Role of Software Engineering Processes to Develop Environmental Model

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***Abstract*—The recently found systemic errors in atmospheric environmental model are evident in the malfunctioning of measuring instruments in West Africa. The software development in the past had been comprised; hence the need to embark on new software development is eminent to avoid future environmental accident. The architectural structures of the new model, as well as the financial importance were examined. Therefore, there is the need for writing of detachable source codes to assist the collective software development of environmental models.**

***Index Terms*—Software engineering, Environmental model, Formal method, Aerosols**

I. Introduction

The dynamism of environmental models especially translating mathematical codes to easy use software may be quite difficult. Mathematical techniques used in design, implementation and testing of computer systems are known as Formal Methods (1). Generally, in the development and verification of software, it is more effective to have an understanding of what the vital components of the software are. Studies of these parts are done in details by creating mathematical models of these sections and verifying them. However, creating mathematical models for environmental situation is somewhat challenging due to changing parameters that are dependent on geographical locations (2-6).

There are different techniques in mathematical modelling as regards to environmental studies. The first is to take a definite transition system and according to that system check whether all the important properties hold for every part of the system. For example, the analysis of the aerosol size distribution requires a modest check on salient parameters that are mostly ignored. Emetere et al. (7) proposed that the malfunctioning of measuring instruments in West Africa is more systemic than design error. The systemic errors are embedded into the software formulation and may not be corrected unless a holistic process is initiated. Hence environmental model is not limited to minute varieties of the system under investigation. Since our world depends largely on technology and this technology is rapidly advancing, it is important that mistakes which may have dire consequences be avoided. To avoid such terrible mistakes, the Formal Methods can be used in achieving this safety measure.

Software engineering for environmental models begins with the mathematical structures forming the semantic conceptual model associated with a system; system of descriptive characters given by the syntax, graphics or tables used in the document of a software system; and connecting real life aspects of applications by using software description techniques.

Incorporating the software engineering into solving environmental challenges is the aim of this paper. Section two of this research relates the importance of software development to environmental field. Section three illustrates specific environmental processes. Section four illustrates the incorporation of systems.

II. The Internet of Things: Application and Challenges

In this section, we examine the Internet of Things (IoT) to see how it fits in into our objectives. IoT can be generally classified into many types but not limited to smart city, environment and enterprise. Smart City is modeling a city is totally incorporated to form a smart grid. We can see this in things like power distribution and monitoring of living conditions in a city. Smart environment monitors and regulates the environmental conditions to increase efficiency. IoT is used to assist other remote devices to manage equipment used in the manufacturing sector; it can also perform an assessment of the assets owned by a company and also help with situation management. By monitoring hazards and risks and providing emergency response if need be.

IoT is also very useful in home energy management. It monitors the energy system in a house and can control it automatically. It also includes the option of notifying its owner when the energy source or generation needs to be serviced or renewed (e.g. paying of electricity bills or servicing of solar panels or their repair. It may have also been programmed to automatically perform these functions in alliance with a bank or trusted service provide. Finally, it balances the power or energy generated and the energy used.

IoT can be used to perform the function of enabling medical doctors monitor their patient remotely. It also

Manuscript received June 29, 2016; revised July 08, 2016. This work was supported in part by Covenant University, Ota, Nigeria.

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enables a notification system to call for help in the case of an emergency. It uses Medicare devices that monitor patient's vital signs in patients as well as specialized implants that are meant to monitor special health conditions in a patient. These devices are fitted with the ability to get, analyze and store data and communicate it with other devices and send notifications if serious medical attention is needed. IoT is very important here because it ensures proper treatment for patients and reduces fatality rate.

In the light of this research, we envisage problem in automacy and security as it relates to incorporating IoT into enviromental mobile applications. With the way everything will be connected by the Internet of Things, nothing will be essentially private anymore, as every body's personal information will be stored to the digital cloud and will invariably make it accessible to anyone with technical know-how and adequate motive. Its automacy and control will also pose a problem, this is simply because the technology can be hacked in such a way so as to control or manipulate only one person or group of persons. For example, if a mobile device is expected to alert its users of an impending environmental hazard, a system that is hacked may be compromised. Since the objective of environmental mobile apps is to fissile-out the public alert system, it means that the concept of automacy and security must be looked into. Also, if the interface is not properly structured or written, it can lead to inaccuracy in control, due to an overlay in the way the program for the controls are written.

Security can easily be the largest problem with 'The Internet of Things'. As technology is improving, hacks are being written in step with these technologies, so are bugs and viruses. They are all moving forward in sync with technology. People's personal information and lives will be susceptible to hacks from cyber criminals. They could monitor their victim for a while, using a profile formed from their online maps (i.e, their routine, foods, medical reports, financial reports, etc) and plan an attack on them, it will not be limited to individuals alone, but cities as a whole will also suffer from these as nobody will be safe.

Writing a environmental model that is expected to run on the concept of IoT should be able to resolve: algorithmic structures for Signal Processing; encoding the data to be inputted into the algorithm; reformulation or reanalysis of the algorithm so that it can adequately operate on the data that has been encoded and decode it to give useful information; and sharing the tasks involving processing among the units of the processor that are highly prone to failure, so that these faults will cause the errors to be easily detectable and correctable.

The algorithmic structures for signal processing represent themselves as a major issue, because it is only possible to formulate a set or number of schematics to fit a possible solution. This is because for a function, there are a number of possible algorithmic solutions or source codes to be written to address it. But then when it comes to writing algorithms, you can only write an algorithm to fit into the general and anything apart from the general will pose a problem to the system, so it is not possible to form a number of options. Although, Mathematical methods have been aimed at formulating a general formula to fit into any system and provide a solution.

Encoding the Data to be put into the system may be considered a problem, because the sent information may not be written in the same language that will be understood by the receiving platform. Hence, an algorithm has to be written that will effectively translate the sent or transmitted message into a language that will be understood by the receiving platform. This implies that the encoder should be written with a reliable source code with little or no errors and if any errors are to be found at all, it should have little or no impact on the functioning of the system. And finally, aside from properly transmitting the sent message, it should be able to communicate effectively with the platform to which the message is being sent.

The Algorithm should be reformulated so as to quickly work on the data that has been encoded to decode it and give useful information. This implies that the written algorithm should be able o decode the sent information to give something very similar to the data that was originally sent. It should contain as little ambiguity as possible and should be able to do a thorough job in decoding. It is important to note that the algorithm for encoding will be very similar to that for decoding that is why the algorithm for encoding only has to be reformulated. The mathematical method used for this process should be very simple and may apply laws of probability and binomial distribution among others.

The computational tasks should be distributed among the units of the processor that are prone to failure. This should be done in such a way that the faults will cause detectable and correctible errors. When the code is written, there will be some parts that are weak or are more likely to fail or have error. This may be due to parity or a clause in repetition or any other number of reasons. These units of the code or units of the processor should be given computational tasks that will easily expose the faults or errors of these units of code. They should then be reviewed by the software developer and adequate corrections should be made. At the end of all these a standard algorithm should have been reached that will address all the possible errors or problems of the system.

III. Environmental Model: Architectural Structure

The concept of accurate aerosol estimation is salient to many aspect of living. For example, it could initiate significant climate change; it determines the pattern and volume of rainfall; it initiates wind recirculation in some region; it determines the thermal comfort over a region; and has significant effect on daily solar radiance. Most meteorological centers utilize a mono aerosols retrieval technique. The mono aerosols retrieval technique entails the direct measurement of aerosols from sun photometer or sondes. One of the disadvantages of the mono aerosols retrieval technique is the sudden change of climate which alters the readings emanating from the aforementioned measuring devices. Hence, it leads to loss of large data set (Fig. 1) or sudden spikes within a set of stable measurement (Fig. 2).

ISBN: 978-988-14047-1-8
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

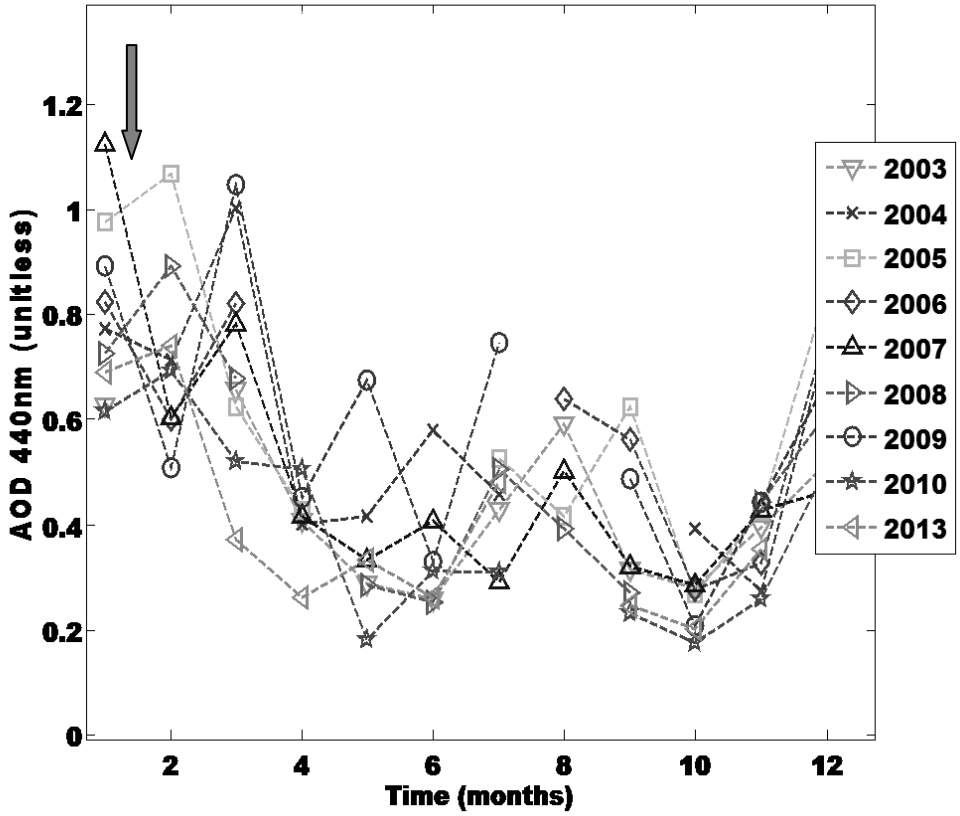

Fig 1. Very scanty data set from over 14 years

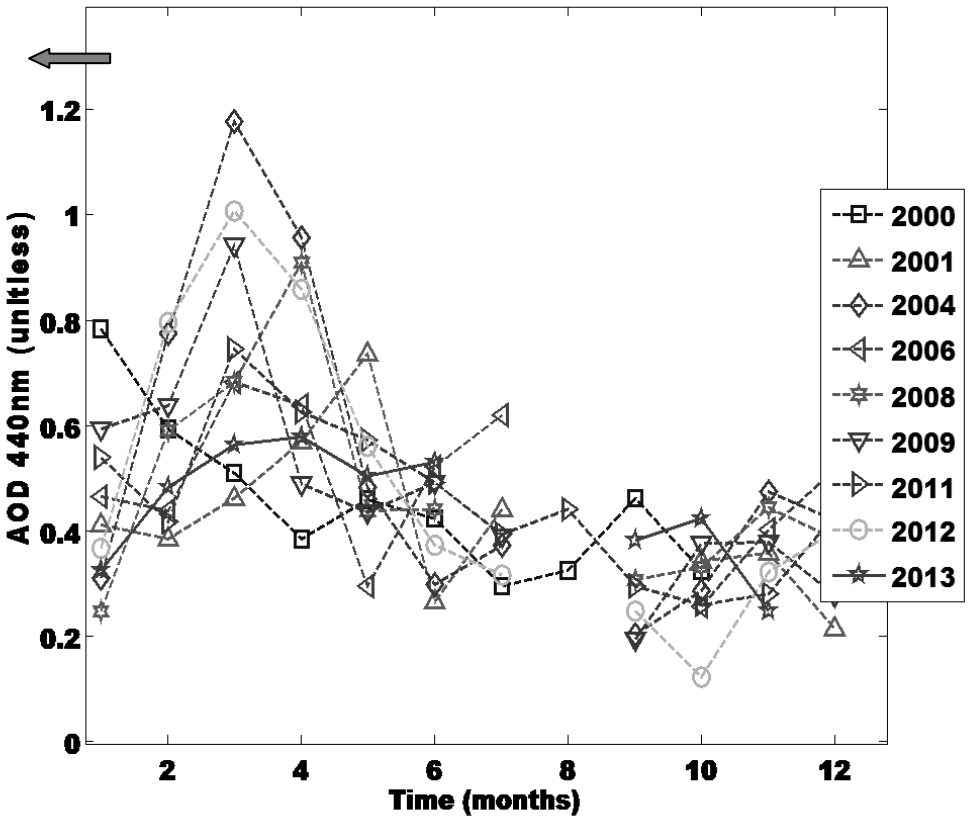

Fig 2. Sudden spike in data set over 14 years

ISBN: 978-988-14047-1-8
ISSN: 2078-0958 (Print); ISSN: 2078-0966 (Online)

The technical suggestion to avoid danger of negligence is to repackage the operating software in the measuring instruments to run on four models i.e. two main models and two supportive model (Fig. 3). The main model is the end-results expected from the measuring devices. The supportive model is used to determine the possibility of engaging the main model per time. For example, the supportive model determines if the weather condition is expected to be harsh to guide the choice of the 'command line' to vary the tuning parameters of the main models.

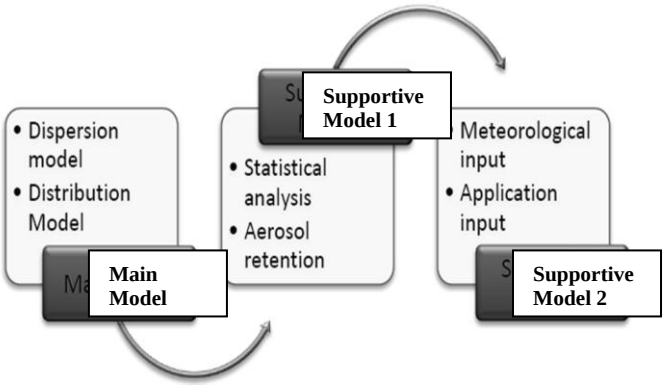

Fig 3. Proposed software description of environmental software

IV. Software Development

There are important steps to be considered in software development as it relates to environment research. In the previous section, we established the steps required for a successful completion of the environmental model. Beyond the need to understand the task in preparing list of algorithms or architectural structure of the environmental model, it is important to examine the financial bottlenecks like demands for shorter investment periods, faster time-to-market, and increased operational agility [8]. For developing nation, this is a herculean task because of its undefined market parameters [9]. How important is the proposed environmental model? All the funded projects such as like AErosol RObotic NETwork (AERONET), African Monsoon Multidisciplinary Analyses (AMMA), Dynamics-aerosol-chemistry-cloud interactions in West Africa (DACCIWA), West Africa Climate DRandD Project, Saharan West African Monsoon Multiscale Analysis (SWAMMA), and West African Science Service Center on Climate Change and Adapted Land Use (WASCAL) depends on the outcome of the research to improve on the accuracy of its exploration programme in West Africa. Hence, the urgency of the relevance of the environmental model to the teeming population in West Africa requires a radical approach to its software development.

The environmental model expressed in the last session requires a group of software developmental methodologies that form their grounds based on development gotten by the repetition of certain procedures both supporting models to ascertain the adequate application of the main models. The main model requires an iterative kind of development and a continuous feedback to ascertain that the software systems are efficient to perform the given task. How has past software fared in calculating environmental model? The ISC3, CTDMPLUS, BLP, OCD, CMAQ and REMSAD software [10] had shown that it occupies disk space and requires large free disk space to operate. The large processes and the expected high turn-around time are the basic properties needed for developing the software that must be compactable with environmental model in Figure 3. Therefore, there is the need for the writing of detachable source codes that can be individually transformed by a compiler program into low-level machine code that is understood by the computer. This would facilitate the comprehensive software development of recent environmental models.

V. Conclusion

In conclusion, though the project discussed in this paper is still ongoing. It is imperative to state that the need development of environmental mobile platform is unequaled. The success of this project would be majorly to adequately disseminate environmental alerts without necessarily relying on public alert system. Hence, the project is both lucrative and informative if all mentioned procedures are carefully executed.

Acknowledgment

The authors appreciate the partial sponsorship of Covenant University.

References

[1] P. Cousot, R. Cousot, J. Feret, L. Mauborgne, A. Mine, and X. Rival. (2009). Why does Astee scale up? Formal Methods in System Design, 35, 229-264.
[2] M. E. Emetere, M. L. Akinyemi, and O. Akinojo. (2015). Parametric retrieval model for estimating aerosol size distribution via the AERONET, LAGOS station, Environmental Pollution, 207. pp. 381-390
[3] M. E. Emetere. (2013). Modeling Of Particulate Radionuclide Dispersion And Deposition From A Cement Factory. Annals of Environmental Science,7(6). pp. 71-77
[4] M. E. Emetere. (2014). Forecasting Hydrological Disaster Using Environmental Thermographic Modeling. Advances in Meteorology 2014, pp. 783718.
[5] M. E. Emetere. (2016). Statistical Examination Of The Aerosols Loading Over Mubi-Nigeria: The Satellite Observation Analysis, Geographica Panonica, 20(1), pp. 42-50.
[6] M. E. Emetere., M. L. Akinyemi, and T. E. Oladimeji. (2016). A Conceptual Mathematical Examination Of The Aerosols Loading Over Abuja-Nigeria. Communications in Mathematics and Applications, 7(1). pp. 47–54.
[7] M. E. Emetere. (2014). Volcanic Eruption Trends in the Five-Years Pre-Eruption Era. Journal of Volcanology and Seismology, 8 (6), pp. 411–417.
[8] Denne, M., Cleland-Huang, J., (2004). The incremental funding method: data-driven software development, IEEE Software, 21, pp.39-47 doi: 10.1109/MS.2004.1293071
[9] Ilene Grabel, (1996). Marketing the third world: The contradictions of portfolio investment in the global economy,World Development, 24, pp. 1761–1776
[10] EPA, Guidelines for Developing an Air Quality (Ozone and PM2.5) Forecasting Program, (2001) www3.epa.gov/airnow (Retrieved 23rd January, 2016)