American Journal of Engineering Research (AJER)
e-ISSN: 2320-0847 p-ISSN : 2320-0936
Volume-10, Issue-8, pp: 69-74
www.ajer.org
Research Paper Open Access

Digital Post Data Processing for Increased Reactivity in Neural Networks

J.K.Rahul Jayawardana (H.N.D (Electrical.Eng.), Ce. Eng (Aerospace.Eng.USA), MAIAA, AMIET, MIEEE)
School of Physics, Engineering, and Technology, University of Hertfordshire, UK
T.Sameera Bandaranayake (BSc.Hons (Engineering), MBA (Aus.), MIE (SL), AFHEA (UK), CEng), Engineer/Switching, Programe Leader/B.Eng. Programe.SLT Training Center, Welisara, Sri Lanka.

ABSTRACT
Neural networks are the main functional elements of a large artificial intelligence program that can have various structures and formats according to the application and the scenario which it is applied. In some situations the speed of the prediction results generation and the time which it takes to a relevant systems to act according to the prediction results are extremely important. In the method of the binary coded prediction generation, the idea is to generate a single binary code including all the important and vital characteristics of the input and the system, so the system can act or react according to it more quickly decreasing the reaction time of the overall performance in the neural network.

Date of Submission: 18-07-2021 Date of acceptance: 03-08-2021

I. INTRODUCTION

The use of neural networks and machine learning algorithms is a widely advancing technology. The main purpose of the concept is to make more reliable, and accurate automated systems that can simulate and implement the decisions of a human brain more logically and consciously rather than the traditional programmed circuits. Primary uses of neural algorithms are the fields of control, guidance and navigation, and robotics(*How Does AI Work?* | n.d). Almost all of the modern electronic systems are having some portion of its operation implemented by neural networks. From household equipment and procedures to automobiles, communication, aviation, defense and safety features of the latest devices and methods are implemented mostly with the A.I platforms which uses the, neural networks(*Artificial Intelligence/* n.d).

Considering the some of the scenarios of practical applications in neural networks, they are acting as a processing unit for the system, where it collects a range of inputs and converting them to neural results with the network.

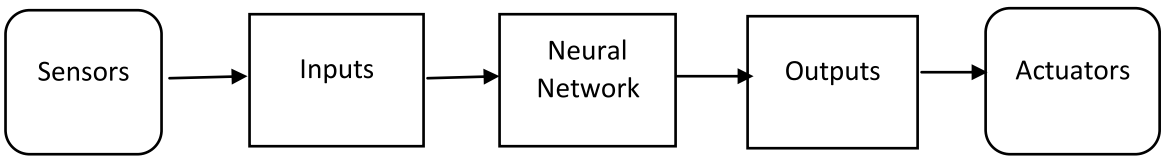

***Diagram 01** - Block diagram of typical system with a neural network and functional elements*

According to the above diagram, it is clear that the actuators or the action implementing components of a mechanical, electrical or electronic, or in a electromechanical (mechatronic) system is depending on the processing power of the neural network as well as how fast the predicted or the processed data are delivered to the action implementing components to implement the relevant actions according to the outputs. Therefore the attention is given to the result prediction format of the neural network as well as optimizing the ability for the system components to recognize the prediction and processed data results with much easier and simpler, so they are capable of reacting with less time and with increased efficiency. This concept is extremely important for neural networks in production lines, automobile automation, finance, medicine, aviation and the defense applications where the time is a significantly important factor to the overall system performance.(*Future Potential Aviation Today*, n.d)

II. SIGNIFICANCE OF REACTION TIME IN DYNAMIC NEURAL NETWORK SYSTEMS.

Neural networks are supposed to use as a tool to compute, calculate, predict, monitor and to guidance for real time practical applications. The dynamic systems which are using the neural networks must have a quick responsive ability and as well as to deliver the results data from the neural networks into the control system gateways of the system.(*Network : learnmachinelearning*, n.d)

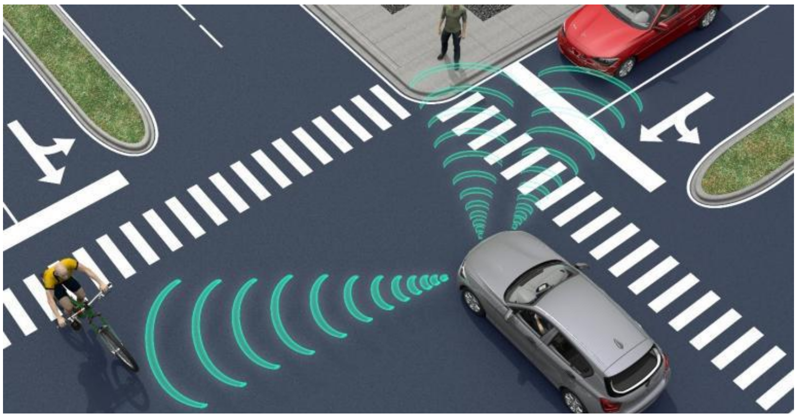

Fig 01 - Dynamic system of a autobobile where neural networks can be operated

In most of the cases the attention has given to optimizing the neural network according to the output required. But in the concept of the digital post data processing the data related to the neural network are generated in a machine language form so that the preprocessing steps needed are much less.

III. DIGITAL POST DATA PROCESSING

Digital post data processing is a concept which concentrates specially on the nature of the output in a neural network. The output is received as a binary format or digital format, so that the digital signal processing steps and processors can process the data and direct them to the relevant system components with much less steps(*(DSP) | Design Center | Analog Devices*, n.d).

Considering a neural network for a dynamic environment as an example a neural network which is associated with the autopilot system of a commercial jet airliner, which is used to reduce the pilot error during the landing phase, will be considered(*Pilot Error Flying*, n.d).

Within a dynamic system the results from a neural network must have the capability to represent the operational status of more than one system component. Let's take the above mentioned neural network as an example.

Input data and output data for the neural network

The neural network is having 11 input entries and 8 output entries

Inputs	Outputs
Altitude_Feets	AOA_Notification
Speed_knots	Flaps_Notification
ATC_Clearance	Autobreacks
Distance_to_Runaway_NM	Spoilers_Notification
AOA_degrees	Landing_Gear_Notification
Flaps	Cabin_Status_Notification
Runaway_Length_m	Go_around
Autobreack	Caution
Spoilers	
Landing Gear	
Cabin Status	

Table 01 - Inputs and the output of a dynamic neural network

As above shown, the neural network is having 8 output fields, that represent each various systems within the aircraft. In a landing phase, especially at the final approach towards the runaway, the things inside the cockpit is a bit tense and hard for the pilots, they require to give the full attention and the operational readiness to the approach. At this point the probability to occur pilot error is high, due to the busy work load and the stress caused by the landing situation. For a system like this (dynamic system) application of a neural network is effective as long as its results can be implemented as soon as possible.

For that, each of the system outputs from the neural network is represented by a 0 or 1 denoting the 'Deactivation' or 'Activation' respectively. And the each system is formed as a binary code, which each digit of it is occupied to represent a single system component status of the main system.
For example considering a scenario, with following inputs to the system.

Inputs	Value
Altitude_Feets	5000
Speed_knots	180
ATC_Clearance	Cleared(1)
Distance_to_Runaway_NM	6
AOA_degrees	3
Flaps	Full(4)
Runaway_Length_m	4000 (4km)
Autobreack	Medium (2)
Spoilers	Armed (1)
Landing Gear	Down (1)
Cabin Status	Ready and Notified (1)

Table 02 - Example inputs given to the neural network

The predicted outputs from the neural network

Inputs	Outputs
AOA_Notification	0
Flaps_Notification	1
Autobreacks	0
Spoilers_Notification	1
Landing_Gear_Notification	1
Cabin_Status_Notification	1
Go_around	1
Caution	1

Table 03 - Outputs for the given inputs from neural network

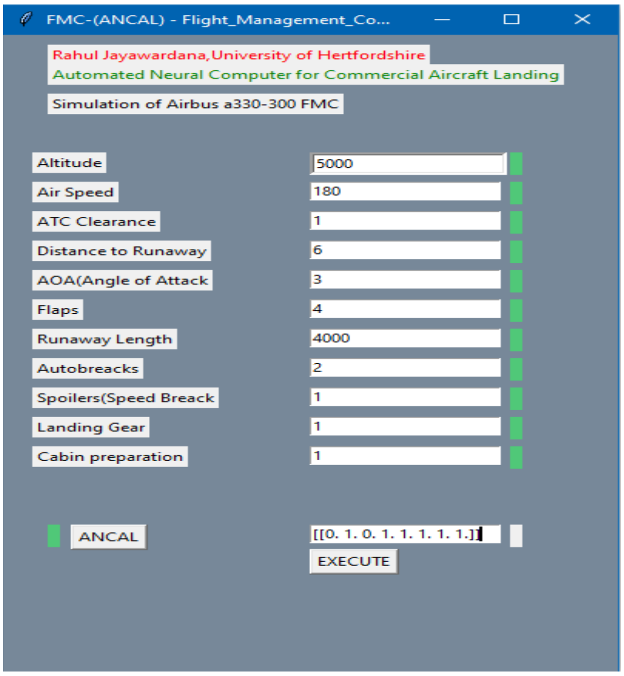

Figure 02 - The simulated FMC interface of an Airbus A330-300 aircraft.

As the above results shows the neural network is giving a binary number array, which can be used as a binary code or a digital signal to represent output signals to the system.

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Prdiction Results. [[0. 1. 0. 1. 1. 1. 1. 1.]]
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The prediction result is now to be fed into the main computer of the aircraft which can then be sent to the relevant sections in the aircraft to the aircraft.

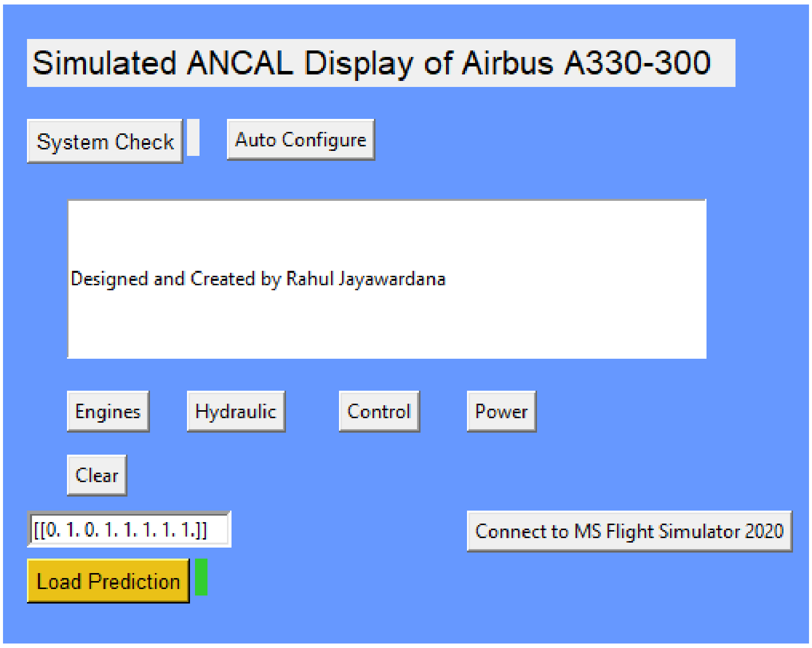

Figure 03 - Simulated Main Computer interface of an Airbus A330-300 aircraft

After loading the digital code in to the computer it is executed.

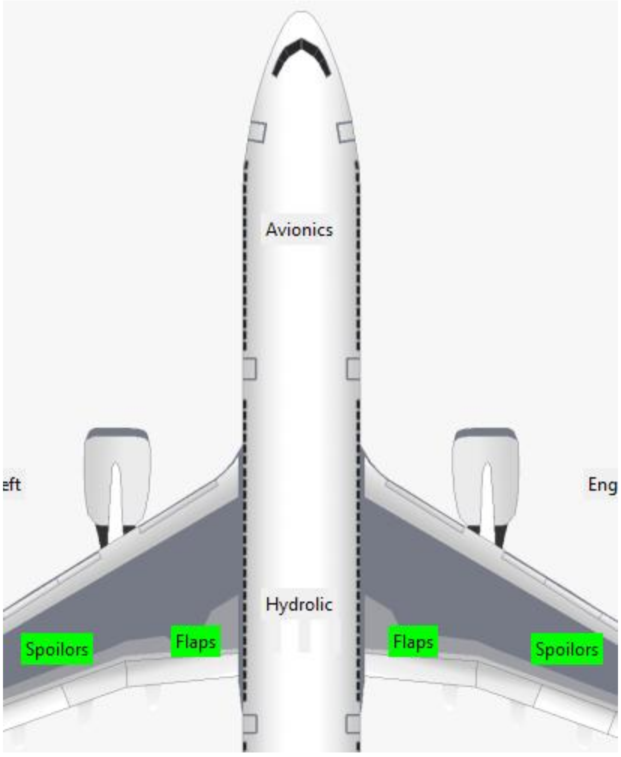

Figure 04 - The control system display of the aircraft

According to the prediction the Caution alarm is activated due to appying full flaps at a altitude of 5000 feets far away from the runaway. And that is instantly identified by the computer and is indicated in the main ECAM or ECAS display of the aircraft, allowing the pilots to re correct the operational action.

Similarly the landing gear nortification is activated due to deploying the landing gear at altitude of 5000 feets and far away from the runaway. As normaly it is done within a 3 NMiles to runaway at a typical autitude of 2500 or below.

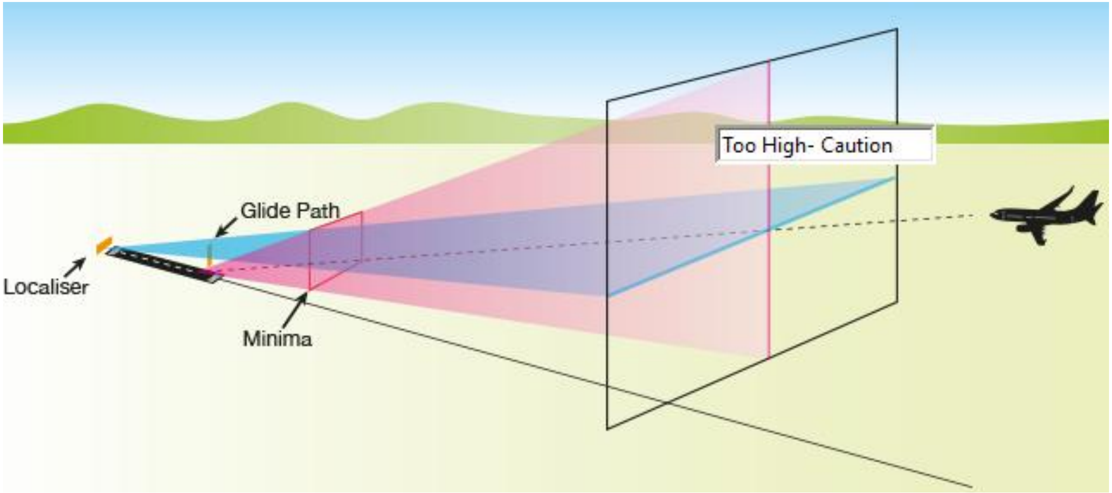

Fig 05 - Indication of the high altitude approach

The message of too high altitude is directly given through the relavent indication monitors to the pilots to make the landing approack in to textbook landing with much safer and reliable manevers.
And finaly with consirering the given inputs to the systems, The 'Go Around' message is activated until the relavent correctyive actions are taken by the pilots for a safe landing.

IV. CONCLUTION

The use of digital signals or digital codes with representing neural network outputs to a purticular dynamic system is effective and efficient due to their reduced data processing steps and procedures. The binary nature of the resultant code is extreamely familiar to a any computer based system since the machine languages with 0s and 1s are the most easiest way to communicate data with a such system. The reduced reaction time is important to take decitions and actions within a very narrow period of time allowing the end user or the other depending systems to react quicker and strategically in their tasks.

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Authors Profile

J.K.Rahul Jayawardana

(H.N.D (Electrical.Eng.), Ce. Eng (Aerospace.Eng.USA), AIAA, AMIET, IEEE) School of Physics, Engineering, and Technology, University of Hertfordshire, UK

Mr. R. Jayawardana is an undergraduate engineering student in Electrical and Electronics Engineering of University of Hertfordshire. Having the educations in aerospace engineering from Massachusetts Institute of Technology (MIT), United States, he is a passionate researcher in the fields of aerospace, mechanical, electrical engineering and physics.

Email – jayawardanarahul@gmail.com / (+94)719690522

T.Sameera Bandaranayake

(BSc.Hons (Engineering), MBA (Aus.), MIE (SL), AFHEA (UK), CEng), Engineer/Switching, Programe Leader/B.Eng. Programe.SLT Training Center, Welisara, Sri Lanka.

Mr. Bandaranayake is a qualified, experienced engineer and a lecturer having greater hands on experience in conducting engineering projects, and researches with great results. His performance in the fields of telecommunications and switching combined with the mentoring consultation for students makes him to be recognized as an expert in the field.

Email – bandaranayake@slt.com.lk / (+94)112956026

J.K.Rahul Jayawardana. "Digital Post Data Processing for Increased Reactivity in Neural Networks."*American Journal of Engineering Research (AJER)*, vol. 10(8), 2021, pp. 69-74.