EGU2020-18511
https://doi.org/10.5194/egusphere-egu2020-18511
EGU General Assembly 2020

IoT systems for the study of cultural heritage monuments - case of Uplistsikhe, Georgia

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Cultural heritage monuments, that were created by mankind for centuries are scattered throughout the world. Most of them are experiencing impacts coming from nature and humans each year that result damage and changing their common state. Many of the monuments are facing the critical condition and require diagnostics, study and planning and management of conservation/rehabilitation works. Due to impact of environmental factors such as temperature, humidity, precipitation, existence of complex structure of cracks, infiltrated water and runoff water streams, together with active tectonics in the region, Uplistsikhe rock cut city monument located in central part of Georgia faces problems and permanent destruction.

In parallel with technological development, it is now possible to conduct complex monitoring of the environment parameters in real time using sensor systems, data acquisition, communication network, data visualization and processing methods.

Complex approach with equipment used in research and experiment was used to study various factors affecting the monument and presents the very important issue. Gained experience, research methodologies and technical skills will be good basement for future study/research projects on similar monuments as the collected information gives us an in depth understanding of processes that impact on the monument and can then be followed by a coherent plan of risk reduction to increase the effectiveness of the used solutions.

During the study of cultural heritage monuments, there are some technical limitations that can occur: The electricity or communication wiring might not be available on the site or the wiring is impossible without damaging the monument itself. So, there is a rising need of low power wireless sensor acquisition and transmission systems.

Paper discusses the usage of IoT based sensor systems for study of Uplistsikhe Cultural heritage monument. The built system uses low power data transmission network based on LoRa standard.

Measurement points were selected where several parameters (Temperature, Humidity, Crack meter value) are acquired and sent to the central information platform using so called Internet of things.

Central web-built system that is based on open platform Grafana is responsible for the data

storage, visualization, processing and alarm generation.

The statistical processing of acquired collected data resulted in calculation of the parameter ranges. Calculations were made on the 24-hour data of each day to calculate the variations. First the maximal and minimal recorded values were identified, then the difference between maximums and minimums were calculated. Additionally, the mean values and the standard deviations were calculated resulting to the ranges considered as normal, excessive, dangerous and critical parameters.

These parameters were integrated into the web-system. In case of dangerous and critical parameters the system is able to distribute alarm state information via several channels such as email, chat message, SMS or other means.

As a result, the low power wireless system sensor measurement system was created that sends acquired data it to the cloud-based web platform with possibility of the data processing and issuing alarms.

This work was supported by Shota Rustaveli National Science Foundation of Georgia (SRNSFG) [Grant Number fr17_90]