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Monitoring the Manufacturing Operation Process Data through the Cloud Database

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ABSTRACT

The level of service provided by disseminating industrial management was difficult to match by the customer or multivalent based on embedded data stores now in usage. An Embedded Cloud Database Service (ECDT) approach is proposed as a solution to the problems. To enhance the actual-time performance and dependability to transaction processing, ECDT architecture should be first built, and a Dual-Timing Transaction Control (DTC) mechanism was proposed. Then, a different network sniff-timing calculation method was presented to increase the effectiveness of the ECDT method, and a cloud services middleware component was built to carry out dynamic access control and real-time DB search. In comparison to MySQL and Berkeley DB, the total transaction processing time could be slashed by 45.5% and 36.7%, correspondingly. The DNS2 algorithm could also function with average demand and time change and use less energy. Finally, the results of the numerical and commercial experiments show that the DTC technique could improve the real period precision of transmission operations in a condition where reading consistency was guaranteed, and the data transfer speed could be 20 MB/s.

1. Introduction

Where human eyes or ears fail to detect or gather sensitive information from equipment, primarily motors, automated systems offer practical solutions to numerous sectors. Proactive maintenance combined with integrated sensors, could prevent needless component replacement, minimize machine downtime, identify the root cause of the issue, decrease costs and increase efficiency [1,2]. In terms of planning the maintenance activity to prevent machine breakdowns, predictive maintenance and preventive maintenance share some similarities. Predictive maintenance programs, as opposed to traditional preventative maintenance, are based on information collected through sensors and analysis algorithms [3]. Induction motors account for over 70% of all driven

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electrical loads in process industries. In this respect, there has been a lot of interest in finding better ways to assess the health of these motors.

The data-driven method, sometimes referred to as the data mining technique or the machine learning method learns to a model of system behaviour using past data [4]. The physical understanding of the intended result could be incorporated into a model-based approach, which relies on an analytical model to depict the system's behaviour. In areas where the availability of information was growing, like the management in the industrial sector, machine learning technologies are effectively applied [5]. Effective solutions, cloud-based solutions, and recently developed technologies are all progressively being offered. The following two main categories could be used to categorize machine learning-based PdM: Unsupervised - where logistic and/or process data is accessible but no maintenance data are provided [6] - and Supervised - where data on the incidence of faults was provided in the modelling database. The type of the current planned maintenance policy largely determines the accessibility of maintenance information. The use of supervised solutions was advised to be feasible.

Different criteria could be used to classify quality features; one taxonomy would be to separate them into run-time and design-time categories [7]. The former class contains the quality qualities that characterize a system's behaviour while it is in use; in other words, those characteristics that affect how users or other computers may use the system externally [8]. Contrarily, system sustainability over time and ease of controlling system art facts during the software development lifecycle is determined by design-time quality traits. To concentrate our attention on the trade-offs between the quality qualities across the 2 categories rather than inside categories, they used this dichotomy [9].

A crucial study field would be the control of trade-offs between run-time qualities on the one hand and design-time qualities on the other. For handling such trade-offs, the embedded systems sector in particular needs specialized tooling, methods, and techniques [10]. Many tools, both free/open-source and commercial, are currently available, however, they are solely intended to help the monitoring of specific quality characteristics of importance in embedded systems. To our knowledge, there are no methods for managing trade-offs, and there is no information addressing the particular requirements of the embedded systems sector about controlling quality attribute trade-offs [11].

2. Related Works

A decision that favours one quality attribute while negatively impacting another is known as a trade-off between two quality characteristics. Software engineering requires trade-offs since every choice has advantages and disadvantages [12]. The quality characteristics implicated in a trade-off could not always be understood directly, and not every decision could involve a trade-off between quality characteristics [13]. Implicit trade-offs may be hidden by some decisions, which the decision-maker could be aware of at the time of the decision or later. Several strategies could be employed to deal with trade-offs, with one of the more well-known ones being [14], which concentrates on assessing the trade-offs while creating or developing a software system.

Design-time quality measures were applied to the source code using a separate methodology, and they were contrasted to performance-related metrics obtained during system operation. To demonstrate the existence of trade-offs between design-time quality measures and performance, the authors compared four different architectures of an example system [15]. More specifically, a decline in the number of cycles run and memory consumed was connected with an improvement in the McCabe Cyclomatic Complexity indicator.

This study integrates the embedded system or portable CC of the dispersed detection domain and provides an integrated internet database server approach [16] to address the aforementioned issues. The CC method & the CC middleware subsystem are the 2 main challenges that the method addresses. The contribution of this article is the provision of an agile integrated DB method through equipment interfaces and DMS methods, which would be focused on the two major difficulties indicated above [17]. It offers online data operations for DMS networks and could be viewed as a unique dispersed DB cache with some data swap methods. Furthermore, the approach combines the benefits of embedded systems and network monitoring, the domain can create a foundation for an MCC monitoring service for dispersed industrial equipment.

The existing level of service provided by disseminating industrial management, particularly in terms of customer or multivalent satisfaction based on embedded data stores, faces significant challenges. The need for a solution to enhance real-time performance and reliability in transaction processing has led to the proposal of an Embedded Cloud Database Service (ECDT) approach. The development of the ECDT architecture, along with the introduction of a Dual-Timing Transaction Control (DTC) mechanism, is crucial for addressing these challenges.

However, the current literature lacks a comprehensive understanding of how to efficiently implement the ECDT architecture and the impact of the proposed DTC mechanism on real-time precision in transmission operations while ensuring reading consistency. Additionally, the optimal network sniff-timing calculation method and the development of a cloud services middleware component for dynamic access control and real-time database (DB) search require further exploration. The need for a systematic comparison of the proposed ECDT approach with existing database management systems, such as MySQL and Berkeley DB, is evident to validate its effectiveness. The absence of a well-defined algorithm for handling average demand and time changes, while simultaneously optimizing energy consumption, presents an opportunity for further research.

In summary, the current state of industrial management disseminated through embedded data stores faces challenges in terms of real-time performance, transaction processing efficiency, and energy consumption. The proposed ECDT approach, DTC mechanism, network sniff-timing calculation method, and cloud services middleware component require thorough investigation to determine their feasibility, efficiency, and superiority compared to existing solutions.

3. Self-Adapting Network Model

Device point, control point, and data service are the three components that Universal plug and play (UPnP). This could offer self-networking services and use a UPnP bridge to adapt to non-IP situations. As a result, they put up an SNA mode and present it to the industrial monitoring area. The industrial workshop, network service centre, and middleware service are the three divisions of the model. IW would be the production entity with the machinery and support equipment that the DP nodes, or the managing method of UPnP & DMS, refer to. NSC or cybernetic core includes CPs and servers designed specifically for managing and controlling networks [18]. The performance of DMS's engagement was increased by the UPnP service, a digital element that exists in each node of the IW and NSC.

An independent node of the DMS, UPnP-based embedded DB handles playing management, inquiry, and storage functions. It performs the actual period information method of DMS networks and offers a medium integrated DB connection between user interfaces and the main DMS network. The benefits of intelligent network middleware & embedded computer systems are thus combined by UPnP-based EDBS, which can create an MCC method of dispersed industry monitoring. The four components of the UPnP-based EDBS are the user observation terminal, information gathering gadget, query service module, and information collection device, as shown in Figure 1. A management interface, or DMS-CP with an embedded database, is UME. The target device, a DP with real-time data processing and gathering capabilities, has a DCD as a manager. The third one connects customers and providers and offers DB pre-query service for CP. The final one would be responsible for collecting all online DCDs' regular state information.

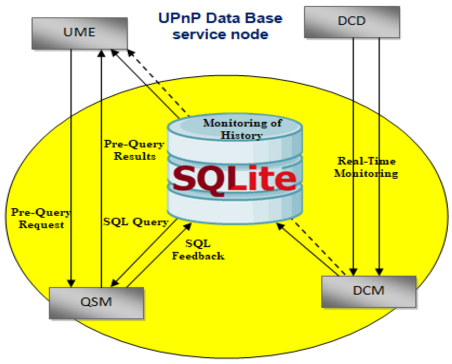

Fig. 1. UPnP-based embedded DMS-DB

The processing and classification of the information index determine how efficiently a database query runs. They propose a distributed pre-query technique [19] to address the issue, where the search response was based on pre-query findings that make use of the customer's conclusive index to evaluate the query's feasibility and raise the query action's success rate. According to the findings of the pre-query, UME (UPnP-CP) in Figure 1 executes data and controls data engagement through QSM by calling the information pre-query method and directly accessing the database. Every online DCD is polled by DCM**,** which also calls the actual period method interface to get real-time data packets and introduced extra monitors to the database. The UME could collect actual-period data packets from the DCM via a multithreaded manner if the comparative research activity was launched.

This article identifies the query framework in QSM, that is employed to record the pre-query requirements and outcomes, to receive the query results accurately. As a result of the various query architectures used by UMEs, a pre-query component linked list is generated. This component would look for the framework node matching of the CP in the linked list when a UME submits a pre-query service request. If the node was absent, one will be constructed and added to the kind in its place. This component then breaks down and groups the pre-query criteria, saving them as a node in the query data framework. When the pre-query was complete, this component modifies the DMS-DB accessible data, including the DB system password, account, and address, while writing the pre-query results into the appropriate location of this component.

3.1 Embedded Cloud Service Framework

One of the main tasks of this study is the ECDT architecture. Because SQLite has sufficient transplanting capabilities, it is used to carry out the essential DB functions. So, as illustrated in Figure 2, we construct an ECDT architecture for dispersed industry management. The SQLite-based embedded DB's major characteristic was load balancing, which would be carried out by CP nodes via UPnP services. The intermediate information management was handled by CP, who also manages data resource conflicts between user terminals and central servers while enhancing DMS-DB performance and entry performance. Some industrial applications demand continual assessment throughout the day since it takes a long time for the monitoring activities to be completed during the session. As a result, the network address must be maintained throughout the entire session. The ECDT system may distinguish between IP and non-IP addresses and offer private nodes specialized services. The DB will respond to the existing service demand as determined by the dynamic scheduling approach. By utilizing the UPnP function calling and message subscription allows, the ECDT system can provide a more adaptable data service when contrasted to schemes like a weighted round robin or weighted round robin.

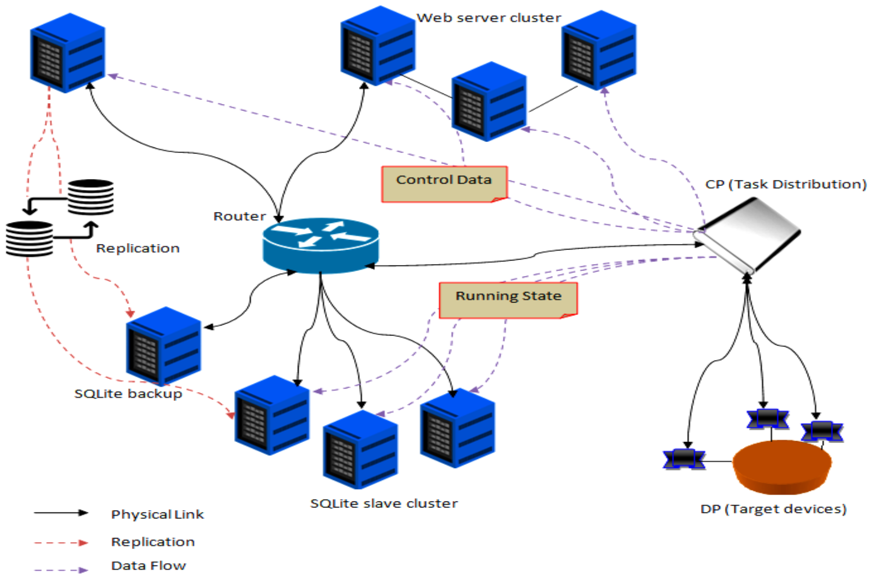

Fig. 2. The proposed Model for Manufacturing Operation Process with cloud

3.2 Dynamical Scheduling

To control an enterprise, data collected would be a crucial problem. To overcome the aforementioned issue, a middleware subsystem for ECDT was developed in this study. The subsystem would be a unique UPnP-CP to operate on UPnP-DS and could sporadically contact internet UPnP-DP. The aforementioned actions could sniff to record UPnP-DP service information, get the goal device's operating status data, and store that information in an integrated database. Figure 3 multi-group circular sealing chained list serves as the ECDT middleware component. The linked list could create a decentralized system because any single node having UPnP service has the potential to self-network. The three linked lists g01, g02, and g03 were three subnetworks. The connected category's nodes are all UPnPDP data structures with DCD. The head reference component was thought of as the subnetwork's master node, and the remaining nodes were thought of as slave nodes. The head nodes, or so-called participants in numerous subnetworks, were simultaneously the slave nodes of other subnetworks.

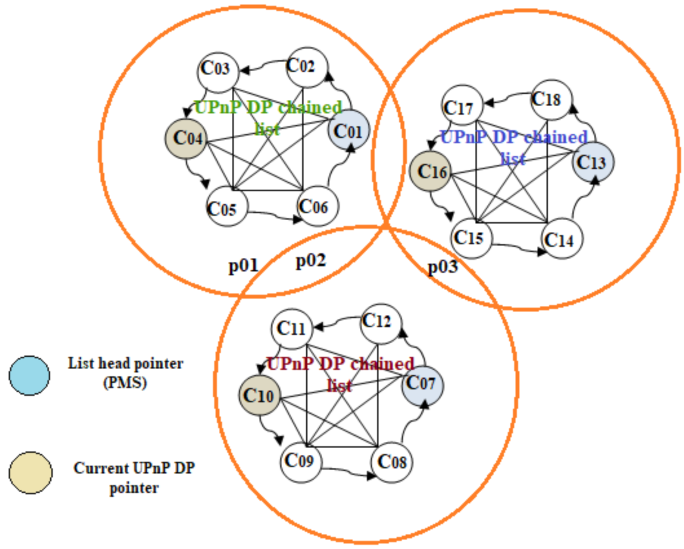

Fig. 3. Proposed Architecture Circular Link

4. Results and Discussion

The investigation's findings are displayed in Figure 4, where the incorrect steps are the vertical coordinate and the READ-WRITE stage is the horizontal interrelate. Following laws could be deduced from Figure 4.

i. The erroneous steps of the ASM technique exhibit a linear rising pattern with an increase in READ-WRITE steps, demonstrating of the READ-WRITE accurate rate of the ASM technical was likely impacted to READ-WRITE procedure of random databases.
ii. dual-timing synchronous control mechanism used by the proposed DTC method allows it to maintain a constant READ-WRITE accurate rate, especially for 1 kB and 1 MB data matrices.
iii. Two approaches' incorrect stages are with logarithmic growth curves as information amounts increase.
iv. The READ-WRITE error rate for the 4 matrices could be managed at0.5%, 0.15%, 0.01%, and 0.08%, using the DTC approach, which can perform fewer incorrect steps. While a result, the READ-WRITE success rate can be successfully increased using the proposed transaction processing approach, and the erroneous steps do not significantly change as the number of READ-WRITE stages and data volumes increase.

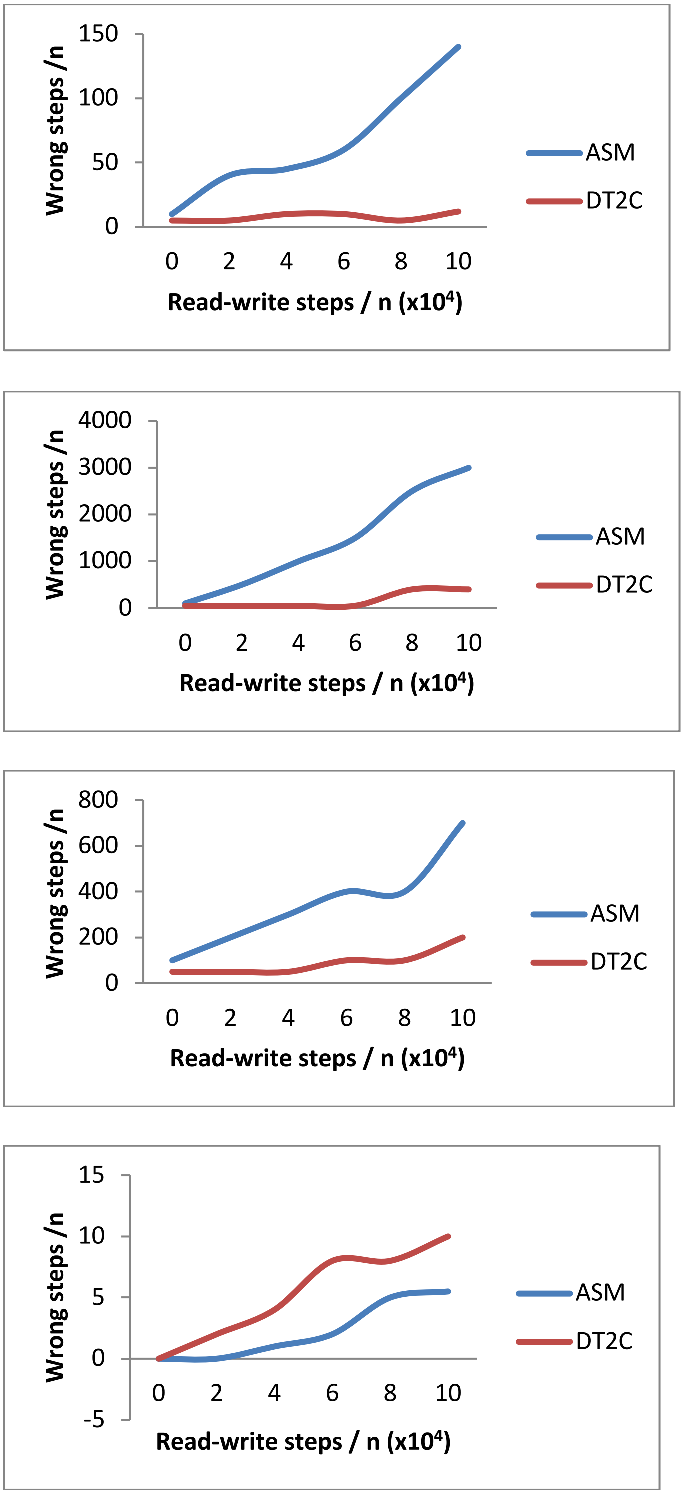

Fig. 4. Comparison of Read-Write Success Rates

The research findings were displayed in Figure 5, the vertical interrelate was the READ-WRITE time & the horizontal interrelate was the number of packets of data: First, the single U-Timer has the worst real-time performance because it lacks a synchronous management technique for resource allocations, and second, the double UTimer technique has self-adapting manage capabilities of transaction processing, which enables to superior actual-time achievement without submitting periods. A benefit appears obvious to the rise in information amount. The proposed DTC approach can enhance real-time transaction processing efficiency in a setting that ensures access reliability, and the median data transfer rate could exceed 20 MB/s.

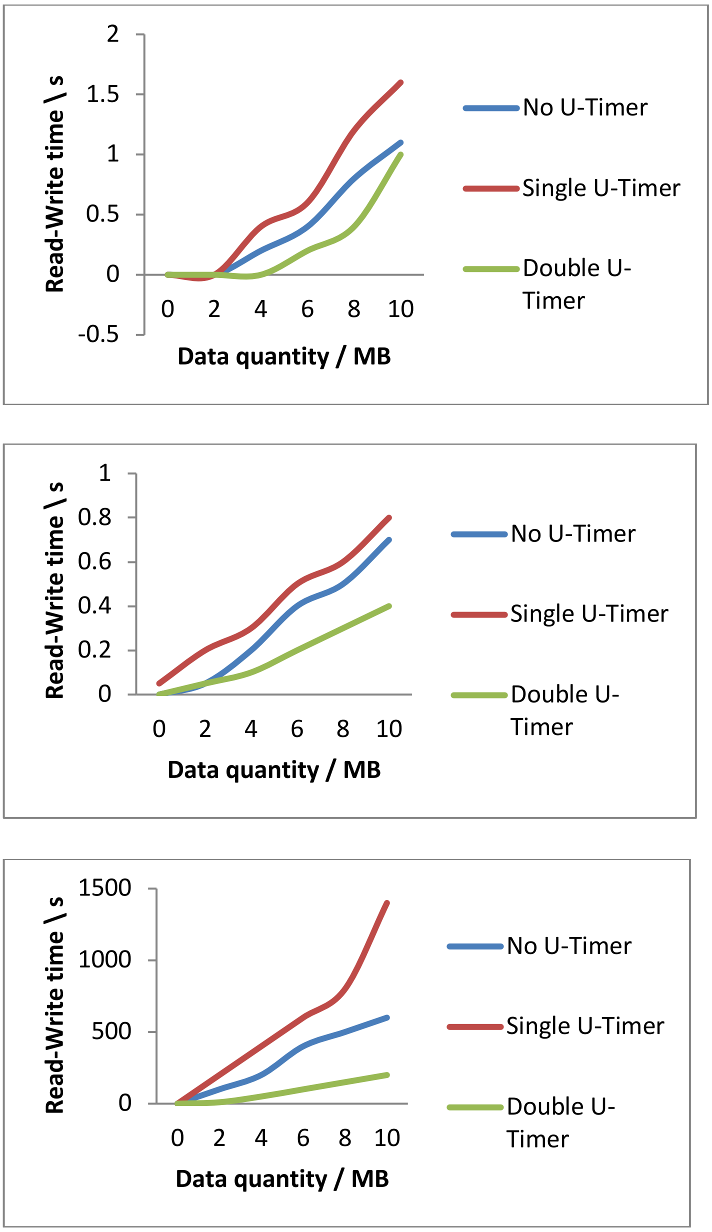

Fig. 5. Scheduling Management Experiments Analysis

4.1 Embedded Experimental Platform

Real-Time Data Collection System (RDCS) and management systems are the two components of the technology. For UPnP-DP, RDCS provides the physical entity, and it is responsible for measuring and pre-processing the target device's state data. Real-time data packets are obtained through RDCS by DCMS, which then transmits control commands by the control data obtained from CP. The digital storage component, communication unit, graphic display component, serial port method, ISA bus component, and energy control component make up the core subsystem of integrated DP and CP. mass storage, flash storage, and RAM are the three types of information storage modules. The communication module consists of a USB method and an industrial Ethernet module, the latter was responsible for data interactivities to integrated DP/CP and the latter is responsible for communication with RDCS. The data acquisition component of DMS, or RDCS, could offer several data collection methods to various target units. The actual-time data transfer methods use varied sample periods depending on the characteristics of the temperature, pressure, audio, RAM, vibration, or video.

An initial was employed to cell UPnP-DP/CP capable of carrying out patrol surveillance operations. The other serves as a smart equipment interface that could offer field managers internet information services. As illustrated in Figure 6(a) and (b), prototype systems for the transportable investigator and stationary equipment have been created (b). An ECDT program, a component of the status monitoring and defect diagnostic system for large-scale devices, has been created based on the aforementioned studies. RDCS, DCMS, an embedded DB node, and industrial Ethernet make up the SMFDS. In the disciplines of mechanical production, metallurgy management, and other industrial areas, it is used to carry out the surveillance & diagnosis of critical systems. The ECDT software was viewed as a separate entity that offers database services to customers and mediates integrated database communication between consumer interfaces and providers.

Fig. 6. Embedded system for ECDT

The DNS2 algorithm produces a dynamic device list. The objective DP was chosen in consideration of user requirements, and the UPnP device mapping mechanism would then enable the UPnP effective engagement, which includes the PCT, real-time data statistical metrics, and historical data. The customers could also choose a data connection, like phase-frequency data, to assess the objective device's operational state using an online comparison analysis based on the DTC approach. Axial plunger pumps could operate in three normal states and three defect states, denoted by the symbols N1–N3 and F1–F3, correspondingly. A channel of the pump valve's vibration analysis was gathered for the system depicted in Figure 7 that has been chosen, and Figure 8 shows the real-time phase-frequency wave, which appears to have periodic slow-descending characteristics.

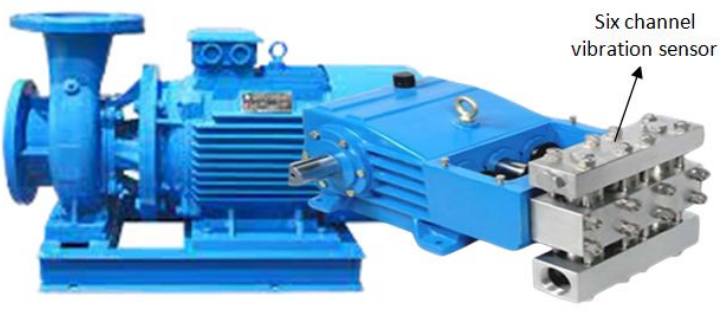

Fig. 7. Injecting Polymer Liquid Machine

The customer could purchase the standard state wave using the ECDT program's standard template library, as shown in Figure 8(a), and the current running condition of the pump might be determined by verifying that it adheres to the standard state-speed regulation.

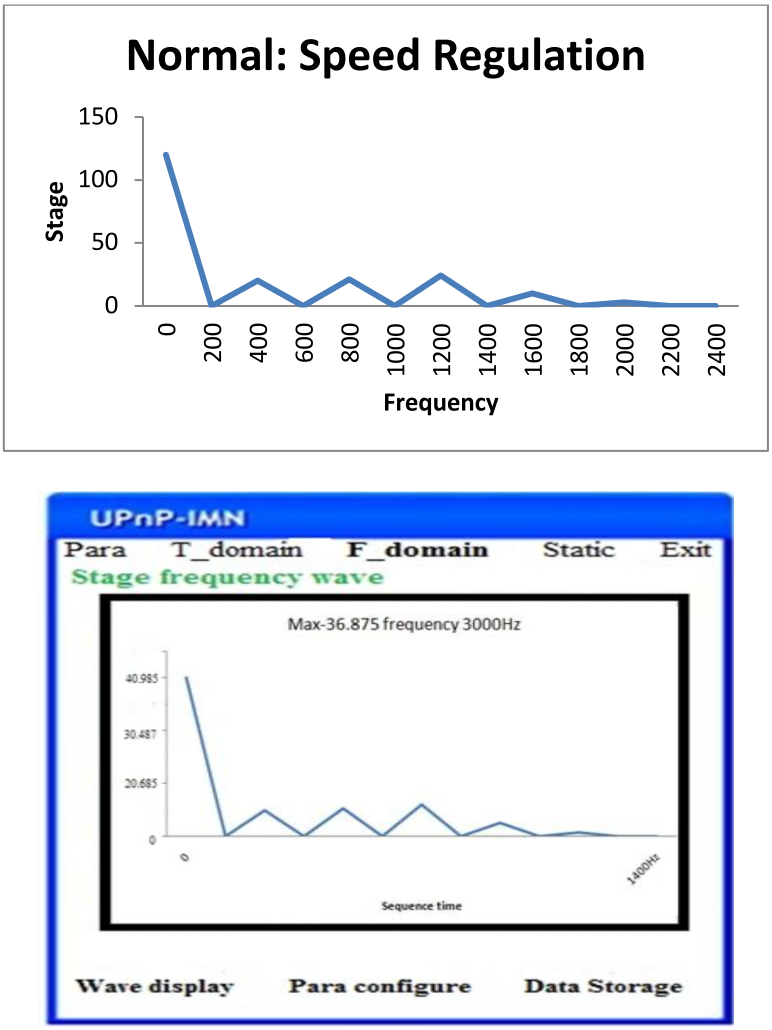

Fig. 8. Slow-variation Device on Injecting Polymer Liquid

The ECDT template library yields the usual state wave (see Figure 9). Evidently, the current status may verify the typical state-under-load by referring to the characteristics of the standard wave. The comparative studies with MySQL and Berkeley DB are then carried out to the seven different running conditions.

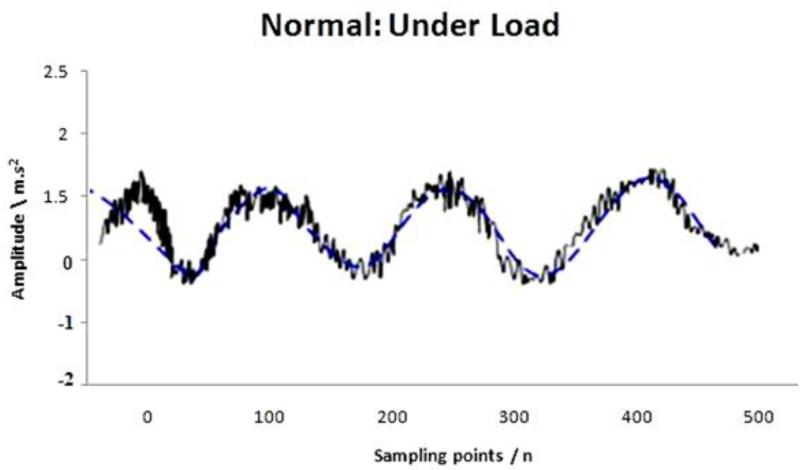

Fig. 9. Amplitude-frequency

5. Conclusion

The engineering importance of EDBS in enhancing the DMS's operational effectiveness and running stability cannot be overstated. The present C/S, MA, or EDBS could adequately perform self-adapting services of diverse advanced control jobs due to the NA restrictions of Intranet and actual IP address. This study suggests ECDT architecture and associated service mechanisms in light of the issue. The construction of ECDT architecture for dispersed enterprises manages multiple it to offer the following adaptable services: network address holding DB node self-discovery, load conflict balancing, for both IP & non-IP and dynamic scheduling tactics. A DTC approach is proposed based on the framework, which uses 2 self-model UPnP timers to enhance the actual-time accuracy & stability of the database processing transactions. The approach combines the benefits of lightweight DB engines, integrated processors, and intelligent network middleware to create an MCC method of dispersed mechatronic systems. In addition to providing helpful resources for technique improvement & theoretical modelling related to MCC, this study could directly enhance dispersed DB service techniques used in corporate systems.

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