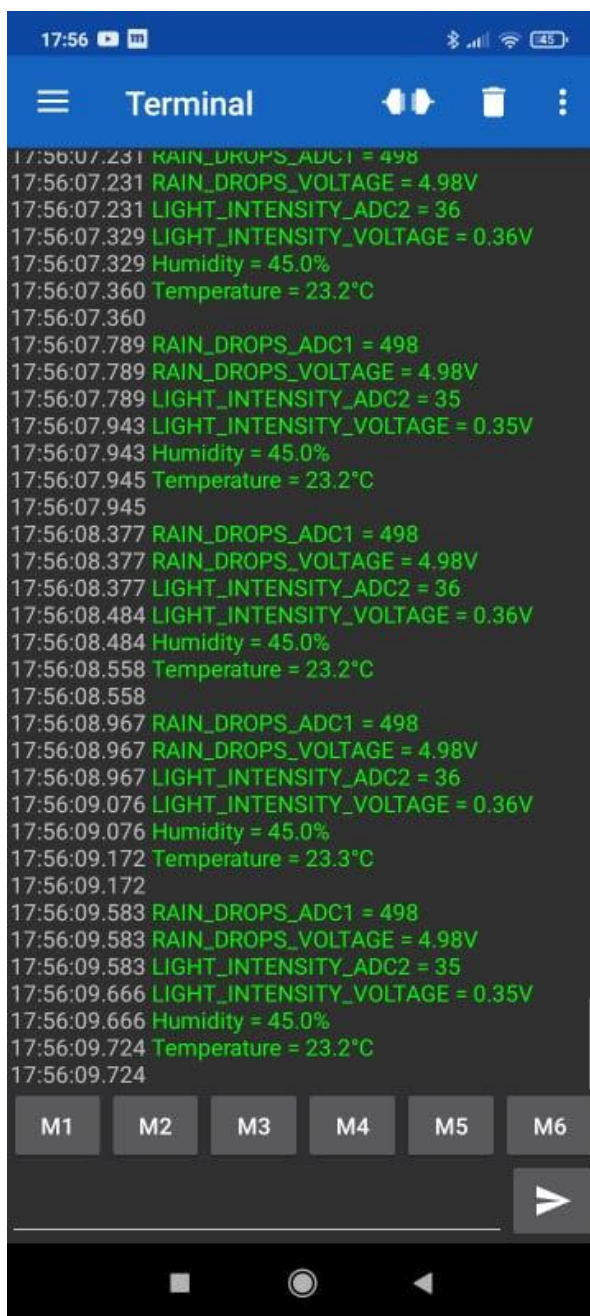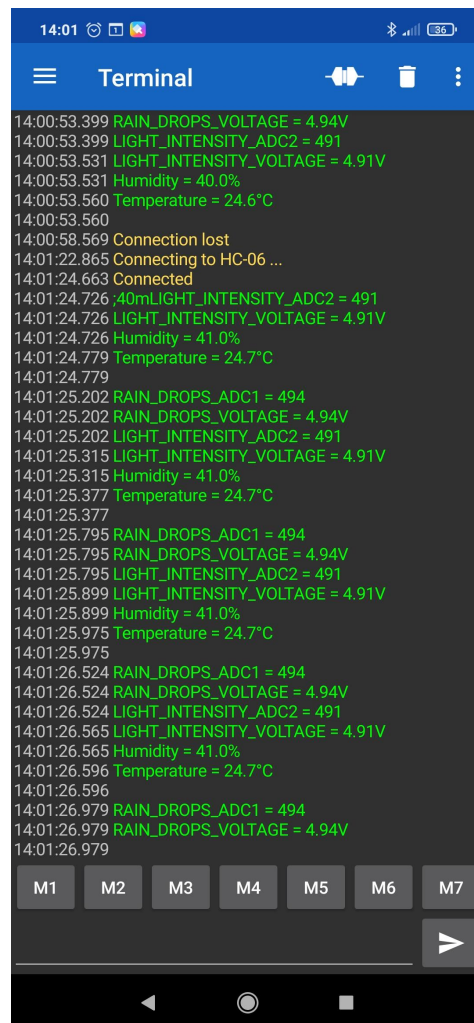
Photo no. 6 - display all information on a smartphone using application "Serial Bluetooth Terminal"

Functionality tests.

Bluetooth disconnection.
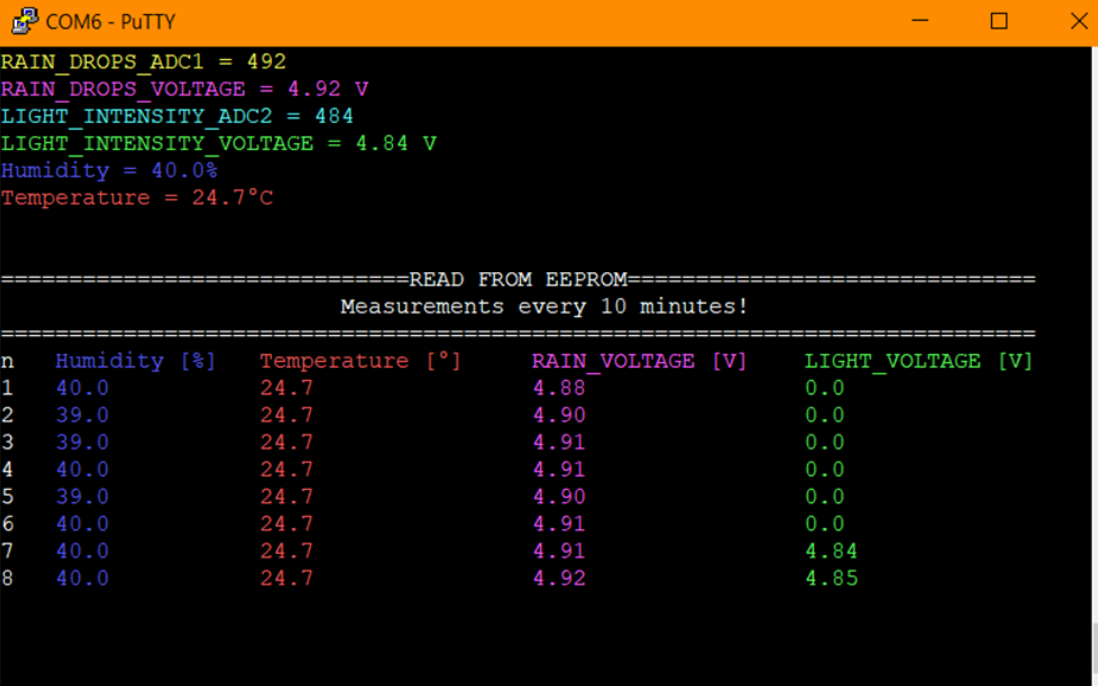

Photo no. 7 - lost connection with bluetooth sensor

After lost connection (lack of power, bluetooth error) application will wait for resuming. Other applications can not support this functionality therefore we need to manually reset the connection or renew the connections.

When we have a connection to the terminal (Serial port) we need to manually reset the connection in program such as "putty".

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Light sensor disconnection.

Photo no. 8 - lost connection with light sensor

After disconnecting the light sensor, the device will continue to send the rest of the data and the value of the light intensity will be zero.

Raindrop sensor disconnection.

Photo no. 9 - lost connection with raindrop sensor

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After disconnecting the raindrop sensor, the device will continue to send the rest of the data and the value of the raindrop will be close to zero.

DHT11 (humidity and temperature) sensor disconnection.

Loss of connection with the sensor is the most inexpedient situation because the program will stack in an infinite loop when is waiting for a response from DTH11. When such a situation occurs, you need to reboot the device.

Power consumption.

Situation	Average power consumption
All sensors are connected	15 mA
DTH11 sensor	0,5 mA
Bluetooth sensor	0,2 mA ~ *3 mA
light sensor	0,5 mA
raindrop sensor	4 mA

Table no. 2 - Power consumption of device sensors

* 3 mA amper is power consumption while Bluetooth module sends data.