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Artificial Intelligence Technique for DC Motors operation, control and Condition Monitoring

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ABSTRACT –

With the development of various artificial intelligence (AI) techniques, power systems are undergoing major technological changes whose main goal is to reduce execution time, reduce maintenance and operating costs, and ensure the efficient operation of power systems. AI technologies process large amounts of data faster than traditional numerical methods with high computational complexity. With these advantages, AI methods can enhance and improve the performance of healthcare systems. This paper provides a comprehensive overview of various AI technologies that can be used in the control, monitoring, and planning of healthcare systems, with the aim of fulfilling their various applications. This paper discusses the design and implementation of an artificial intelligence (AI)-based DC load control application. A replica of a DC motor is built to simulate the design. Two neural network models are run under no-load and low-speed conditions to estimate the amount of torque applied to a real DC motor to achieve the required torque output. The neural network model estimates the amount of power used from the output of the proportional-integrated (PI) controller and determines how much power should be used at the maximum speed of the DC motor.

Keyword: Artificial intelligence, PI controller, DC motor, speed control.

1. INTRODUCTION

DC motors are used in a variety of control applications, including pulse generators, pulse oscillators, pulse-driven generators, and actuators. Their high flexibility, scalability to various control methods, and ability to accurately detect objects over a wide range of conditions have led to many solutions that no longer exist. Although there are many factors involved in thermocouple failure, such as electrical damage and thermal stress, the primary cause is thermal overload. The life of the mold is reduced by half for every 10°C increase in temperature. Research on the use of artificial intelligence (AI) in building control systems has gained significant interest in the past few decades, with much attention being paid to the development of efficient processing and deep learning algorithms. The potential of AI in areas such as independent pulse input (PID) controllers and wind power generation system monitoring and control is clear evidence of the rapid growth and bright future of intelligent control. In this article, we will study the feasibility of using AI and PI algorithms together to control DC loads and voltages, and compare their performance with that of classical PI algorithms in real time. DC motors are used in a variety of control applications, including valve actuators, piston controllers, rotary controllers, and disk controllers, due to their high torque, wide control parameters, and precise control function speed in a variety of environments. High frequency range generation. Resonance to solve the complex resonance problem. Although there are many factors involved in the failure of thermocouples, such as mechanical damage and thermal stress, the main reason for these reasons is thermal overload. The life of the mold is halved for every 10°C increase in temperature. The research on the application of artificial intelligence (AI) in control system engineering has gained much attention in the past few decades, and is closely related to the development of computational power and deep learning algorithms. The potential of AI in fields such as the automatic optimization of pulse impedance (PID) control parameters, wind power, provides clear evidence for the rapid development and bright future of controllers. In this paper, the feasibility of using AI and PI algorithms together for DC motor speed control and load control is studied, and the performance of this algorithm and the classical PI algorithm in real time is evaluated.

2. BACKGROUND

The two main parameters that determine the speed of a DC motor are as follows. When adjusting the current flow, the current flow is adjusted by the change, and the speed of the motor is adjusted by the change under the current adjustment. The relationship between the compression and the elastic modulus is reciprocal, and the elastic modulus approaches zero at high temperatures. The motor power reaches its maximum value and the power consumption is small under no-load conditions. On the contrary, in the case of a high value, the conductivity decreases and the heat increases. The increase in load or moment of inertia causes the power loss from the resistance I2R (current I, resistance R). The speed change varies depending on the conditions.

For example, in a motor driven by a motor, when the motor is not running for a long time, the motor torque decreases due to the friction between the motor seat surfaces, which causes the motor speed to increase. Various tools and devices are used by the thermal monitoring device to monitor the maintenance conditions. This device has a ground fault protector, a high-pass filter, a low-pass filter, and a low-pass filter.

3. LITERATURE REVIEW

Overvoltage relays act as overload protection devices for electric motors and are widely used in industries. In this way, the question arises about the motor coils when the hardware fails. To overcome the above problems, we introduce a software-level overvoltage protection method using AI. PID controller is a closed-loop control method with three main coefficients that are changed to achieve the best response of the control system and is often used in manufacturing industries. The aim of this research is to study how to remove the overvoltage signal from the controller under high load conditions without affecting the performance of the controller for DC motor speed control applications. Another serious problem in using conventional PID controllers is that the change in the required inertia will affect the stability of the speed control system. Although there are various optimization methods for PID controllers, the actual tuning of the controller remains a major challenge for many control applications. Mo-yuven Chow and Alberico Menozzi conducted a comparative study on the performance of artificial neural networks (ANN) and fuzzy logic control techniques compared to conventional control techniques for DC motor speed control. The study argues that classical PI controllers are more limited and inflexible than fuzzy logic controllers. A new approach to optimization design can improve the performance and stability of the control system compared to the conventional controller design in solving the problem of power systems. Traditional approaches, such as efficient numerical optimization methods (e.g., lambda iteration and Newton-Raphson method), have been used.

Since the optimization problems are non-linear and involve various constraints, these optimization problems are slow and complex. Therefore, several AI techniques are discussed here to solve many optimization problems with less computation time. In addition, experiments are conducted to determine which backpropagation algorithm can train the most efficient and reliable networks.

To evaluate the performance of RNNs, a dynamic model of computer networks and experimental data obtained from linear curves are compared. These results indicate that RNNs outperform the dynamic ROM model, demonstrating its predictive ability to handle the dynamic behavior of leg joints. It also achieves this while significantly reducing computational resources. Healthcare systems are one of the most important research topics for the rapid development of AI. The application of AI algorithms to electrical engineering has been an intensive research topic since the advent of expert systems. However, in many cases, problems such as long running time, complex computation, and learning problems are caused by traditional AI methods. In recent years, the efficiency has improved significantly along with the continuous development of AI methods. Different samples of big data sources have gradually emerged, the volume of data has increased, and new opportunities and challenges have emerged along with the application of AI in healthcare systems. AI includes many technologies, such as expert systems. Pattern recognition, artificial intelligence (GA) and neural networks. Integrating AI into electrical automation systems has the potential to improve the control efficiency of electrical machines, reduce the risk of accidents and ensure long-term operation of electrical power. According to related research, machine learning (ML) has found significant applications in the prediction of common battery-powered devices, especially those that use heat and electricity, as well as in the design of new products. With the development of ML technology and the creation of new and unprecedented challenges in battery performance research, the number of ML applications will continue to increase. Although ML has shown great potential in modeling complex systems, its implementation also poses new challenges. These challenges include the difficulties involved in communicating relevant and reliable data sets and the need to correct modeling errors before ML can be widely used.

With the widespread use of ML, clear evidence of its applicability in various areas, such as manufacturing processes, energy production, storage, and distribution, is needed. In addition, the use of commercial software and experts with relevant expertise is essential. ML has proven to be useful in developing data-driven models that accurately simulate real-world properties, including activity, selectivity, and stability, in terms of the resulting properties. As a result, progress has been made in designing efficient and state-of-the-art reactive catalysts with desired properties. However, challenges remain in using existing ML algorithms to accurately predict catalyst activity or to design high-performance catalyst design strategies. This review presents recent developments in ML applied to low-reactivity catalysts, discusses the limitations and challenges of ML in this field, and discusses some opportunities to effectively use ML to design low-reactivity catalysts.

The successful use of ML in short-term facility planning emphasizes the link between real-world performance and case studies, and prepares the facility automation component by identifying current and future facility network requirements and availability. In this study, the state of the art of ML applications in the energy mix is examined. Smart technologies have a significant impact on the services of the energy market and the security of citizens and electricity consumers, especially in small households. Sustainable smart home systems can improve energy efficiency, use local energy, reduce carbon in the distribution and distribution system, and promote responsible charging for electric vehicles. The next decade is crucial to achieving global goals for reducing CO2, and decarbonizing buildings is a major challenge. Reducing water and greenhouse gas emissions is essential to addressing climate change. Research on energy efficiency and sustainability is essential for improving lives in the face of climate change. Several key issues related to the current state and potential of smart homes are highlighted. It is noted that despite the increasing popularity and familiarity of smart homes, there are still significant challenges that researchers need to overcome to achieve widespread adoption. One technical challenge addressed is the diversity of manufacturers and devices, each with different charging systems, circuits, and communications. This fragmentation can hinder interoperability and connectivity between devices and systems. The widespread adoption of smart home technologies poses significant challenges. This review highlights the critical role of convincing consumers of the safety and security of these technologies. Methods are presented to develop predictive models that can detect faults and failures in power systems, demonstrating their effectiveness in predicting the progression of faults. The challenges presented include monitoring the state of the device technology and identifying the likelihood of the current fault condition.

ZHIGUANG HUA Due to the advantages of small size, light weight and more compact structure, brushless DC motor (BLDCM) is widely used in industry. Centrifugal compressor converts compressed air into pressure, and can supply air to the vacuum cleaner. The driving and control method of BLCM not only affects the behavior of thermocouples, but also affects the thermodynamic efficiency, especially in high frequency conditions. This paper provides a high-speed BLDCM model and turbine with a power of 1 kW and a speed of 250,000 rpm. The three-phase, six-state driving and control method of BLDCM is elaborated, and it is used to drive electric motors. The parameters of speed, density, density and density are studied, and the relationship between heat conduction and heat conduction are studied. In recent years, high-speed semiconductor DC controller (BLDCM) has gradually replaced the traditional motor drive in many aspects. Especially with the development of high-performance semiconductor materials such as SmCo, NdFeB, BLDCM, which has an electric drive to replace the mechanical and thermal components, has the advantages of good efficiency. High energy density etc. to complete the cells.

HARSHA KUKDE This article discusses the solar PV system applied to the grid system to maximize the benefits of the solar source including to enable BLDC grid starting. The model focuses on studying the thermodynamic parameters of the PV system related to the operating temperature and solar radiation level. This article considers the real-time interpretation of the photosynthetic system. Apart from the noise factors such as temperature and irradiance, the BLDC motor power is transmitted through the entire generator. The VSI is controlled to reduce the starting cost, avoid losses due to overload, and to increase the efficiency of the proposed system. Solar energy is a sustainable renewable energy source which is gaining more popularity nowadays. Hydroelectric power from solar power source is always clean, heat free and environmental friendly. Since solar power source is widely used everywhere, it provides maximum benefits from this energy source.

JIRAPUN PONGFAI This article focuses on the comparative analysis of the efficiency and effectiveness of PID controller optimization for brushless DC motor (BLDC motor) using Artificial Intelligence (AI) algorithm as the classical parameter optimization method for PID. Artificial Neural Network (NN) algorithm and Genetic Algorithm (GA) are some of the popular algorithms available today. While the classical method is Ziglor-Nichol (ZN) algorithm to compare the controller performance. The prediction accuracy and response accuracy of the components were evaluated by analyzing the average material condition, state error, and response time of the linear model.

F. ARAMA The objective of this study is to find the effective response of a wind turbine energy conversion system (WECS) using a spread frequency generator (DFIG). The DFIG rotor is connected to the grid via a switch. The voltage and current control are achieved by controlling the DFIG transformer module using a fused frequency control (FOC). The DFIG vector control is achieved by using dragged PI parameters and artificial neural network (NN) analysis. The mathematical model is applied in Matlab/Simulink software to simulate a 1.5 MW DFIG to demonstrate the capability and efficiency of the studied control system. The simulation results show that the efficiency and response time of the PI artificial neural network analysis. Wind is one of the most widely used energy sources worldwide due to its clean and non-polluting characteristics.

Wenzhongzhou, using the integrated use of artificial intelligence technology, this paper presents a software and design model for an underground coal mine drainage system based on artificial intelligence control. By monitoring the amount of water in the pipeline and other parameters, the system controls the pipeline to operate in cycles and the loading pipeline to start at the right time, so as to realize the working time of the pipeline reasonably, and has the function of fault control, which greatly reduces the labor intensity of workers and improves the utilization rate of resources. The system also has good reusability, and is suitable for coal mine drainage in the production, road or surface water, or for filtering and reducing environmental pollution, improving water quality. Water is mainly composed of water, surface water, stagnant water, surface water and mining areas. The mine drainage has a certain cubic volume. If it is not removed from the coal mine in time, it will seriously affect the health and safety of the production. Therefore, the mine water wells can operate safely and stably, and are directly connected to the coal mine to ensure the safety of personnel and equipment.

4. NEED OF CONDITION MONITORING

Life has improved both domestically and industrially. A modern home in a developed country has 20-30 electrical appliances with an electrical power of 0-1 kW, including fans, blowers, room fans, fans or filters. Modern cars use electric motors for windows, wipers, starters and now also hybrid cars. The new Mercedes-Benz S-Series has more than 120 types of electrical appliances. Most small electrical appliances do not require maintenance. The components of electrical appliances are reliable enough to last the entire life of the product. However, modern society directly or indirectly relies on high-quality and efficient machinery to improve the quality of life. Monitoring the condition of electrical appliances can significantly reduce repair costs and the risk of unexpected delays, as it allows the detection of potential hazards at an early stage. In order to maintain the operation, it is not advisable to repair or replace the machine based on historical records or predicted performance. Therefore, decisions are made based on the data provided by the system that measures the condition of the machine.

Therefore, the key to the success of risk-based management is the correct risk assessment tools and the implementation of risk assessment. The concept of safety or security that has been developed leads us to the problem called rational control. Functional monitoring refers to the assessment of the reliability of equipment and devices throughout their life cycle. The conditions for monitoring and repair work are closely related. However, the monitoring methods for each task are very different. In addition, the benefits obtained from monitoring are very different from what we expect from prevention. The main reason is that monitoring should be carried out to prevent consequences, while prevention is not. In many cases, monitoring can be designed to provide initial protection, but its real function should be to try to detect the development of errors at an early stage. The above warnings are necessary, as they give the maintenance personnel more freedom to adjust the protection system, resulting in higher safety (safety) risks and improving the protection measures. The comparison between the input and output levels of the machine tool must be ensured through state control. Determining the state of the machine and predicting errors from the input signal is not easy and is complicated by many factors. Electrical machines, both motors and generators, are often used as components in large systems whose design is not controlled by the manufacturer.

5. NEED OF AI TECHNIQUE

Human experts may be forced to make decisions quickly and accurately, especially when there are many machines in a factory. Good decisions may depend on the knowledge and experience of many experts, who do not all have machines available at the same time. Manufacturers are adding additional features to new machines, while operations departments are increasingly focusing on extending the life of existing machines. It is well known that human experts who are faced with inspection tasks generate a lot of data, some of which may be simple, while others may be complex. There are differences in how people process such data.

6. CONDITIONING MONITORING

Condition monitoring can be used as a comprehensive data collection and analysis tool that will identify problems at an early stage and the need for ongoing and effective maintenance of the machine before it fails. Advantages of Condition Control Techniques Malfunctions and malfunctions in electrical machinery often lead to production losses, costly repairs and operating costs. The investment cost of modern machinery is so high that the need for continuous and uninterrupted maintenance has become essential to maintain economic activities. There is a trend to use various types of condition monitoring to identify the failure conditions of machine components long before they fail, in order to make repairs, which contributes to better electrical system health and reduces maintenance costs accordingly.

7. BRUSHLESS VS. BRUSHED MOTORS

Brushed DC motors were invented in the 19th century and became popular. The development of high-voltage motors in the 1960s allowed for brushless DC motors. An electric motor produces torque by varying the resistance of the windings attached to the shaft, the motor shaft, and the windings placed in the stator around the shaft. One or two coils of wire, made of wire strands, are wound around a metal core. The DC current flowing through the windings creates a magnet, which provides the motor with torque. However, for every 180° rotation (half a turn) of the motor, the north and south poles of the motor rotate. If the magnetic fields of the coils were the same, the motor coil would rotate half a turn each time and the average speed would be zero and the torque would be constant. Therefore, in a DC motor, to produce torque in one direction, the path of electricity through the windings must be reversed (or blocked if in the wrong direction) for every 180° rotation of the crank. This reverses the direction of the crankshaft as the crankshaft rotates, so the motor on the crankshaft is always in the same direction.

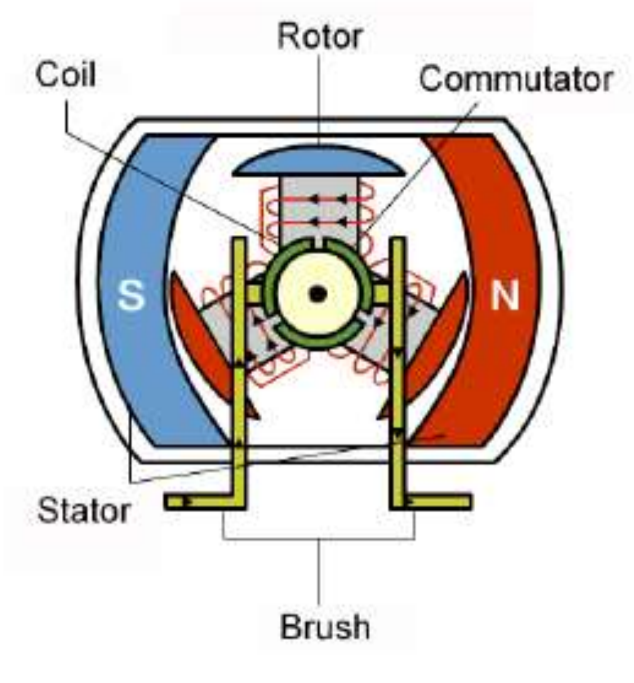

Figure 1. The general principle of the brushed motor

8. METHODOLOGY

The quantitative method is used as a research method in this paper. The quantitative method used in this paper is organized as follows: First, this study investigated the potential risks and malfunctions of protection and protection devices. In addition, a detailed study on the use of AI for predictive and predictive control systems was conducted. The above article highlights the problems and obstacles and provides a definition of the problem. The next step in this approach is to create a simulation of the characteristics and solutions to the identified problems and then perform real-time simulation. The DC motor model is developed using a real-time load control algorithm for the DC motor in MATLAB/Simulating. The model is validated by performing the same simulation for no-load and full-load idle loads and comparing it with the engine data. The PID control loop time for the DC output speed control will be zero due to the first-order transfer curve of the DC motor. As a result, the PID controller is converted to a PI controller. A conventional PI controller was tested to study the response of the DC motor to the speed control system under different load conditions. The mathematical solutions of the DC motor model are within tolerance and the same model is used to generate training data and test data to validate the proposed neural network model for the proposed solution. Although the real-time measured motor speed is within the tolerance range, the small noise present in the measurement can be removed by the mathematical model due to its noise. The damping parameters were adjusted to obtain the appropriate power through the neural network model created using the Neural Network Toolbox in MATLAB/Simulating.

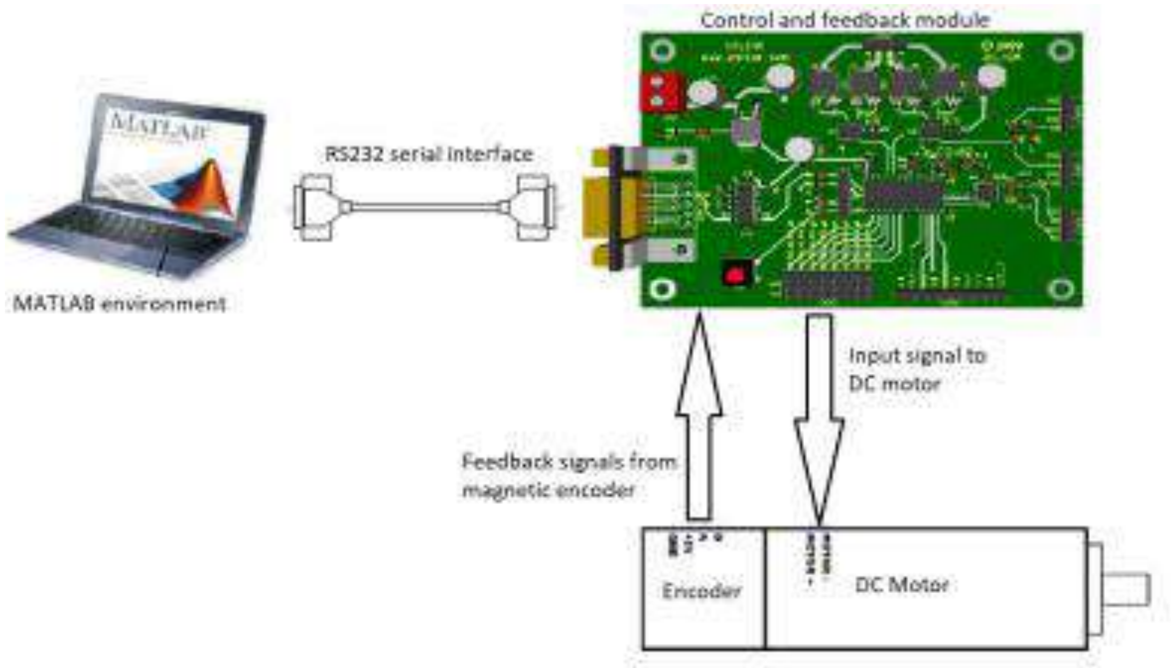

Figure 2. Schematic representation of the system

9. RESULT AND DISCUSSION

The PI controller controls the input power through an ART neural network model based on the setpoint power and measured samples, with the control gain determined using the PID Tuner tool from the Control System Wizard in MATLAB. Based on the output of the PI controller, one ART neural network model (trained under no-load conditions) predicts the output current to be applied to the DC motor. Conversely, the same ART neural network model (trained under waveform conditions) predicts the flow rate to be applied to the waveform conditions from the amplitude of the waveform. The amplifier adjusts the safety signal to the remote control system settings. The final difference is made to ensure that the maximum pressure does not exceed the maximum temperature, thus ensuring the stability of the pressure.

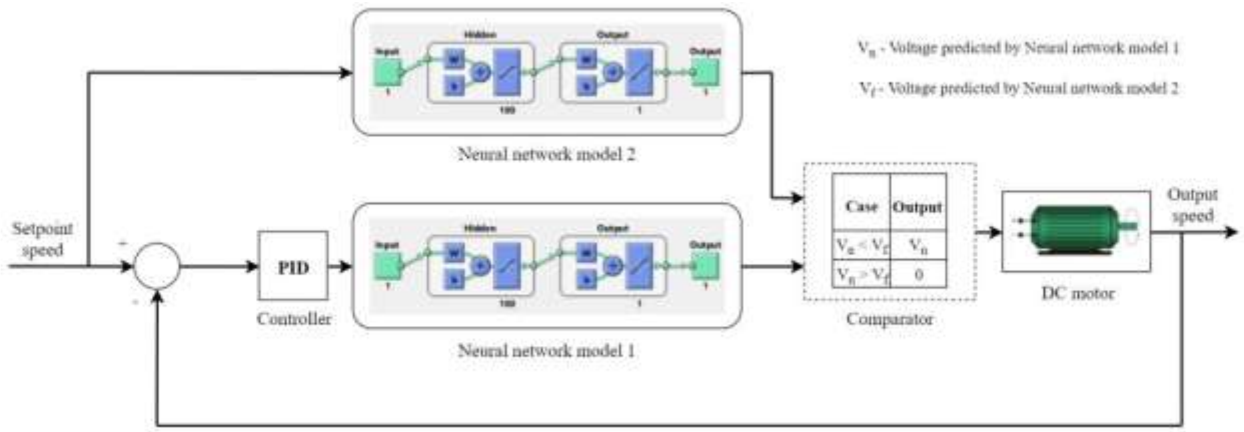

Figure 3. Block diagram representation

The data is organized as features as input features and colors as input/output to the neural network. In this research, set points such as circuit voltages at different frequencies are signals, and the corresponding signals are signals. The applied forces and torques are collected and simulated using the Animal Analysis Tool from the Artificial Neural Network Toolbox in Matlab/Simulink.

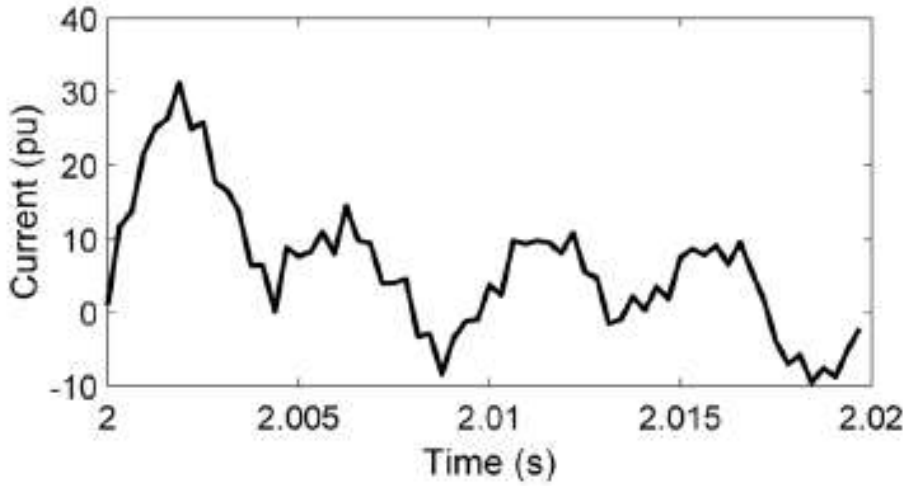

Figure 4. (a)

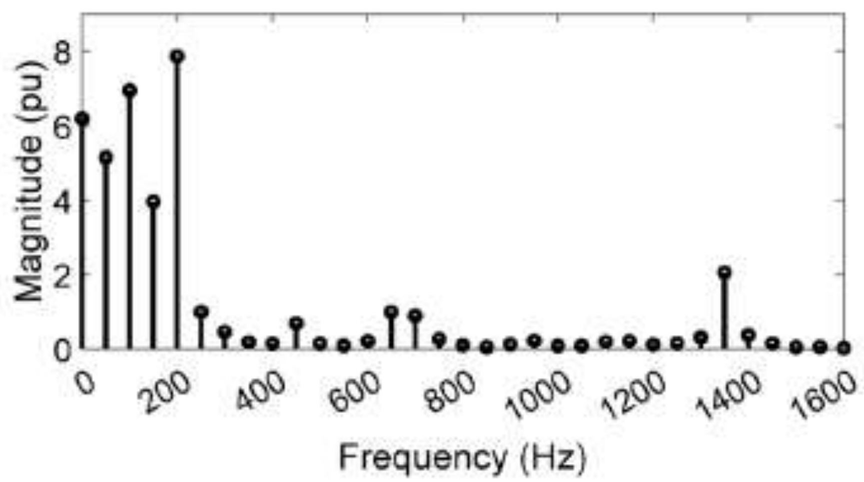

Figure 3. (b)

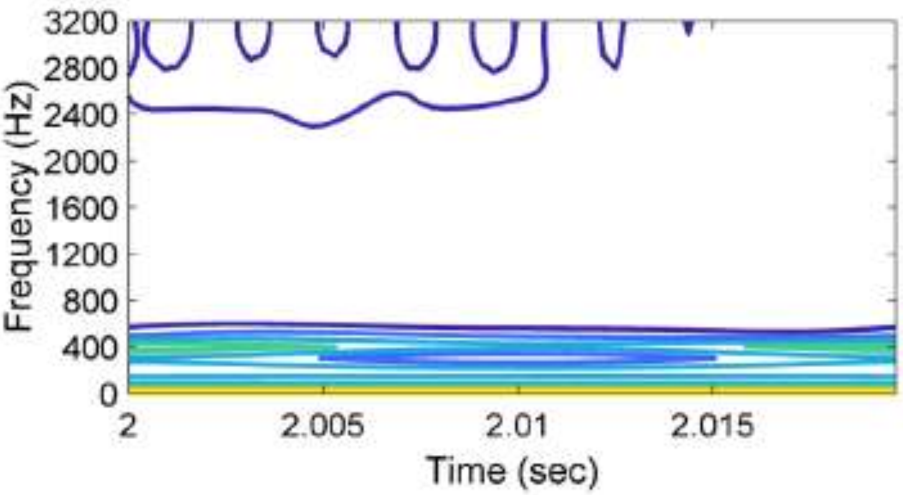

Figure 3. (c)

Figure 4. DC internal fault event: Signal analysis using various techniques (a) (b) (c)

10. CONCLUSIONS

Appropriate condition monitoring devices can improve the reliability of DC motors and reduce maintenance costs. Condition monitoring involves detecting fault signals, using these signals to generate a fault-sensitive signal, detecting the presence of a fault, and determining the type of fault. In Paper A, we developed and implemented an AI-based fault protection method for DC motors. We control the motor speed and compare its performance and reliability with a classic 2010 PI controller in real time. From the comparison and analysis results, it can be seen that the high-load system performance is better than that of competing PI controllers in terms of equipment protection.

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