Proceedings of the 7th International Electronic Conference on Sensors and Applications, 15 – 30 November, 2020, Sensors MDPI, Basel, Switzerland.

A CONFERENCE PAPER PRESENTATION

By:

***SANI ABBA AND* CHINAKA IHECHUKWU LIGHT**

DEPT. OF MATHEMATICAL SCIENCES (COMPUTER SCIENCE)
FACULTY OF SCIENCE, ATBU UNIVERSITY, BAUCHI, NIGERIA.

Paper Title:

IoT-Based Framework for Smart Waste Monitoring and Control System, A Case Study of the Smart Cities

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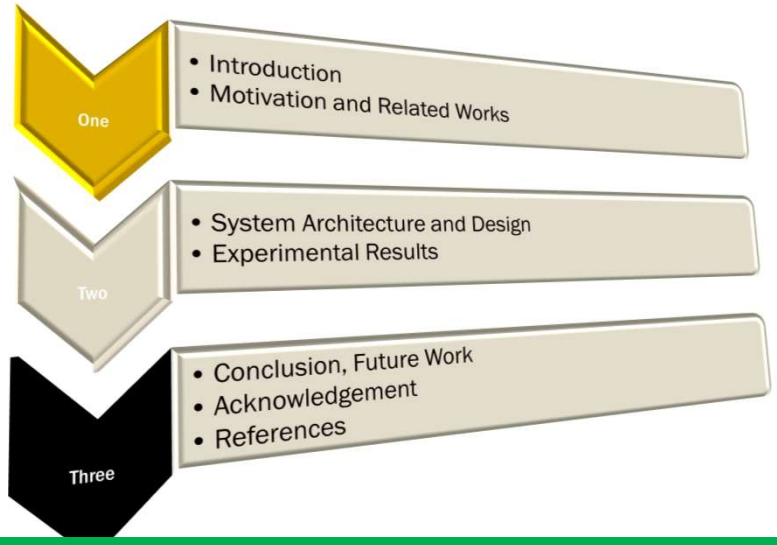
Presentation Outline



S. Abba and Chinaka I.L., ATBU University, Bauchi, Nigeria.

Introduction

- This research paper presents the design and implementation of an IoT-based Arduino microcontroller working with the ultrasonic sensors that detects the level of waste in the garbage bin placed from garbage locations,
- and constantly at regular intervals display the status information as FILLED, HALF-FILLED or EMPTY on an LCD screen, as well as send the content level information at those intervals to a central web-server system that displays the garbage bin levels graphically.
- This is achieved using a microcontroller, Wi-Fi module and ultrasonic sensors. The programming of the Arduino uno microcontroller was done with an Arduino IDE and embedded C programming language.

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Introduction Cont'd

- The communication with the web-server was done using the hypertext pre-processor (PHP) scripting programming language. The prototype was designed and simulated using Proteus 8.0 professional simulation software.
- The prototype was designed and simulated using Proteus 8.0 professional simulation software. This process helps to automate garbage bin monitoring and control. Experimental results demonstrate a promising solution to waste management and control.
- A number of testing had been performed to evaluate the device workability in real situations.

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Introduction Cont'd

- The measured distances from the garbage bins are transmitted to the website.
- This webpage performs analytic and visualization and displays a bar-chart showing the levels of the garbage waste, time, and location in real-time for viewing.
- The proposed prototype is an innovative system which will help to keep the smart cities clean and tidy using ultrasonic sensors.

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Research Contribution

1. A working prototype for the identification of garbage bins to know its location and increase efficiency to empty it in real-time.
2. Autonomous monitoring and control of the garbage bins level using an ultrasonic sensor.
3. The garbage bins, send data to a web application via a Wi-Fi modem.
4. An LCD screen and light emitting diodes (LEDs) are used to display the status of the garbage bins to the end user.
5. A web-saver and web page interfaces were designed to graphically display the level of the garbage bins.

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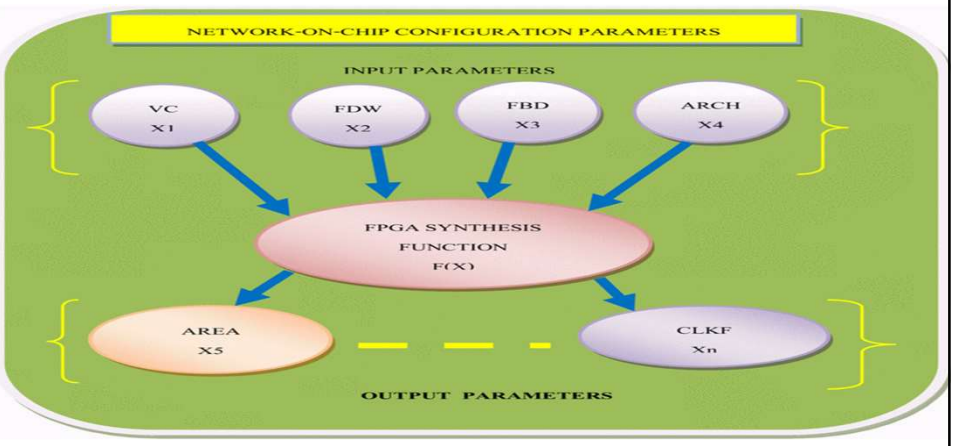
Motivation and Related Works



S. Abba and Jeong-A L., A Parametric-Based Performance Evaluation and Design Trades-off for Interconnect Architectures using FPGA for Network-on-Chips, Microprocessors and Microsystems Journal, Volume 38, Issue 5, July 2014, Pages 375-398.

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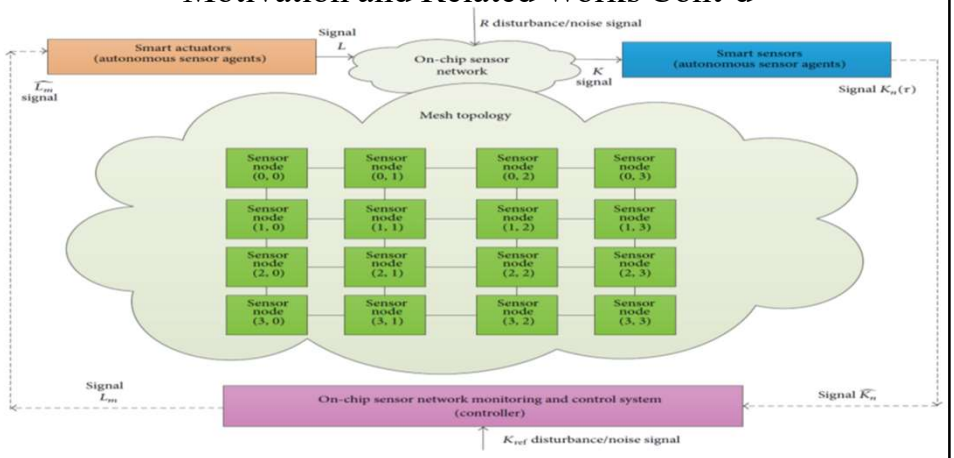
Motivation and Related Works Cont'd



S. Abba and Jeong-A L., FPGA-Based Design of an Intelligent On-Chip Sensor Network Monitoring and Control Using Dynamically Reconfigurable Autonomous Sensor Agents, Int. Journal of Distributed Sensor Networks, Volume 2016, Article ID 4246596, 29 pages.

S. Abba and Chinaka I.L., ATBU University, Bauchi, Nigeria.

Motivation and Related Works Cont'd

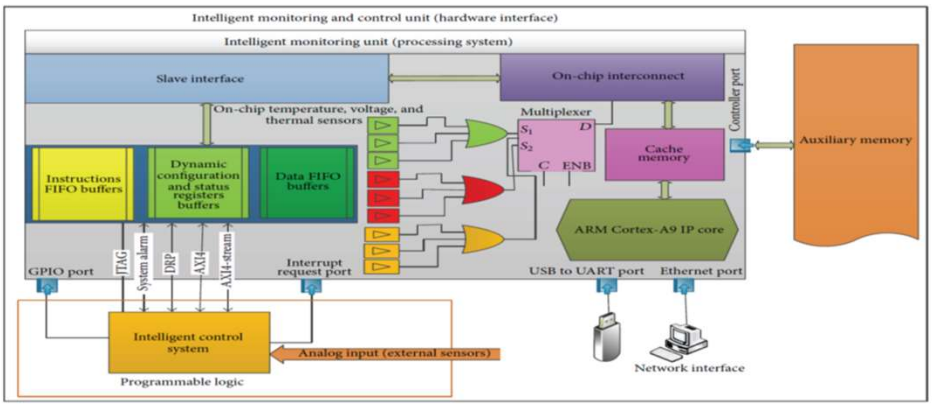


FIGURE 13: On-chip sensor network monitoring and control system (hardware interface).

S. Abba and Jeong-A L., FPGA-Based Design of an Intelligent On-Chip Sensor Network Monitoring and Control Using Dynamically Reconfigurable Autonomous Sensor Agents, Int. Journal of Distributed Sensor Networks, Volume 2016, Article ID 4246596, 29 pages.

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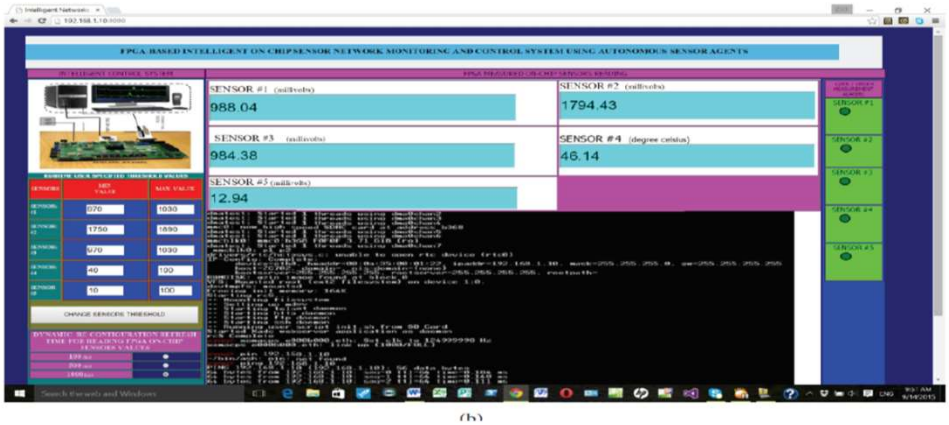
Motivation and Related Works Cont'd



(b)

S. Abba and Jeong-A, L., FPGA-Based Design of an Intelligent On-Chip Sensor Network Monitoring and Control Using Dynamically Reconfigurable Autonomous Sensor Agents, Int. Journal of Distributed Sensor Networks, Volume 2016, Article ID 4246596, 29 pages.

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Motivation and Related Works Cont'd

```
// Autonomous Self-aware and Adaptive Route Repair Technique (in ASAART)
1.  Let Sensor_Network = sensor network consisting of sensors
2.  Let Sensor_node = sensor node
3.  Let d = destination node
4.  Let k = intermediate node
5.  Let s = source node
6.  Let Route_Metric = route computation metric
7.  Let AutoSelf-Awareness-Back-offDelay = use equations 4 to 10
8.  Let RR_ACK = route repair acknowledgement packet
9.  Let RRDP = route repair discovery packet
10. Let Sequence-Number_s-d = sequence number from source to destination
11. Let Sequence-number_i-d = sequence number of intermediate node to the destination node
12. Let Local-Node-Neighbor_info = set of nodes within the sender's node transmission range
13. Let Global-Node-Neighbor_info = set of nodes within the sender's node outside transmission range
14. Begin {
15. With s as starting node update the Global-Node-Neighbor_info (k) using the Local-Node-Neighbor_info (s)
16.     If (k not equal to s) and (k not equal to d) then
17.         If RRDP then
18.             If Sequence-Number_k-d greater than Sequence-Number_i-d then
19.                 K transmit RR_ACK together with Sequence-Number_k-d
20.             Else if ∀ neighbors in Sensor_Network receive the RRDP then
21.                 Discard RRDP
22.             Else
23.                 Compute AutoSelf-Awareness-Back-offDelay to get the global update information
24.     If Sensor_node transmits RRDP and Global-Node-Neighbor_info (k) = null using equation 4 to 10 then
25.         Discard RRDP
26.     Else
27.         Global-Node-Neighbor_info (s) = Global-Node-Neighbor_info (k)
28.         Route_Metric = Route_Metric + 1
29.     End if
30.   End if
31.  End if
32.  Else if k = d and RRDP is initiated then
33.     Transmit RR_ACK
34. End if
35. }
36. End
```

S. Abba and Jeong-A, L., An Autonomous Self-Aware and Adaptive Fault Tolerant Routing Technique for Wireless Sensor Networks, Sensors Journal, 2015,*15*, 20316-20354.

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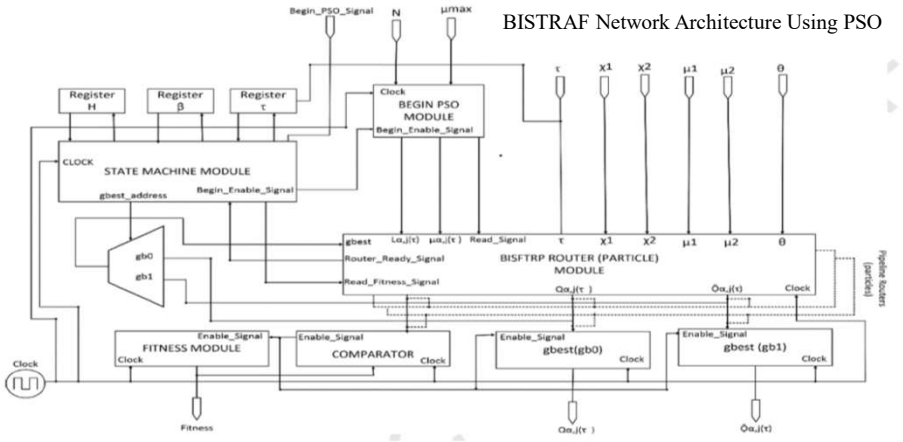
Motivation and Related Works Cont'd

BISTRAF Network Architecture Using PSO



S. Abba and Jeong-A, L., Bio-inspired self-aware fault-tolerant routing protocol for network-on-chip architectures using Particle Swarm Optimization, Microprocessors and Microsystems Journal, Volume 51, June 2017, Pages 18-38.

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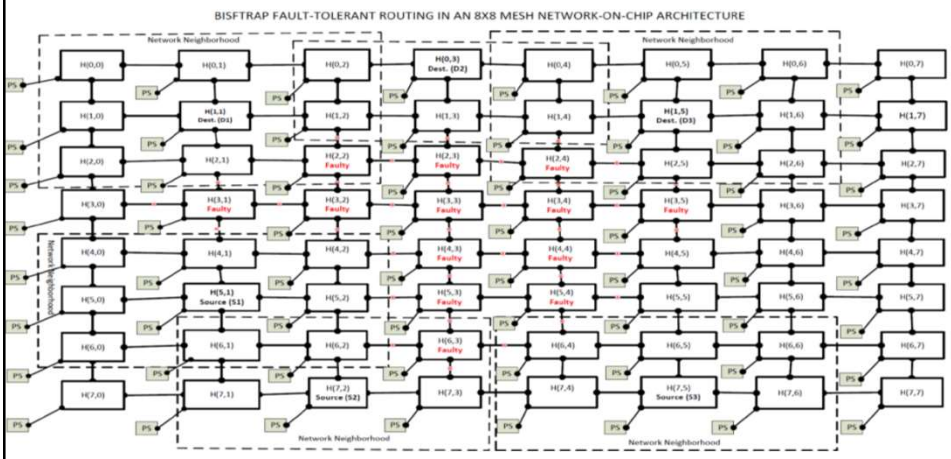
Motivation and Related Works Cont'd



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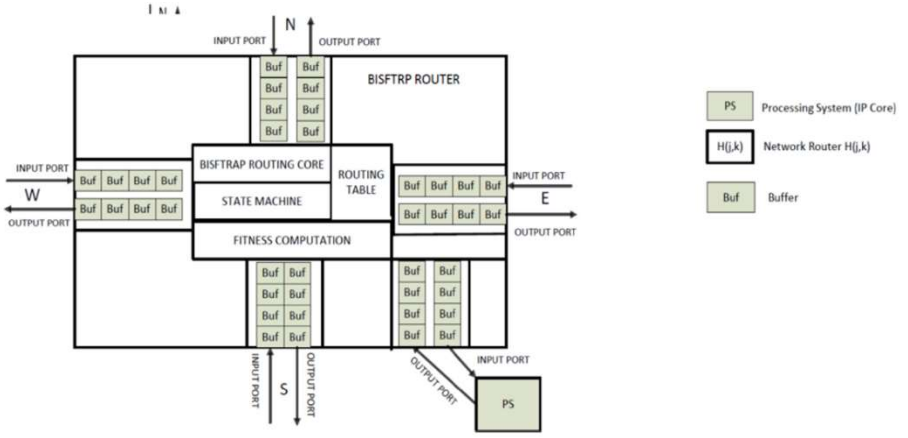

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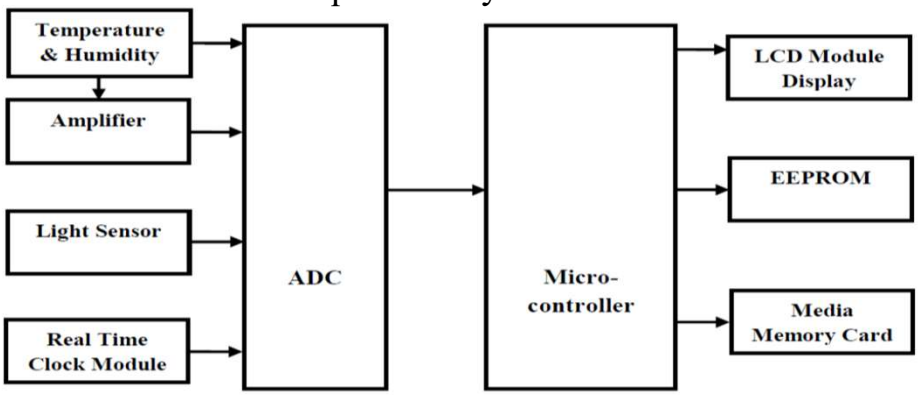
Motivation and Related Works Cont'd

Data Acquisition System Architecture



S. Abba and I. M. Nyam, Design, implementation and performance evaluation of wireless sensor networks for data acquisition system (A case study of smart homes), *in proceedings of the 1st International Conference on Microelectronic Devices and Technologies (MicDAT '2018)*, 20-22 June 2018, Barcelona, Spain, 2018, (34), 101-107.

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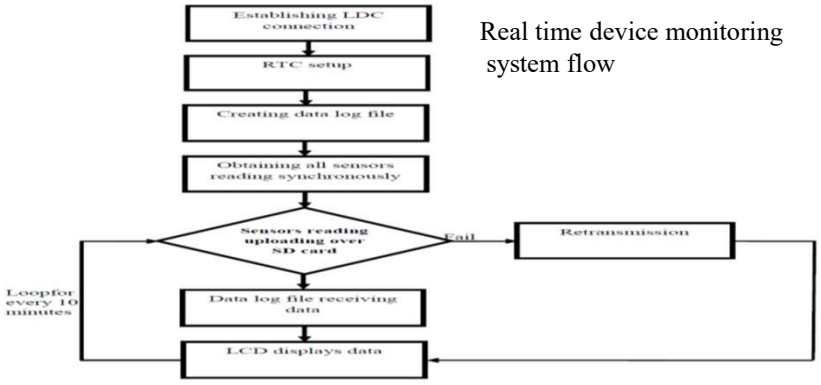
Motivation and Related Works Cont'd



Real time device monitoring system flow

S. Abba and I. M. Nyam, Design, implementation and performance evaluation of wireless sensor networks for data acquisition system (A case study of smart homes), *in proceedings of the 1st International Conference on Microelectronic Devices and Technologies (MicDAT '2018)*, 20-22 June 2018, Barcelona, Spain, 2018, (34), 101-107.

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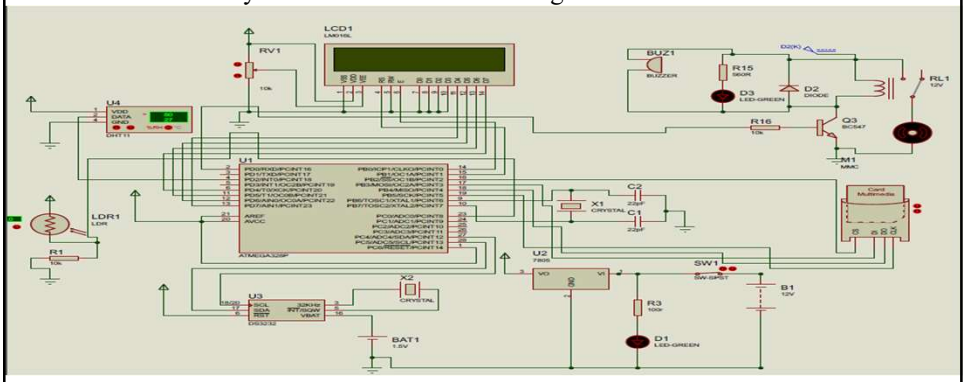
Motivation and Related Works Cont'd

System Schematics Block Diagram



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Motivation and Related Works Cont'd

The implemented Prototype

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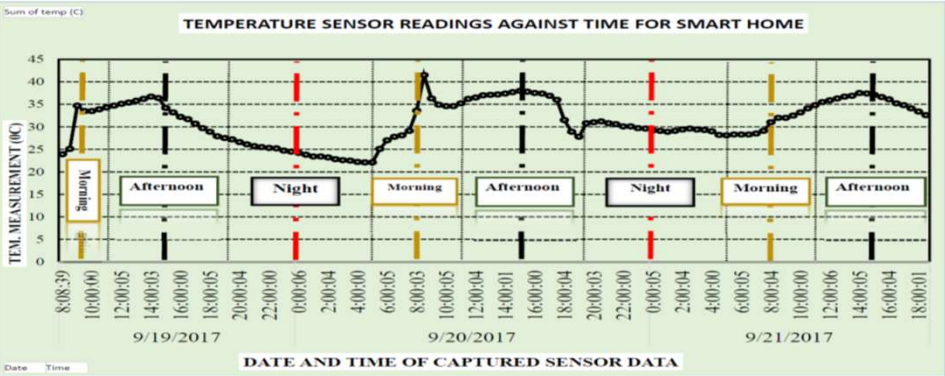
Motivation and Related Works Cont'd

Experimental Results



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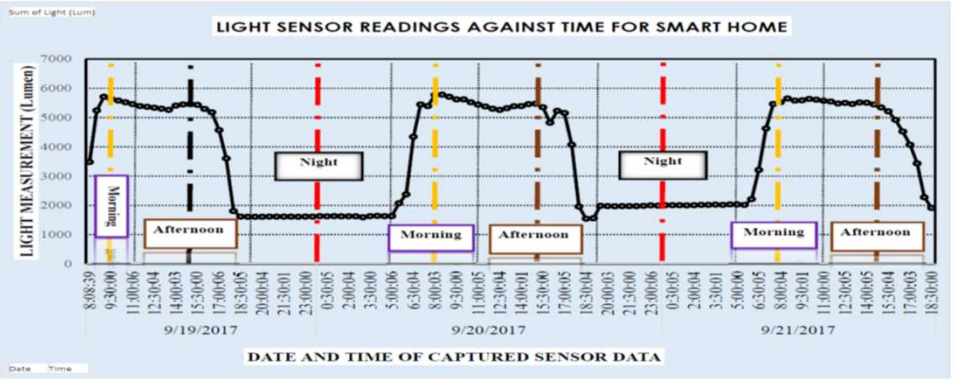
Experimental Results Cont'd



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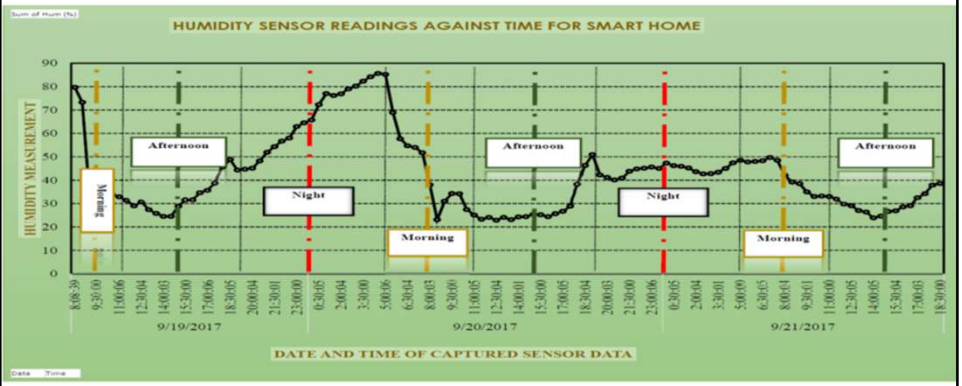
Motivation and Related Works Cont'd

Experimental Results Cont'd



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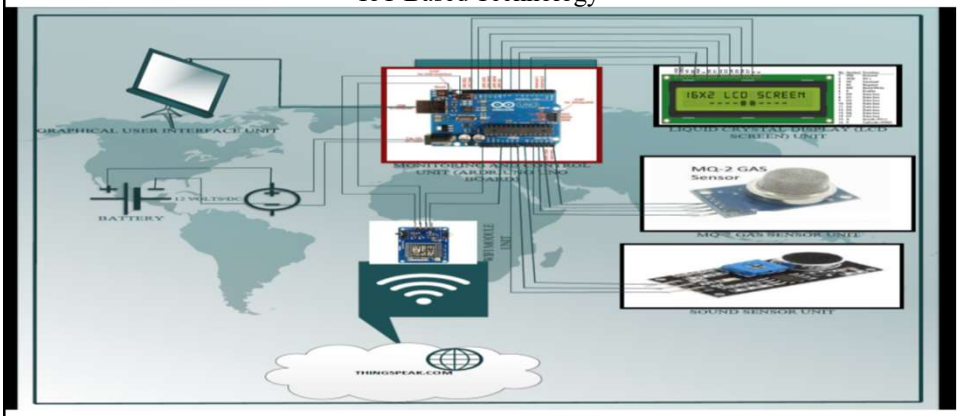
Motivation and Related Works Cont'd

Smart Framework for Environmental Pollution Monitoring and Control System Using IoT-Based Technology



Sani, A.; Beauty, P. E., Smart Framework for Environmental Pollution Monitoring and Control System Using IoT-Based Technology, Sensors & Transducers, Vol. 229, Issue 1, January 2019, pp. 84-93.

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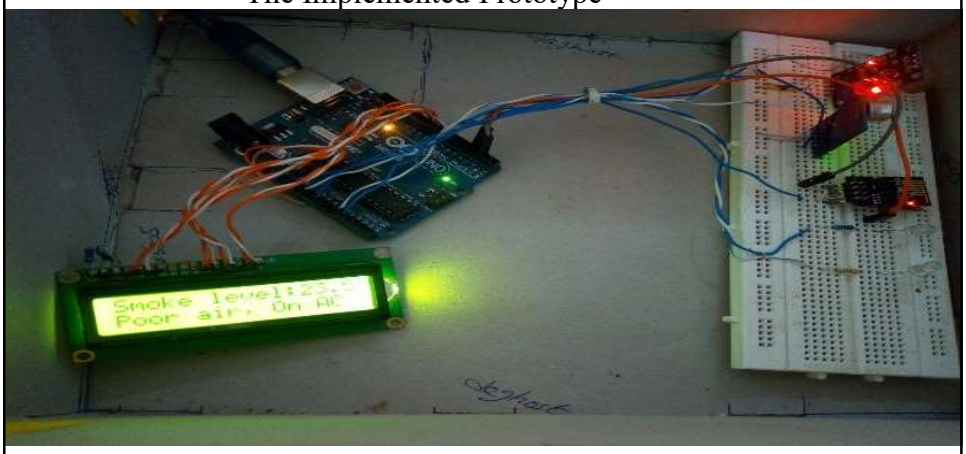
Motivation and Related Works Cont'd

The Implemented Prototype



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Motivation and Related Works Cont'd

Experimental Results (Sensor Data Logging)

	Date_of_Captured_Sensor_Data	Entry_ID	Gas_Sensor_Readings	Sound_Sensor_Readings
2	2018-01-12 09:58:59 UTC	477	4.4	19.06
3	2018-01-12 09:59:14 UTC	478	4.4	19.06
4	2018-01-12 09:59:29 UTC	479	4.89	19.06
5	2018-01-12 09:59:45 UTC	480	4.89	19.06
6	2018-01-12 10:00:00 UTC	481	5.38	19.55
7	2018-01-12 10:00:17 UTC	482	4.89	19.06
8	2018-01-12 10:00:39 UTC	483	4.89	19.06
9	2018-01-12 10:00:54 UTC	484	4.89	19.06
10	2018-01-12 10:01:10 UTC	485	4.89	19.06
11	2018-01-14 17:27:50 UTC	486	26.25	19.06
12	2018-01-14 17:28:23 UTC	487	29.33	20.04
13	2018-01-14 17:28:45 UTC	488	23.46	19.55
14	2018-01-14 17:29:05 UTC	489	18.57	19.06
15	2018-01-14 17:29:20 UTC	490	16.62	19.06
16	2018-01-14 17:29:44 UTC	491	14.66	20.04

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Motivation and Related Works Cont'd

Experimental Results (Sensor Data Logging) Cont'd

Date_of_Captured_Sensor_Data	Entry_ID	Gas_Sensor_Readings	Sound_Sensor_Readings
2018-07-31 14:07:29 UTC	500	31.28	20.53
2018-07-31 14:07:47 UTC	501	25.42	20.53
2018-07-31 14:08:09 UTC	502	23.46	21.99
2018-07-31 14:08:31 UTC	503	30.3	21.99
2018-07-31 14:08:52 UTC	504	21.51	21.99
2018-07-31 14:09:14 UTC	505	29.33	21.51
2018-07-31 14:09:29 UTC	506	20.04	20.53
2018-07-31 14:09:46 UTC	507	28.73	20.53
2018-07-31 14:10:08 UTC	508	30.3	21.51
2018-07-31 14:10:29 UTC	509	20.53	21.99
2018-07-31 14:10:52 UTC	510	19.55	20.53
2018-07-31 14:11:10 UTC	511	19.55	21.99
2018-07-31 14:11:43 UTC	512	16.62	21.99
2018-07-31 14:11:59 UTC	513	14.17	20.53
2018-07-31 14:12:14 UTC	514	14.17	20.53

Sani, A.; Beauty, P. E., Smart Framework for Environmental Pollution Monitoring and Control System Using IoT-Based Technology, Sensors & Transducers, Vol. 229, Issue 1, January 2019, pp. 84-93.

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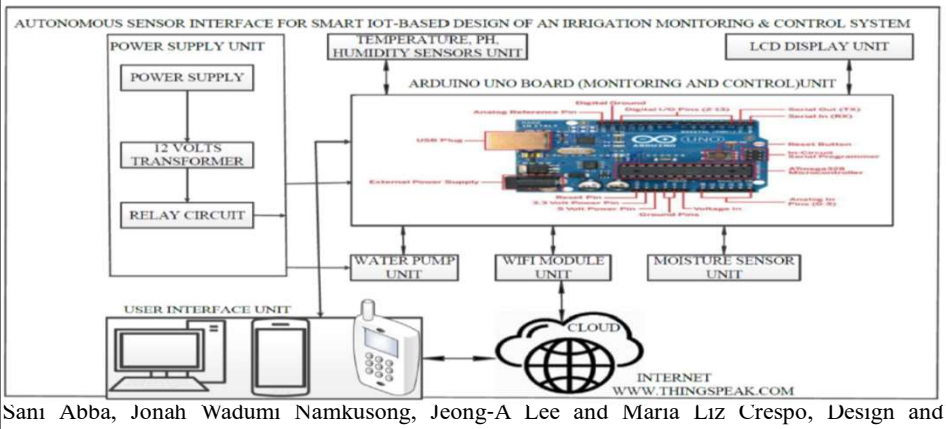
Motivation and Related Works Cont'd

Smart Framework for Environmental Pollution Monitoring and Control System Using IoT-Based Technology



Sani Abba, Jonah Wadumi Namkusong, Jeong-A Lee and Maria Liz Crespo, Design and Performance Evaluation of a Low-Cost Autonomous Sensor Interface for a Smart IoT-Based Irrigation Monitoring and Control System, *Sensors* **2019**, *19*, 3643; doi:10.3390/s19173643

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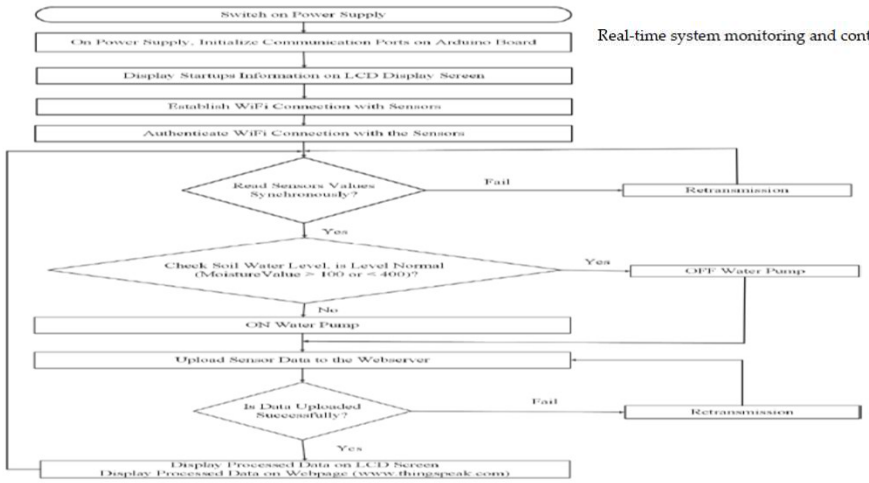
Motivation and Related Works Cont'd



Real-time system monitoring and control.

Sani Abba, Jonah Wadumi Namkusong, Jeong-A Lee and Maria Liz Crespo, Design and Performance Evaluation of a Low-Cost Autonomous Sensor Interface for a Smart IoT-Based Irrigation Monitoring and Control System, *Sensors* **2019**, *19*, 3643; doi:10.3390/s19173643

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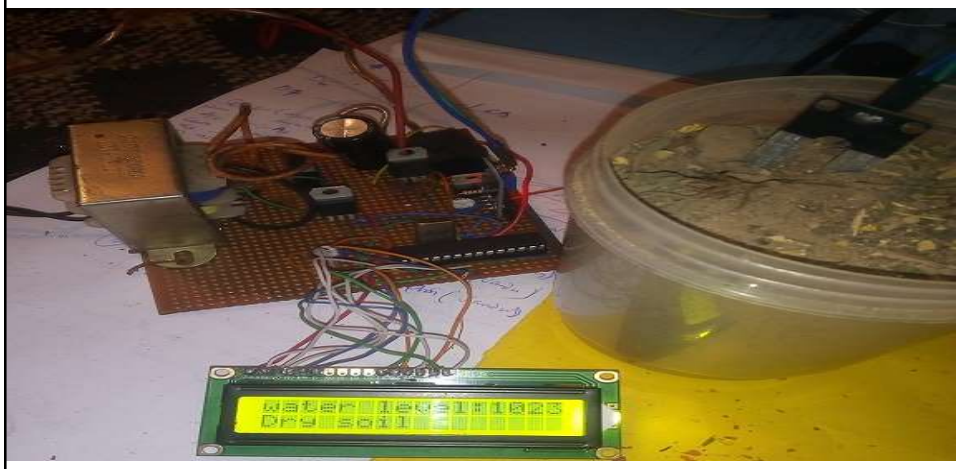
Motivation and Related Works Cont'd



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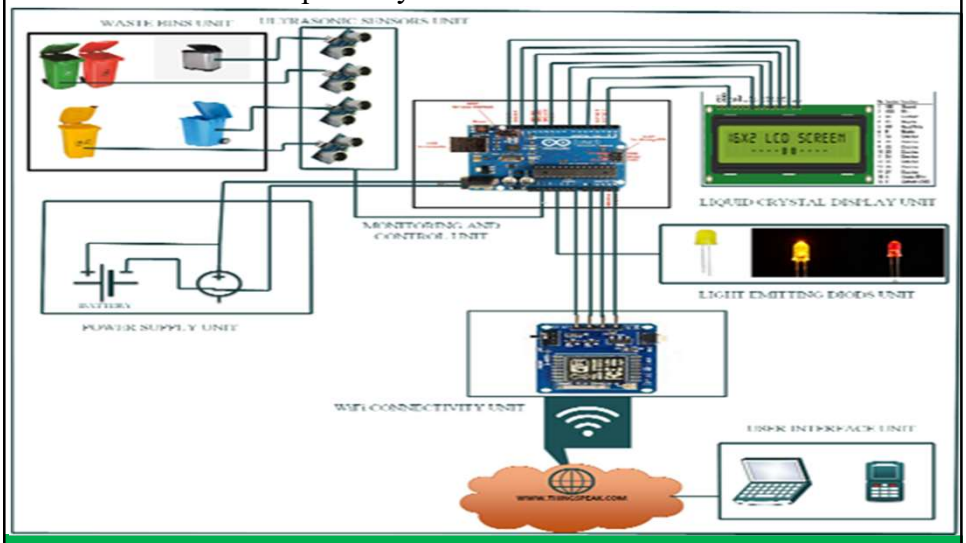
This Proposal

Proposed system architecture.



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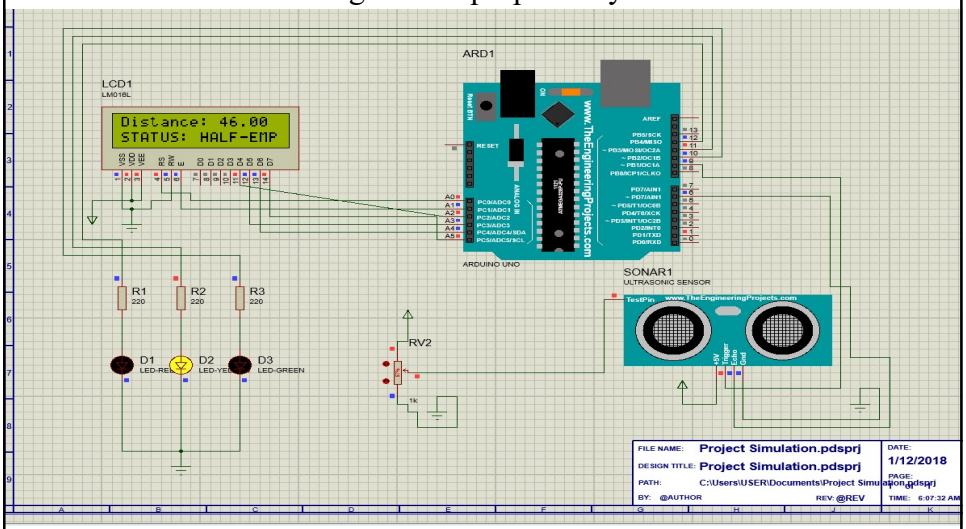
This Proposal Cont'd

Schematic design of the proposed system architecture.



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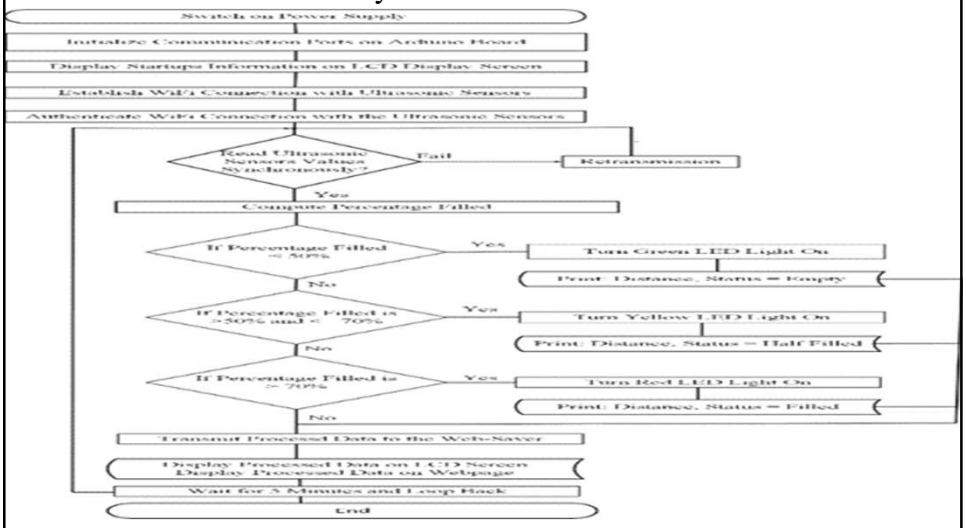
This Proposal Cont'd

System flowchart



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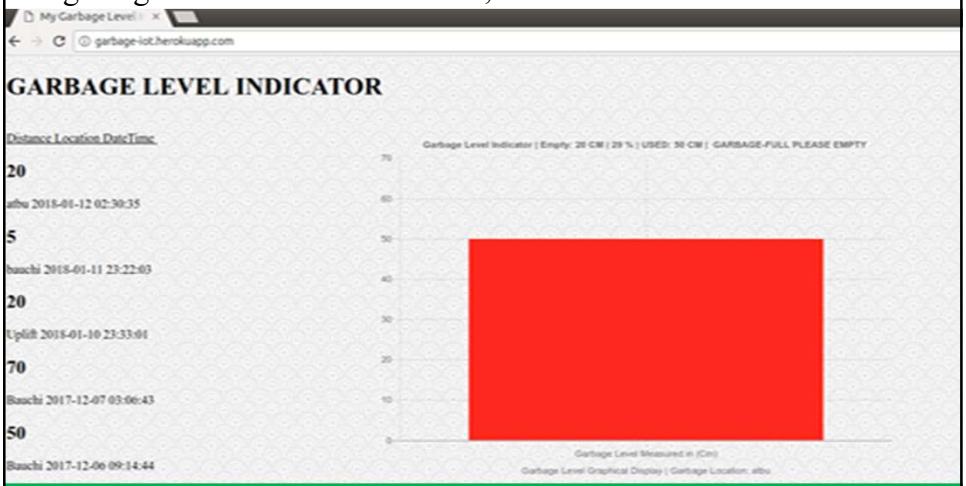
This Proposal Cont'd

Experimental Results

The garbage status is almost FILLED, is due for collection.



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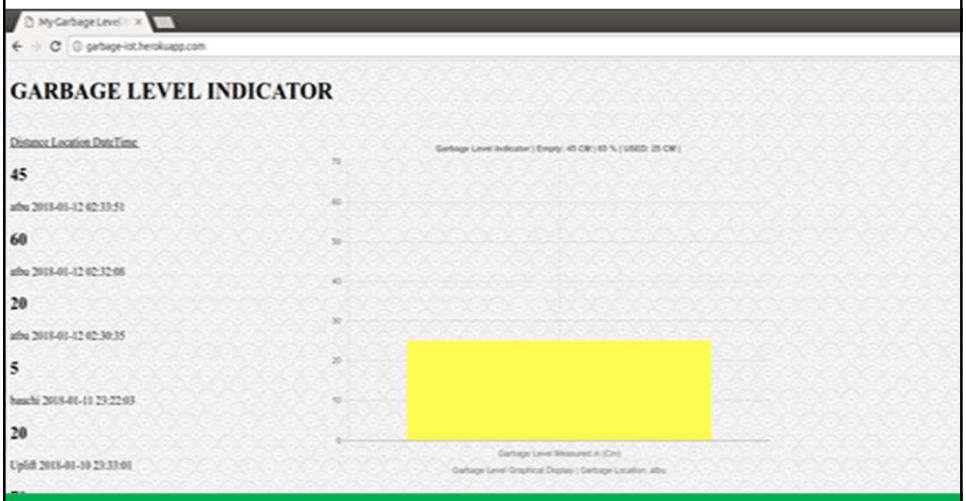
This Proposal Cont'd

Experimental Results Cont'd

The garbage status is HALF-FILLED



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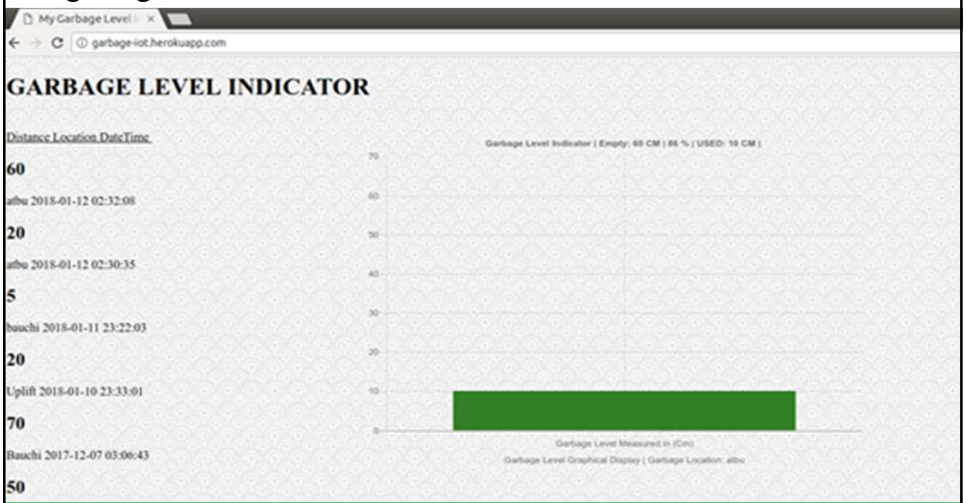
This Proposal Cont'd

Experimental Results Cont'd

The garbage status is almost EMPTY



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Conclusion

- This research paper presents an innovative approach to facilitate the process of keeping the environment clean, tidy, and conducive for living.
- The proposed approach, presented the design and implementation methodology to strategically monitor and control the rate at which garbage bins are filled and eventually help prevent overflow which in most cases leads to environmental pollution.
- The research paper presents the design and implementation of an IoT-based Arduino microcontroller working with the ultrasonic sensors that detects the level of waste in the garbage bin placed from garbage locations and constantly at regular intervals display the status information as FILLED, HALF-FILLED or EMPTY on an LCD screen.

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Conclusion Cont'd

- as well as send the content level information at those intervals to a central web-server system that displays the garbage bin levels graphically.
- This is achieved using a microcontroller, Wi-Fi module and ultrasonic sensors. The programming of the Arduino uno microcontroller was done with an Arduino IDE and embedded C programming language. The communication with the web-server was done using the hypertext pre-processor (PHP) scripting programming language.
- The prototype was designed and simulated using Proteus 8.0 professional simulation software. This process helps to automate garbage bin monitoring and control. Experimental results demonstrate a promising solution to waste management and control.

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Future Work

- Future work will consider the use of the field programmable gate array (FPGA) to provide high performance real-time computing capabilities compared with the Arduino microcontroller.

- The proposed system can be extended to monitor and control waste in remote locations for sustainable development.

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Questions and Answers

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