Smart Waste Monitoring System

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Background

Garbage is a direct source of spreading diseases in underdeveloped countries. Since garbage collection process has to be repeated continuously, some countries simply cannot afford it which leads to portion of garbage not being picked up (Jin et al. 2014).

Taking into account that a major part of costs that city municipalities face comes from data collection, IoT applications in smart cities are argued to have a significant positive impact on efficiency and cost saving.

Project Description

The proposed smart waste monitoring system measures the real-time fill level of the garbage bin and displays it on the web interface. Thus, it is believed that it can increase efficiency of waste collection service workers as well as decrease the cost of the procedure (Hassan et al. 2016).

Methodology

The software and hardware architecture diagrams are presented below in Figure 1 and Figure 2. On the hardware side of this project the following components are used:

- Arduino Yun (Internet connection through built-in WiFi module).
- Ultrasonic sensor (measures distance to the closest object).

The software side is distributed among three different layers:

- Arduino (gets distance to the nearest object and sends it to the web server; written in C++).
- Web server (stores distance values in PostgreSQL database; written in Python).
- Web interface (displays the current fill level along with chart of historic data; written in JavaScript).

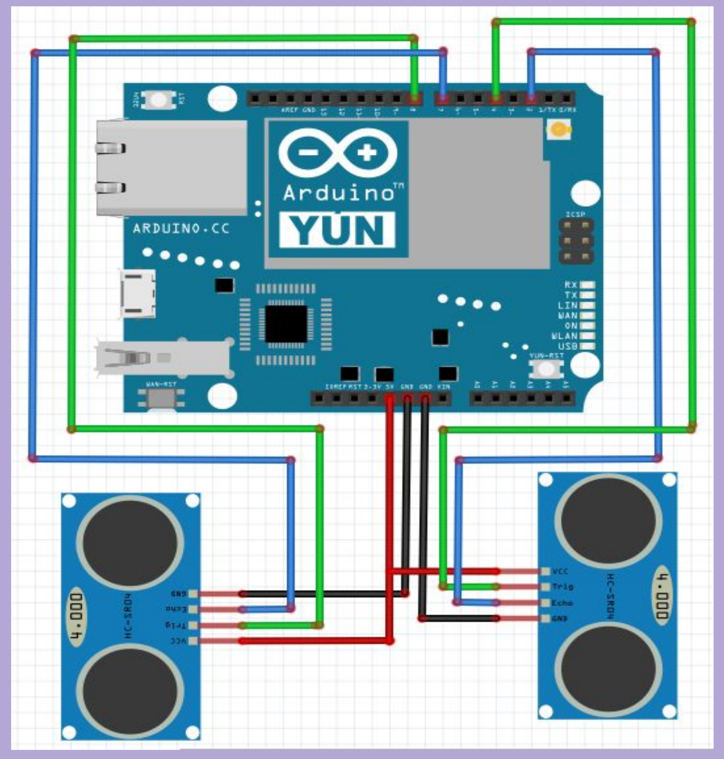

Figure 1. Hardware architecture diagram of the designed system.

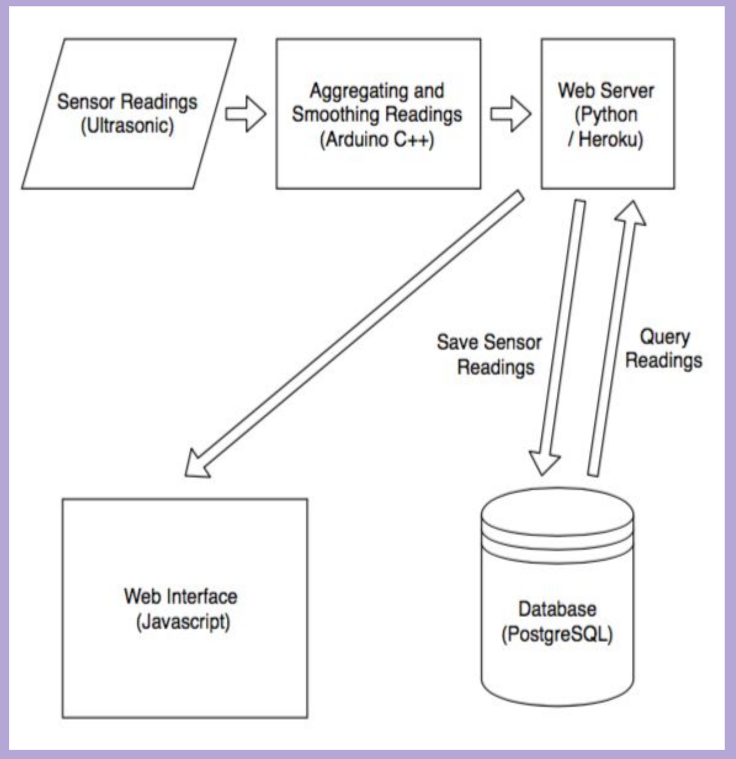

Figure 2. Software architecture diagram of the designed system.

Results

The developed waste monitoring system has been packaged within a clear box which was customized to allow Ultrasonic sensors to be placed outside for interaction with the environment. Figure 3 and Figure 4 present top and side views of the complete hardware part of the designed system.

Figure 3. Top view of the developed system.

Figure 4. Side view of the developed system.

The testing part involved continuous monitoring of the trash can and displaying data on the web interface. Figure 5 presents the testing environment of the created project.

Figure 5. Testing environment of the system.

The web page reloads data from the database every 5 seconds and adjusts the presented values. Figure 6 and Figure 7 depict the visual implementation of the web interface. The doughnut chart dynamically changes its proportion based on the last available value in the database. There are three possible states of the fill level: empty (below 50%), medium (from 50% to 75%) and full (from 75% to 100%). The levels are represented on a doughnut chart in green, yellow and red colors respectively.

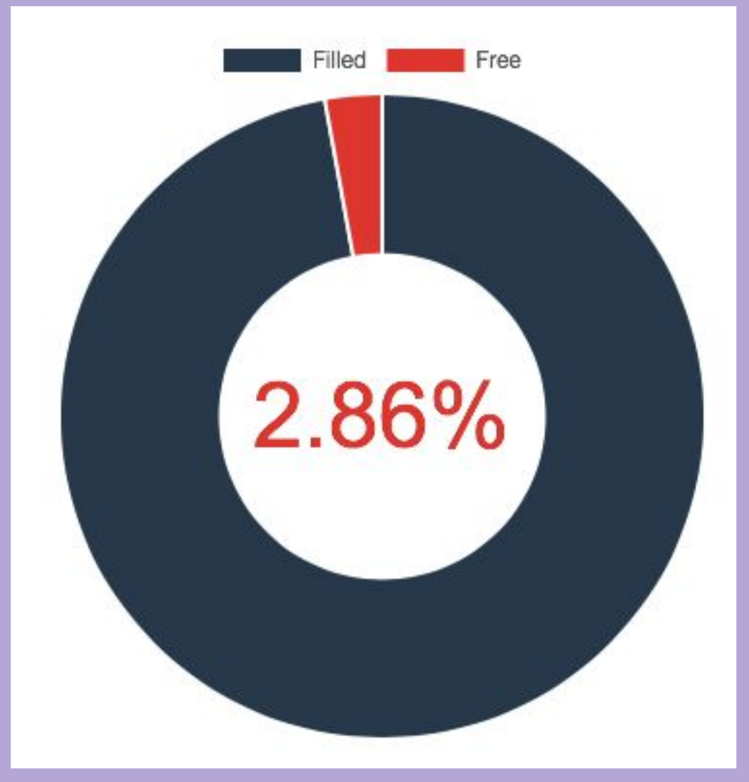

Figure 6. Doughnut chart representing fill level.

The graph of historic data plots last 50 values from the database and adjusts on its own as soon as new values are added.

Discussion and Future Work

The Ultrasonic sensor within the developed project can give wrong distance measurements in 2 cases:

- the object reflects the sound waves at a very sharp angle.
- the object is located on the distance closer than 4 cm.

The software on Arduino board checks the calculated value and initiates a new reading if it is outside of the trash can dimensions. Figure 7 shows that testing of the system has proved that out of range values have not been recorded in the database.

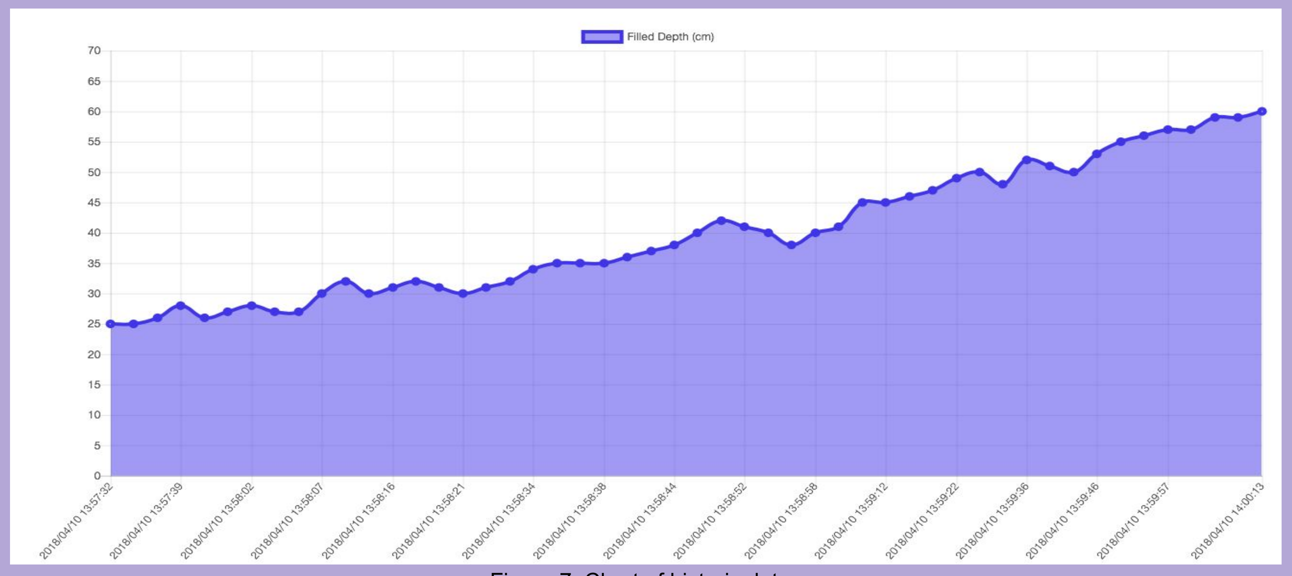

Figure 7. Chart of historic data.

The future work can focus on the following areas:

- efficient power supply (the usage of small solar panel on top of the trash can in outdoor usage might be applicable).
- improve the location of the hardware within a large trash can to avoid wrong estimations of load in case when garbage is concentrated outside of the area where pulses are being sent to (Omar et al. 2016).

References

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