Artificial Intelligence Application in Transportation System Control: An Effective Way To Minimize Global Warming Effect

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ABSTRACT

Effect of global warming is a vast challenges facing human generation in the present world in many ways. The activities of man have seriously retarded the global world due to global warming and change in global climate activities. Transportation industry has been one of the major constituent of the hazards causing the effect of global warming to the Earth surface. This is attributed majorly to carbon dioxide emissions from fossil fuel combustion in the engine of locomotives, and secondly due to the type of controller system (majorly, the Proportional-Integral-Derivative (PID) controller) being used in transport engine system. This (PID) constitutes about an average of about 95% of controls in this industry due to its simple structure and reliability. However, when the process becomes too complex to be described by analytical models in the engine, due to its poor tuning ability, the PID becomes ineffective, causing a poor system performance, leading to high gaseous emission into the atmosphere and hence, global warming effect (an act causing gradual increase in earth's temperature). This paper takes a look at the use of artificial intelligence Control system for effective global warming control in transportation system, since it can withstand any complexity in the system, via the 'IF, THEN' rules, leading to effective system performance and reduction in heat and carbon contents emission into the atmosphere.

Keyword: Artificial Intelligence, Global warming, Transport industry

1. INTRODUCTION

The activities of man have seriously retarded the global world due to global warming and change in global climate activities. In 2010, transportation system accounts for 14% of global greenhouse gas emissions, which involves fossil fuels burned for road, rail, air, and marine transportation. Almost all (95%) of the world's transportation energy comes from petroleum-based fuels, largely gasoline and diesel. Over geological time, this has caused a gradual increase in the earth temperature and negatively caused a change in the climatic condition of the earth. This has changed the heat balance of the earth causing the global average temperature to move outside the range that has characterized the 10,000 years of recorded human history (Intergovernmental Panel on Climate Change, 2007).

These human activities that cause temperature change set in motion a series of associated phenomena such as sea level rise, loss of polar sea ice, melting of continental glaciers, changes in precipitation patterns, progressive shifting in the habitats of species and the boundaries of ecosystems, acidification of the oceans, and more (National Research Council, 2010). These changes and impacts in turn create increasing risks to life; such as expansion of water and subsequent overflowing of its bank to become nuisance to nature.

One cause of this change is burning of fossil fuel, majorly by the transportation industry, which emits large amount of heat and gaseous content (CO and CO_2) into the atmosphere. This high emission is virtually caused by the poor classical PID controller being employed in the transportation machine brain box control system. It is used due to its robustness, easy to tune due to simple structure and relates easily with the control response. The use of this PID gets to the point that much authors say that they occupy between 90% to 99% of an industrial process control (Algreer and Kuraz, 2008).

With these merits of the PID controllers, they are not the best solution to all control processes. In very complex processes with nonlinearities, time varying parameters and delay, that are difficult to model analytically, the response of the PID controllers become very poor, resulting in poor performance of the system being controlled. Sequel to this, adequately control heat and carbon emissions in the transportation industry, a heuristic developed by operators is used; this heuristic is Artificial Intelligent (AI) system related to computer science which make computers think like people (Ibrahim, 2003).

It deals with reasoning algorithms used to emulate human thinking and decision making in machines (Bryan and Bryan, 1997). Using A.I algorithms could enable machines to understand and respond to vague human concepts such as high, medium, low etc, talking in terms of vehicular speed. It also could provide a relatively simple approach to reach definite conclusions from imprecise information via its transfer function; the 'IF, THEN' Rules. In a nutshell, AI can deal with imprecise, thereby making the control of a system more accurate, unlike the PID controller system.

2. LITERATURE REVIEW

God created man in His own image (Genesis, 2015); and breath unto the man a natural intelligence (NI) for natural intelligence control. This has given the man ability to decision making in all ramifications for a close-to-perfect environment. This NI was emulated historically some years back into a system control called artificial intelligence, which thinks like man in its controllability, to make machinery work in a near-to-perfect condition.

Although, Proportional-Integral-Derivative (PID) controllers are the well known and most widely used controllers used in the control of machineries in the industries. The reason behind this is because of its simple structure and reliability. Nonetheless when the plant to be controlled is highly non linear or is subjected to disturbances or we have less knowledge about it, under these conditions poor performance is obtained when we are using fixed parameter PID as controller (Mitra and Singh, 2013). To overcome this poor performance, artificial intelligence, such as Fuzzy Logic, Neural Network etc are put to use. Artificial Intelligence is considered as an area in computer science inspired by human computational abilities which does not require mathematical models and work under imprecise, uncertain, and noisy environments (Ibrahim, 2003). It is also worthy of note that it is numerical in nature, though not a human trait.

In fact, the conceptual design of AI was first developed in the early 1960s. The definition of artificial intelligence varies among people in the computer industry, making the concept somewhat difficult to perceive and understand. In general, AI can be defined as the subfield of computer science that encompasses the creation of computer programs to solve tasks requiring extensive knowledge. The software programs that form an AI system are developed using the knowledge of an expert person (or persons) in the field where the system will be applied. For instance, a food-processing AI system that involves the making and packaging of a food product will consist of knowledge obtained from chemists, food technologists, packaging experts, maintenance personnel, and others closely associated with the operation.

Fuzzy logic (an AI application) was first proposed by Lofti A. Zadeh of the University of California at Berkeley in a 1965 paper. He elaborated on his ideas in a 1973 paper that introduced the concept of "linguistic variables" (Zadeh, 1973), which in this article equates to a variable defined as a fuzzy set. In 1974, fuzzy set was successfully applied to an industrial control of cement kilns (Mamdani and Assilian, 1975).
The fuzzy logic applications in reality are now innumerable and they range from control system for small domestic appliances or electronic devices (on washing machines or camcorders, for example Matsushita, Hitatchi products) to optimized planning of industrial control applications (Kawasaki Steel industry), from efficient and stable control of car engines (Nissan) to controlling of subway systems (Sendai city subway system). These successful applications have convinced almost everyone, not only the Japanese engineers, that fuzzy logic is actual. Some basic variables that can be controlled using this AI control system include temperature, pressure as in cement kiln. As opined in this work, this process is to be applied to transport machines such as vehicles, trains, ship airplane etc, to control the burning process in the engine so as to reduce the rate at which carbon oxide and other fumes are emitted into the air in order to limit the heating effect in the atmosphere and control effectively global warming effect.

3. METHODOLOGY

This study was based on a systemic analysis of the AI system. It has to do with a survey work based on textbooks, journal surveillance and site research. This technique will define the method of analysing the AI process.

3.1 Artificial Intelligence Systems

Bryan and Bryan, 1997 reiterated that artificial intelligence systems could be classified into three forms having sequential order as follow; i. Diagnostic ii. knowledge iii. expert.

3.2 The Diagnostic Subsystems

This aspect of the AI system detects faults within an application through troubleshooting of the process, but with no ability to resolve the issue causing the failure they do not try to solve them. For example, it can diagnose a poor pump problem in the vehicular system by detecting a low pumping pressure.
Diagnostic system achieves its fault conclusion through the knowledge put into its detection system anchored by the inferring techniques to derive a decision of YES or NO.

3.3 The Knowledge Subsystems

A knowledge AI subsystem is, in reality, an enhanced diagnostic system. Knowledge systems not only detect faults and process behaviours based on resident knowledge, but also make decisions about the process and/or the probable cause of a fault.

In the batching system example mentioned in the diagnostic system section, a knowledge system would go beyond just diagnosing the fault. Gives the analytical nature of the system as regard whether the system operation is critical or not and recommends a solution. For example, the case of the transport system engine, it will analyse the amount of fuel going into the engine for burning, in which the recommendation can be to increase/reduce the fuelling system in order to maintain a least carbon dioxide emission to the atmosphere. The system bases these decisions on its programmed knowledge and a set of rules that defines each engine condition. It is possible that the detection of a fault in the example could have been a false alarm, but due to its enhanced features, a knowledge subsystem checks whether the elements signalling the engine condition (i.e., flow meter, pressure transducer) are operating correctly. It then compares these observations (process feedback) with the procedures and measures based on this information.

3.4 The Expert Subsystems

Here, the final applications in the AI control system occur. It has all of the capabilities of a knowledge subsystem with additional ability to examine process data using analytical statistical method. The use this method enables system prediction outcomes based on current process assessments. The outcome prediction may be a decision to increase/ reduce the running of the engine. The decisions made by expert systems also require more sophisticated software programming, since their decision trees involve more options and attributes. The implementation of an expert AI system requires not only extra programming effort but also more hardware capability; this makes the knowledge intake in this subsystem is more complex than in the other types of AI subsystems; therefore, expert systems generate more data verification (feedback information)

3.5 Structural Architecture of AI system

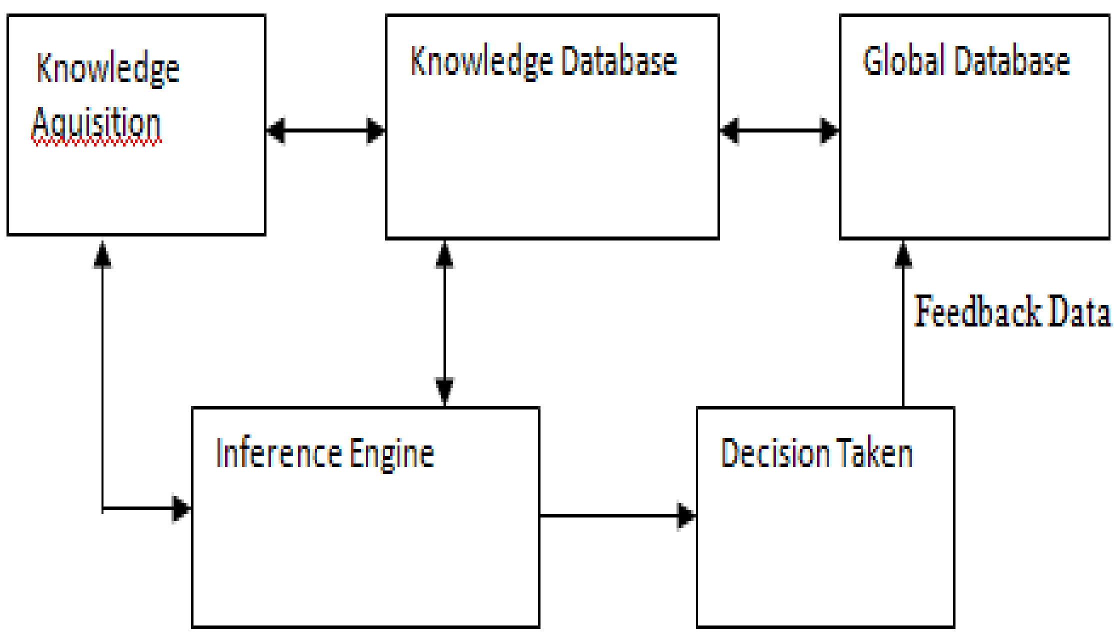

Figure1: AI System Architecture

Figure 1 shows Artificial Intelligence system architecture, with its components. In the AI system architecture, the knowledge acquisition makes possible the gathering of knowledge concerning the process to be controlled. This is done by an operator (an expert) who fully understands the process of machine being controlled. This expert, must communicate all information about system operation, maintenance, fault causes, etc. to the knowledge engineer, the person responsible for system implementation. This knowledge is then stored in the global database.

3.6 Global Database (GB)

The global database could be regarded as storehouse for the information about the system being controlled. This information mainly deals with the input and output data flow from the process. The global database resembles a storage area where information about the process is stored and updated. The AI system accesses the data in this storehouse to perform statistical analysis on historical process control data, used to implement AI decisions.

This storehouse resides in the memory of the control system implementing the artificial intelligence. If a PLC is used to implement a diagnostic AI system, the global database will most likely be located in the storage area of the PLC's data table. If a PLC is used in conjunction with a computer or computer module to implement an AI system, then the global database will probably be located in the computer, the computer module's memory, or a hard disk storage subsystem.

3.7 Knowledge Database (KD)

The AI knowledge database stores the information extracted from the expert in an elaborate manner, which includes information about system operations, faults, along with their probable causes and possible solutions. Moreover, the knowledge database stores all of the rules governing the AI decisions to be made. The more involved the AI system, the larger the knowledge database. Accordingly, the knowledge database of a diagnostic system is less complex than that of a knowledge system; likewise, the knowledge database of a knowledge system is less sophisticated than that of an expert system. The knowledge database is stored in the section of the system memory that implements the AI techniques.

3.8 Inference Engine (IE)

This section takes care of decision making based on the knowledge in the knowledge database to yield an output to execute all applicable rules and decisions about the process. The inference engine also constantly interacts with the global database to examine and test real-time and historical data about the process. The IE may take itst bases from the central processing unit (CPU).

3.9 Knowledge Representation (KR)

This has to do with organizational strategy of the AI system, stating how the knowledge engineer represents the expert's input. This representation is stored in the knowledge database of the AI system. In rule-based knowledge representation, the expert's knowledge is transformed into IF and THEN/ELSE statements, leading to actions and decisions.

3.10 Rule-Based Knowledge Representation

This outlines the conversion of the expert's knowledge into decision making. The rules used are either antecedent (IF something happens) or consequent (THEN take this action). As a case of what is being considered in this paper, the question goes thus; what causes a high CO emission?, the expert may respond with the answer, a high level of fuel supply into the engine. The knowledge engineer may implement this information as the following rule: IF the fuel supply is high, THEN order a reduction in fuel supply to the engine. Rules can be as long and complex as needed for the process, and they usually define the involvement of the AI system. For instance, a simple rule-based system (few rules, not very complex) may formulate a simple diagnostic rule, such as:

IF the fuel burning rate is high, THEN close the fuel valve a little.
A more complex diagnostic formula would involve rules that depend on parent rules:

3.11 Knowledge Inference (KI)

The methodology used for collating and analyzing data to draw conclusions is often referred to as knowledge inference. This occurs in the inference engine during the execution of the main control strategy program. It also occurs in the knowledge database during the comparison and computation of rule solutions.

4. EFFECTIVE CONTROL IN THE TRANSPORTATION INDUSTRY

Several associations demonstrated that it is possible to reduce the emissions of CO in a substantial way through technology, replacing transfers with data transmissions and making economic system more sustainable (Sala, 2010).

Like the cement industry, the use of PID controller has led to a poor output product, because it cannot deal with imprecise condition in the system. This has led to high energy consumption; as a result, high heat emission into the atmosphere is experienced; leading to increase in global warming effect. To curb this ugly phenomenon, technology has introduced artificial intelligent controllers, such as Fuzzy Logic Controller (FLC) which can withstand imprecise in any system, and bring about effective control with reduction in energy consumption, consequently, reduction in global warming effect.

In the transportation industry, the transportation system operation (e.g. vehicular systems) brain box is normally controlled via the classical (say, PID) controller. The brain box is electronic device that incorporates microprocessors (microcomputers) for the monitoring and control of various functions in the system operations. These functions are subject to the program in the microprocessors. Due to the use of the PID controller in the control of the brain box, heat and carbon emissions into the atmosphere have been in the increase, leading to increase in global warming effect.

In order to bring about a control in the adverse activity of this transportation industry to the atmosphere, so as to reduce the energy being consumed in terms of fossil fuel; an artificial intelligence system is more appropriate and should be incorporated in the general control of the transport system engine. This controller system will lead to accurate control in the system. This consequently leads to reduction in the fossil fuel being consumed, and thereafter, reduction in the amount of heat and CO being emitted into the atmosphere; a condition required for the reduction in global warming effect.

4.1 Control variables in transport system engine

In transport control system, some variables of the system that can be controlled are the cruise control, automatic gear shifting, climate control, engine running/emission control, collision avoidance, powered mirror, seat and near mirror controls etc., all these have significant effects on the quality of runs in the system. It should be noted that for effective control of global warming, these variables must be effectively controlled to reduce the emissions into the atmosphere. Therefore, to control an output, it is reasonable to consider that inputs that have more effect on it. In this case, the inputs which have either little influence or no influence on an output should be discarded. In this situation, the control variables to be considered majorly in the AI programming are the cruise/brake control, automatic gear shift, engine running/emission (fuel) control. Since reaching to a specific reference input for these variables at the controller is not a target for the control scheme. However, some authorized ranges are been defined for these variables and they should be measured to be kept in the normal ranges such that having upper values may cause problems in the system running.

The input part to the brain box, which is the process variable, is measured by sensing device and is fed to the error detector where set point and measured variable from sensor are compared and an actuating signal is generated to the controlled device which produces effective linear movement in the system.

4.2 System Operation, Flowchart and Rule Base

In the system operation, the membership function (MF), which is the user-defined charts, of the operation could be defined thus: Very Little; Little; Normal; High; Very High. That is 5 MF is appropriated for the operation in terms of the amount of fuel being injected into the engine depending on the value allotted to each MF; and 5 MF for the emitted gases at the exhaust.

A flow meter measures the amount of fuel injected into the engine; also a flow meter monitors the amount of fume going out from the exhaust pipe to determine the control variables for onward system control.
The rule base of the system could be analysed thus:

- IF the fume (CO gas) being emitted into the atmosphere is very low/low, THEN increase the amount of fuel being injected into the engine.
- IF the fume (CO gas) being emitted into the atmosphere is normal, THEN maintain a constant operation.
- IF the fume (CO gas) being emitted into the atmosphere is high/very high, THEN reduce the amount of fuel being injected into the engine.

The system operation control flowchart is shown in Figure 2. It gives an idea of how the system control will look like.

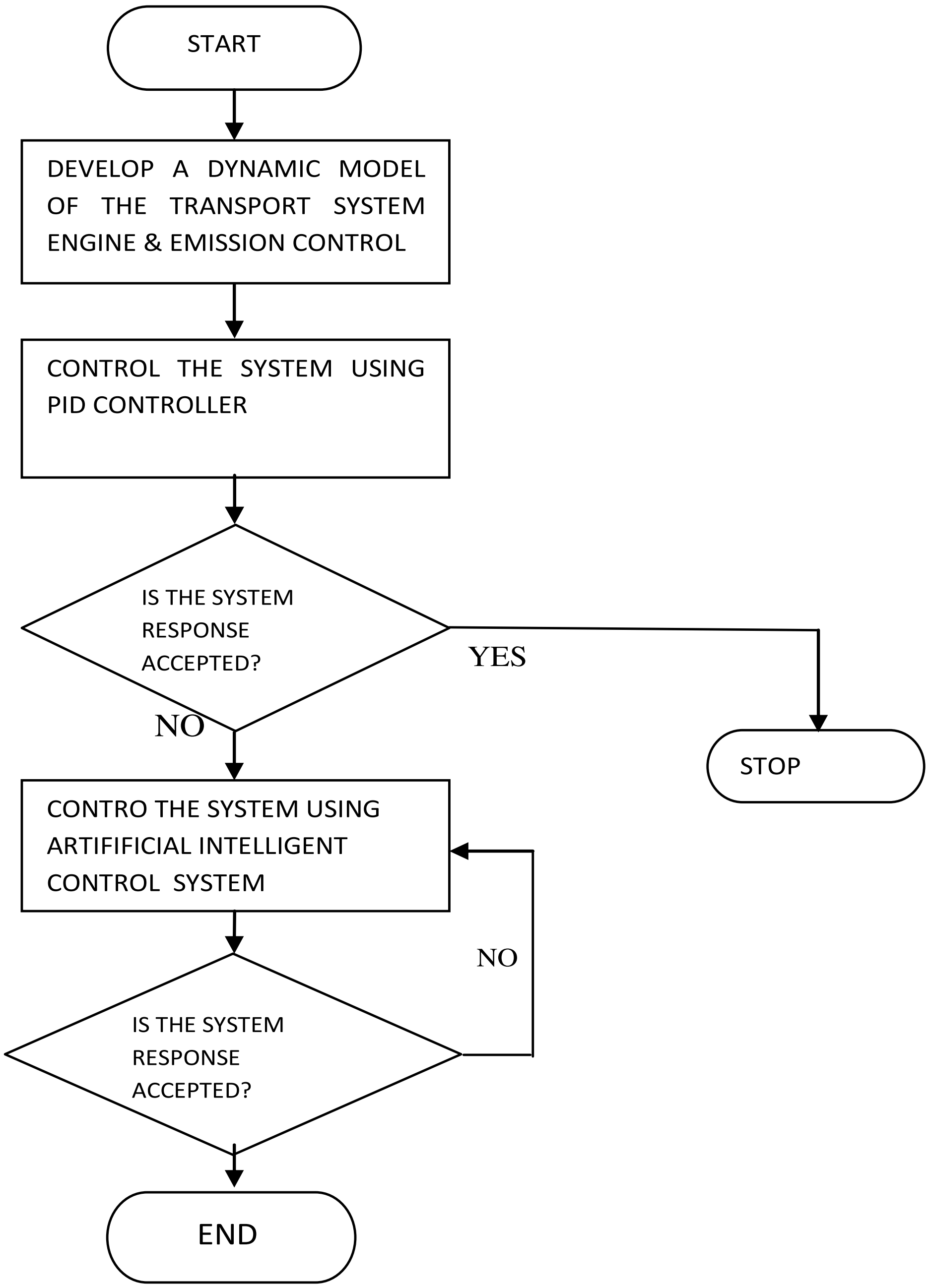

Figure 2: Flowchart Diagram for realizing the System Model

5. CONCLUSION

It is well known that the transportation industry accounts for a large amount of global effect. Therefore, effective control of the global effect in the transportation industry cannot be over-emphasized; it allows the control of the emission of heat and carbon constituents into the atmosphere, and consequently, the temperature of the earth to be well controlled so as to avert the unforeseen doom that could come upon the face of the earth. In a nutshell, the brain box controlling the activities in the engine operations must be well controlled in order to protect the earth from the emission coming from the transportation system world-over, to save the earth from imminent collapse.

6. RECOMMENDATION

It is thereby recommended that for effective control of global effect in relation to the transportation industry, a controller system that can withstand the effect of imprecise in the controlled system should be used. An example is the replacement of the PID controller with the AI in the brain box control in the system.

REFERENCE

1. Algreer, M.M.F and Kuraz, Y.R.M (2008); Design Fuzzy Self Tuning of PID Controller for Chopper-Fed DC Motor Drive, Al-Rafidain Engineering .16(2).
2. Bryan L.A and Bryan E.A. (1997); Programmable Controllers, Theory and Implementation, Second Edition, Industrial Text Company, Georgia, USA.
3. Genesis 1:27 (2015); Old Testament, The Bible; King James Version, Korea.
4. Ibrahim A.M (2003); Fuzzy Logic for Embedded Systems Applications, Second Edition, Elsevier Science, USA.
5. Intergovernmental Panel on Climate Change. (2007); Climate change 2007: The physical science basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change (S. Solomon, D. Qin, M.
6. Manning, Z. Chen, M. Marquis, K. B. Averyt, M. Tignor, & H. L. Miller, Eds.), Cambridge University Press, New York.
7. Mamdani E.H and Assilian S (1975); "An experiment in linguistic synthesis with a fuzzy logic controller," Int. Journal of Man-Machine Stud, 7(1), 1-13.
8. Mitra, R and Singh, S. (2013); Optimal Fuzzy Supervised PID Controller using Ant Colony Optimization Algorithm, Advance in Electronic and Electric Engineering, 3(5), 553.
9. National Research Council. (2010). Adapting to the impacts of climate change. National
10. Academies Press, Washington DC.
11. Sala S. (2010); Communication for Sustainable Development Initiative – CSDI, Rome
12. Zadeh, L.A. (1973); "Outline of a new approach to the analysis of complex systems and
13. decision processes", IEEE Transactions on Systems, Man and Cybernetics, 1.