Bulletin of Social Informatics Theory and Application
Vol. 6, No. 1, March 2022, pp. 84-89

Forecasting IoT Pollution Data Using Forward Newton for Sustainable Green Environment

Asghaiyer Mohamed Asghaiyer [a,1,*], Abdaraouf Abdalla Omar [a]

[a] Faculty of Technical Sciences Bani Walid, Bani Walid, Libya
[1] asghaiyer@gmail.com
* corresponding author

ARTICLE INFO

Article history
Received December 16, 2021
Revised January 16, 2022
Accepted February 1, 2022

Keywords
Internet of Things
Air pollution
Newton method
Future trends
Green environment

ABSTRACT

Internet of Things (IoT) technology proliferates because of its ease of use and low cost. One widely used IoT technology is air pollution loggers in big cities. This technology is often installed in places easily visible to display pollution information. The stored data is not processed, so the data seems useless. The data contains valuable information as long as it is extracted correctly. The pollution data is consistent with time, so the advanced newton method is suitable because the prediction will involve future trends. The results of this study indicate that from 12,432, the amount of data gives the result that in the next year, the amount of CO2 levels will increase by 3%. This needs to be considered by planting trees around the location to make the environment friendly to human health.

1. Introduction

IoT (Internet of Things) technology is developing quite rapidly. This is marked by the emergence of various technologies built by IoT itself [1]–[4]. In Libya, especially in Bani Walid, a city where this research was conducted, the number of vehicles is increasing every year in line with improving economic life, so the number of huge vehicles also increases as trucks, buses, and buses tractors. Diesel fuel consumption has a smoke effect that exceeds gasoline consumption, but both will still be included in this study. The pollution that occurs is not felt, but it can be seen from the data that the temperature in the city is rising [5]–[7].

IoT is used and installed in outdoor locations, such as at campus entrances, in front of shopping centers, schools, and others. The installation of IoT refers to research previously carried out by Beccera *et al. l* [1] about pollutants, one of which is CO_2, as measured in 18 classrooms in schools. IoT technology has been used to capture CO_2 gas levels, which in general [8]–[10], if the levels exceed O_2, researchers can recommend planting trees or reducing air pollution to the government. CO_2 levels are captured by sensors that use the nodeMCU board component with a CO_2 level detection sensor. This sensor works by storing data in a database on the server and displaying daily CO_2 levels through a TV display only. This is done continuously, and the collected data eventually accumulate in the database, especially last month's data, which is no longer used.

The CO_2 level data in the database reaches millions of rows because data sampling through sensors is carried out every 5 minutes and has been running for over ten years. The researcher proposes to process the data so that it is not deleted and used to trend the surrounding environmental conditions so that it will be helpful. The researcher conducted a data analysis test at the beginning of the study and decided to use the advanced newton to conduct research by predicting the trend of air content with the help of computer software using the Python programming language [11]–[13].

https:doi.org/10.31763/businta.v6i1.545

2. Method

This method is carried out systematically, from the system requirements stage to the analysis, design, coding, testing, and maintenance stages [14]–[17]. The passed steps must be completed one by one and run sequentially. This study uses the waterfall software development method, which consists of the sequence in Fig. 1.

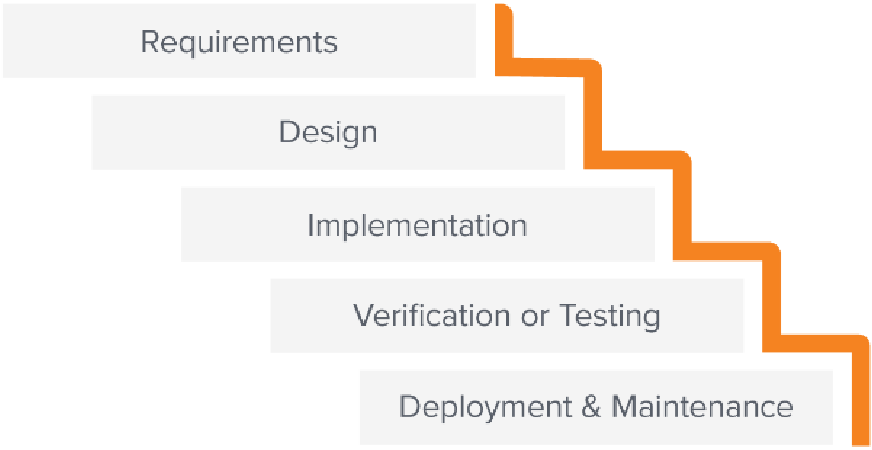

Fig. 1. Waterfall Model

The waterfall stage has five stages: requirements, design, implementation, verification or testing, deployment, and maintenance. For more details, see the next sub-chapter.

2.1. Requirements

Before doing software development, a developer must know and understand the information needs of users for software [18]–[20]. This information collection method can be obtained through discussion, observation, survey, interview, etc. The information obtained is then processed and analyzed so that complete data or information is obtained regarding the specifications of user needs for the software to be developed

At this stage, data is collected on the IoT server, stored in the MySql database, then processed in CSV format and later processed in python. Not all database information is included in the processing. Only the most essential part can be entered. The data converted into csv can be seen in Table 1.

Table.1 Sample dataset is taken from the database

Time	CO2(ppm)
7:04:12	1530
7:09:12	1642
7:14:12	1809
7:19:12	1972
7:24:12	1619
7:29:12	1482
7:34:12	1759
7:39:12	1492

Table 1 shows a column of CO2 levels in the air. The unit of that level is mg, captured by the IoT device every 5 minutes. Furthermore, the data is processed statistically by entering numbers in SPSS as input software.

2.2. Design

Information about the requirements specification from the Requirements Analysis stage is then analyzed and implemented in the development design [21]–[23]. Design drafting is done to help to provide a complete picture of what must be done. This stage will also help developers to prepare hardware requirements in making the software system architecture that will be made as a whole.

This stage is to design the algorithm that will be used in the application. The use of advanced newtons takes a reference from a journal.

i	f_i	Δf_i	$\Delta^2 f_i$	$\Delta^3 f_i$	$\Delta^4 f_i$
0	f_o	$\Delta f_o = f_1 - f_o$	$\Delta^2 f_o = \Delta f_1 - \Delta f_o$	$\Delta^3 f_o = \Delta^2 f_1 - \Delta^2 f_o$	$\Delta^4 f_o = \Delta^3 f_1 - \Delta^3 f_o$
1	f_1	$\Delta f_1 = f_2 - f_1$	$\Delta^2 f_1 = \Delta f_2 - \Delta f_1$	$\Delta^3 f_1 = \Delta^2 f_2 - \Delta^2 f_1$	
2	f_2	$\Delta f_2 = f_3 - f_2$	$\Delta^2 f_2 = \Delta f_3 - \Delta f_2$		
3	f_3	$\Delta f_3 = f_4 - f_3$			
4	f_4				

Fig. 2. Algorithm design using newton's forward

For equidistant points, Newton's polynomial formula becomes simpler. In addition, the divisor-difference table is easier to construct. Here we plant the table as a difference table only because there is no division process in forming table elements. The value of $\Delta fp = f_{p+1} - f_p$ is the difference between the current CO_2 level and previous CO2 levels.

2.3. Implementation

The implementation and unit testing stages are the programming stage. Software development is divided into small modules, which will be combined in the next stage. In addition, in this phase, testing and checking the functionality of the modules made is also carried out, whether they meet the desired criteria or not.

This stage is coding and running the results on the computer. There is an essential part of the program code shown in Fig. 3.

```
for i in range(1,n):
    for j in range(0,n-i):
        f[j][i] = f[j+1][i-1] - f[j][i-1]
```

Fig. 3. Newton forward pseudocode

An essential part of the pseudocode in Fig. 3 is the subtraction of values that point to the right so that later it will form an end of a calculation.

2.4. Testing

All the units or modules developed and tested in the implementation phase are integrated into the overall system. After the integration process, further system inspection and testing are carried out to identify possible system failures and errors.

Table.2 Result of Newton Forward Prediction (NFP)

time	CO2(ppm)	NFP
7:04:12	1530	1502
7:09:12	1642	1690
7:14:12	1809	1827
7:19:12	1972	1962
7:24:12	1619	1620
7:29:12	1482	1452
7:34:12	1759	1766
7:39:12	1492	1459

From Table 2, it appears that the actual value of the data sent by IoT to the server with the NFP value has a difference. This will be explained further in the discussion section.

2.5. Deployment

In the last stage of the Waterfall Method, the finished software is operated by the user and carried out maintenance. Maintenance allows developers to improve errors not detected in the earlier stages. Maintenance includes repairing errors, improving the implementation of the system unit, and upgrading and adjusting the system as needed. At this stage, the calculation results will be stored in the database and will be displayed on a number pad near the sensor, following government policy.

3. Results and Discussion

The results of dataset calculations using the advanced newton method have been carried out on 12,432 dataset samples taken sequentially. The results of the calculation analysis appear in the following Table 3.

Table.3 Simple statistic analysis

time	**CO2(ppm)**	**predict**	**Δ**
7:04:12	1530	1551	-21
7:09:12	1642	1628	14
7:14:12	1809	1817	-8
7:19:12	1972	1969	3
7:24:12	1619	1605	14
7:29:12	1482	1490	-8
7:34:12	1759	1783	-24
7:39:12	1492	1511	-19
parameter	**value**	**predict**	**analysis**
MIN	1482	1490	-8
MAX	1972	1969	3
AVG	1663.125	1669.25	-6.125
STDDEV	172.4118	169.7079	2.703888

Table 3 notes a difference between each real value and the predictor generated from newton forward. The value of the difference between the two can be seen in the last column of Table 3. These values vary; if the percentage is calculated, the difference is not too big.

Likewise, when looking at the statistical count parameters in the table below, it is explained that the min and max values of the data are almost the same. There is a very slight difference. The same is true for the mean and standard deviation. The standard deviation means that the value of 172.4118 is the point difference value with an average of 2.703888 from the predictor value of 169.7079 using advanced newtons. This shows that predictions using this advanced newton algorithm produce values that are not much different from the original. If there is a significant difference ranging from 1.5% and computation results by SPSS, it is shown that increasing of average value from IoT next year is not more than 3%.

4. Conclusion

Pollution in big cities like Bani Walid in Libya requires a solution shortly. Data recording CO2 levels are already available in several corners of the city and have been processed using the advanced newton method to predict the increase in CO2 levels every year. It aims to save the health of an area or surrounding community. This advanced newton predictor provides a calculation error of 1.5% and predicts an annual increase in CO2 levels of 3%. The study gave good results because accurate data with predictors had a standard deviation of 0.36%. This research can inspire other researchers to optimize the calculation speed if the data increases.

Acknowledgment

The researcher would like to thank Universitas Negeri Malang for the research opportunity given.

References

[1] J. A. Becerra, J. Lizana, M. Gil, A. Barrios-Padura, P. Blondeau, and R. Chacartegui, "Identification of potential indoor air pollutants in schools," *J. Clean. Prod.*, vol. 242, p. 118420, Jan. 2020, doi: 10.1016/j.jclepro.2019.118420.

[2] B. W. Wirtz, J. C. Weyerer, and F. T. Schichtel, "An integrative public IoT framework for smart government," *Gov. Inf. Q.*, vol. 36, no. 2, pp. 333–345, Apr. 2019, doi: 10.1016/j.giq.2018.07.001.

[3] F. John Dian, R. Vahidnia, and A. Rahmati, "Wearables and the Internet of Things (IoT), Applications, Opportunities, and Challenges: A Survey," *IEEE Access*, vol. 8, pp. 69200–69211, 2020, doi: 10.1109/ACCESS.2020.2986329.

[4] O. Said, Z. Al-Makhadmeh, and A. M. R. Tolba, "EMS: An Energy Management Scheme for Green IoT Environments," *IEEE Access*, vol. 8, pp. 44983–44998, 2020, doi: 10.1109/ACCESS.2020.2976641.

[5] N. Uskowi, "Temperature Rising: Iran's Revolutionary Guards and Wars in the Middle East," 2018. Available at : ndupress.ndu.edu.

[6] M. LOPEZ, A. GOMEZ, G. MULLER, E. W.- MedRxiv, and U. 2022, "Climate change and the rising incidence of dengue in Argentina," *medrxiv.org*, doi: 10.1101/2022.06.03.22275954.

[7] H. Stevens, P. Beggs, … P. G.-I. journal of, and undefined 2019, "Hot and bothered? Associations between temperature and crime in Australia," *Springer*. doi : 10.1007/s00484-019-01689-y.

[8] V. Suma, R. Shekar, K. A.-2019 3rd International, and undefined 2019, "Gas leakage detection based on IOT," *ieeexplore.ieee.org*. doi : 10.1109/ICECA.2019.8822055.

[9] P. Kumar, A. K.-I. J. of Engineering, and undefined 2019, "Design of Gas Detection and Monitoring System using IoT," *academia.edu*. doi : 10.17577/IJERTV8IS110193

[10] J. B. A. Gomes, J. J. P. C. Rodrigues, R. A. L. Rabêlo, N. Kumar, and S. Kozlov, "IoT-enabled gas sensors: Technologies, applications, and opportunities," *mdpi.com*, 2019, doi: 10.3390/jsan8040057.

[11] Y. Romm, G. D.-J. of P. Conference, and undefined 2021, "Piecewise interpolation solution of ordinary differential equations with application to numerical modeling problems," *iopscience.iop.org*, vol. 1902, p. 12130, 2021, doi: 10.1088/1742-6596/1902/1/012130.

[12] A. Rakshit and B. Banerjee, "Analysis The Internal Pressure Of The Thin Cylindrical Shell By Newton's Forward Interpolation," *irjmets.com*, pp. 2582–5208. Available at : irjmets.

[13] A. R. Mohammed, M. Abdel-Aal, K. S. Hassan, and M. A. M. Abdel-Aal, "Moving Average Smoothing for Gregory-Newton Interpolation: A Novel Approach for Short-Term Demand Forecasting," 2022. doi : 10.1016/j.ifacol.2022.09.499.

[14] F. Heriyanti, A. I.-I. C. S. M. Science, and undefined 2020, "Design of logistics information system in the finished product warehouse with the waterfall method: review literature," *iopscience.iop.org*, doi: 10.1088/1757-899X/801/1/012100.

[15] S. N. Hidayati, "Application of Waterfall Model In Development of Work Training Acceptance System," 2020, doi: 10.29407/intensif.v4i1.12976. doi: 10.1016/j.ifacol.2022.09.499.

[16] A. Sinha, P. D. Electronics, M. E. & Nano, and undefined 2021, "Agile Methodology Vs. Traditional Waterfall SDLC: A case study on Quality Assurance process in Software Industry," *ieeexplore.ieee.org*. doi: 10.1109/IEMENTech53263.2021.9614779.

[17] M. K.-R. of B. & F. Studies and undefined 2018, "Best practices in systems development lifecycle: An analyses based on the waterfall model," *papers.ssrn.com*, vol. 9, no. 1, pp. 77–84, 2018. Available at : papers.ssrn.com.

[18] C. Burr, N. Cristianini, J. L.-M. and machines, and undefined 2018, "An analysis of the interaction between intelligent software agents and human users," *Springer*. doi : 10.1007/s11023-018-9479-0.

[19] E. Gebka, J. Crusoe, and K. Ahlin, "To Capture the Information Needs of End-Users of Open Data: Guidelines to design methods," 2021. doi: 10.5334/dsj-2021-037.

[20] C. Burr, N. Cristianini, and J. Ladyman, "An Analysis of the Interaction Between Intelligent Software Agents and Human Users," *Minds Mach.*, vol. 28, no. 4, pp. 735–774, Dec. 2018, doi: 10.1007/S11023-018-9479-0.

[21] S. Almeyda, C. Zapata Del Río, and D. Cohn, "Integration of User Experience and Agile Techniques for Requirements Analysis: A Systematic Review," *Lect. Notes Comput. Sci. (including Subser. Lect. Notes Artif. Intell. Lect. Notes Bioinformatics)*, vol. 12779 LNCS, pp. 187–203, 2021, doi: 10.1007/978-3-030-78221-4_13.

[22] R. Prasath, R. R.-2021 2nd I. C. on, and undefined 2021, "Autonomous Application in Requirements Analysis of Information System Development for Producing a Design Model," *ieeexplore.ieee.org*. doi: 10.1109/C2I454156.2021.9689440.

[23] M. Kamalrudin, L. Ow, S. S.-J. of Telecommunication, and undefined 2018, "Requirements defects techniques in requirements analysis: A Review," *core.ac.uk*. Available at : semanticscholar.