

## Formation of a dynamic temperature model during the operation of a building's digital twin

## Построение динамической температурной модели при эксплуатации цифрового двойника здания

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### Abstract

The work discusses the methods of temperature control during a building's digital twin operation. The existing options have drawbacks and require improvement. To improve the technology, it is proposed to use remote temperature sensors. For this purpose, prototypes of the transmitter and receiver based on the Arduino board have been designed. It seems possible to introduce temperature control technology into computer-aided design systems. In the Autodesk Revit environment, a system of plugins has been developed for collecting, processing data, and plotting temperature fields on a vertical spatial element - external load-bearing wall. The results obtained clearly demonstrate the possibilities of interaction between Internet of Things (IoT) sensors and Building Information Modelling (BIM) environments in real-time. In the future, it is planned to check the performance of the system in the conditions of work.

### Methods

Methods include comparative analysis of existing solutions, design of a transmitter-receiver device and data integration into the BIM environment of Autodesk Revit.

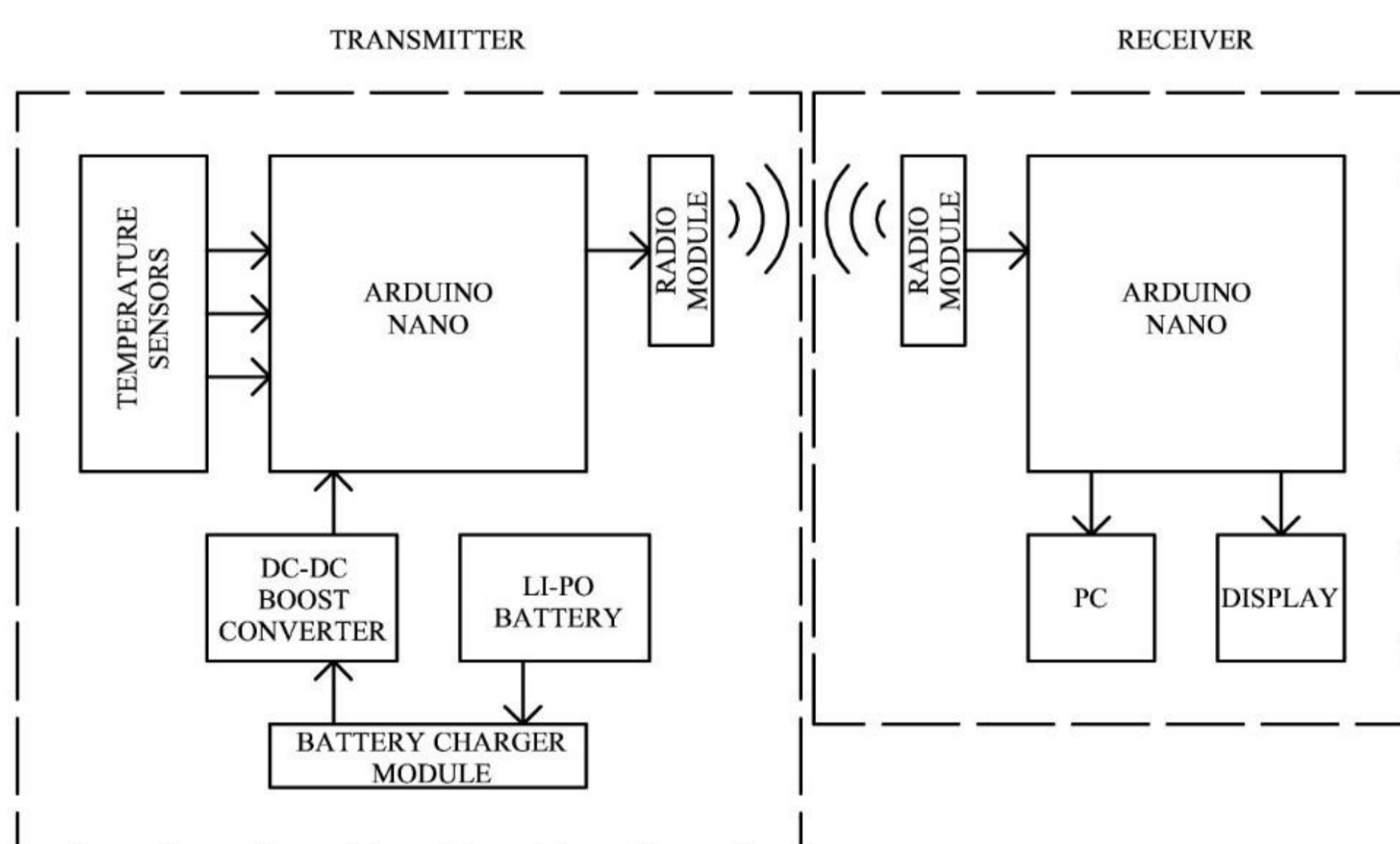


Fig. 1. Circuit diagram

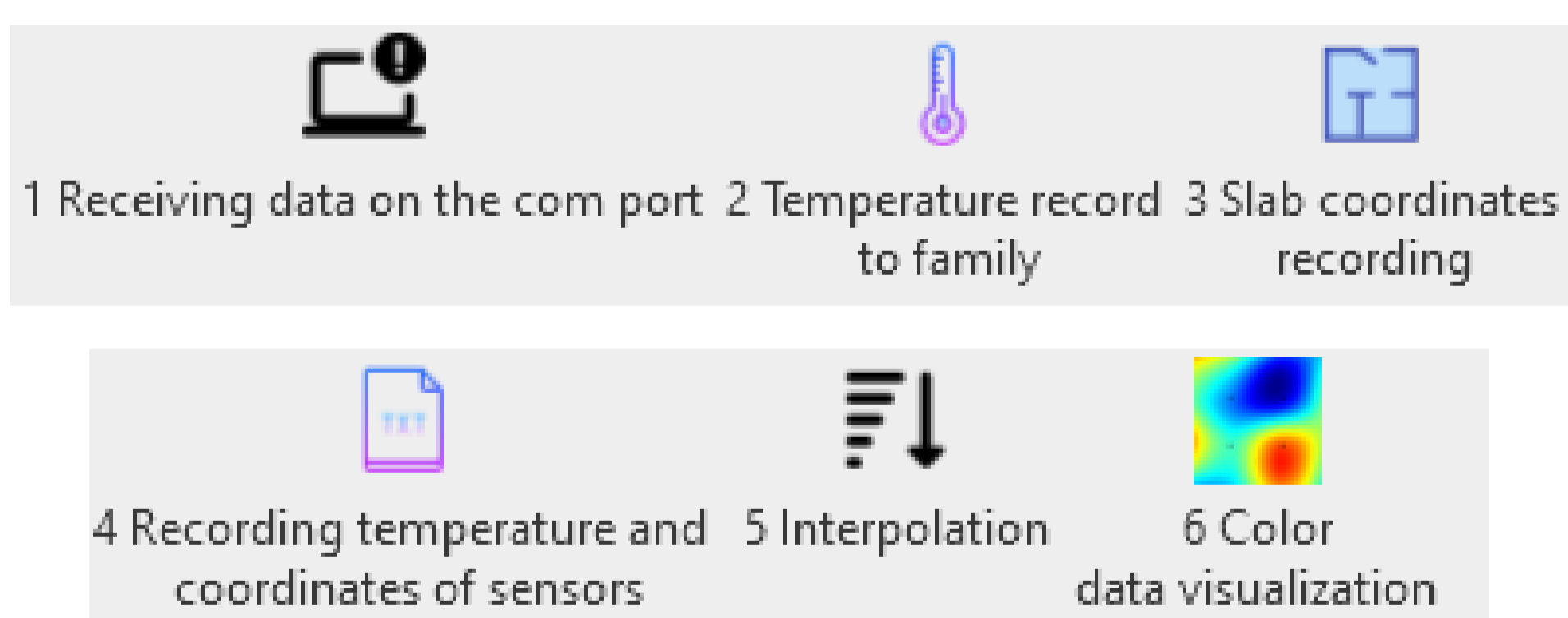


Fig. 2. Plugin buttons

### Results

A working prototype of the device was assembled based on the schematic diagram. To work with the plugin during the construction process, a BIM-model of the wall is created according to the project.

In the process of exploitation at the external load-bearing wall, detectors are installed on the surface according to the sensor layout. Each sensor is pre-configured with its unique number according to the layout in the BIM model. The structure is experienced temperature differences.

The receiver is connected to a PC via a USB cable. By successively pressing the button receiving data on the com-port, the data is read from the receiver. Further, by clicking on Temperature record to family, the data is entered into the parameters of the sensors installed in the overlap model. By pressing Slab coordinates recording and Recording temperature and coordinates of sensors, data on the coordinates of the structure and the temperature at known points with installed sensors are entered. Next, you need to click on the Interpolation button and the temperature will be calculated at all the points according to linear interpolation. The final button Color data visualization allows to display the temperature field on the wall.

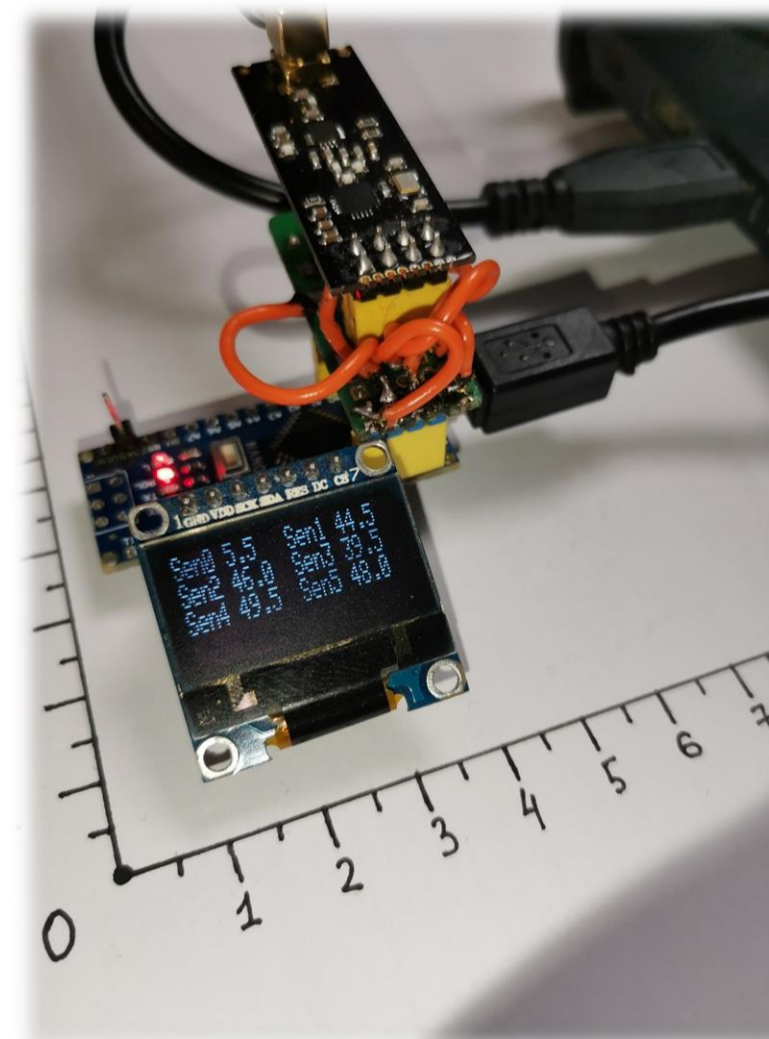


Fig. 3. Device connected to a PC (data is also on the screen)

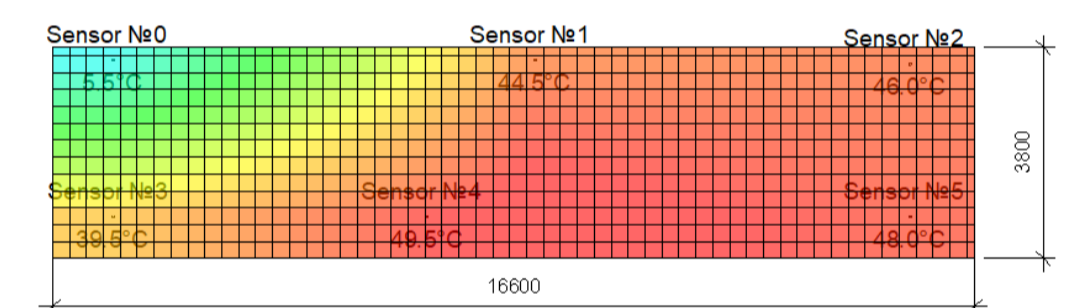


Fig. 4. Results of the temperature data interpolation

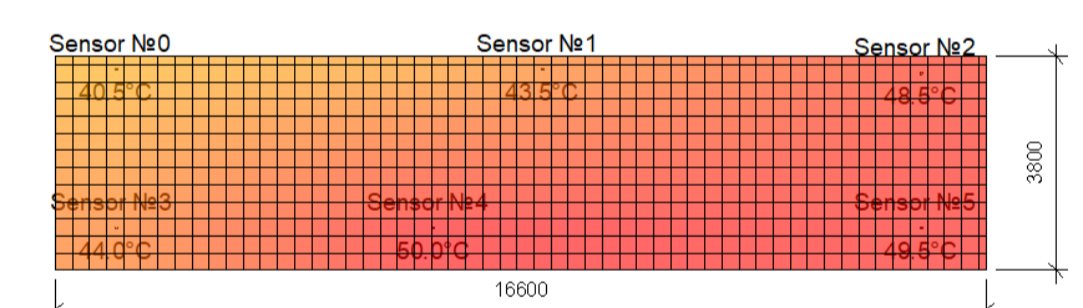


Fig. 5. Example of uniform temperature distribution

### Conclusion

The design of a transmitter taking temperature readings and a receiver transmitting these data to a display or PC is proposed. The device is based on the Arduino Nano board.

To integrate into the digital building model, a system of plug-ins for the Autodesk Revit environment was developed. Testing on arbitrary data shows the efficiency of the program for plotting temperature isofields in real time.

The development of digital technologies makes it possible to simplify the process of building exploitation. For further improvement of the device, it is planned to carry out field tests in conditions of real building's digital twin.