

Digital Autonomous Maintenance System for Efficient Monitoring and Inspection of Machinery Functionalities in Industries

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Abstract

Nowadays, continuous monitoring and inspection of machinery functions in industries are very essential and it is foremost process for sustaining their performance in all aspects. Moreover, the maintenance of machines and documenting data are crucial problem and it also needs huge investment for maintenance and product delivery. Hence, digital autonomous maintenance system is proposed in this article to simplify the maintenance and documentation process. This proposed system involves a web design using software tool in which the worker can entry the data about the machine condition on that particular day and all data are stored in database. The stored data will be analyzed further and the abnormalities are identified. In case of any abnormalities, the worker can raise the ticket for particular problem through interactive dashboard. At the end, this ticket is forward to respective person to get instant solution for that error so that the resolving time becomes greatly reduced. This complete information about the process is automatically stored in the database for future use. Experiment was carried out in small scale industries to automate the process inside the organization and the results are observed. From the results, it is inferred that the proposed system significantly improves the maintenance of the machineries and thereby the increasing the productivity.

Keywords: *Autonomous maintenance system, digital documentation, ticketing system.*

1. Introduction

The problem of maintaining machinery in its full operating system performance poses a challenge for industry; however it is usually classified as a supportive process, with production being considered the main process. Increasingly production and manufacturing companies become aware of the impact of maintenance-related activities on product quality and delivery of product so that can be achieved by machinery condition. In addition to that, huge investment is needed for machinery inspection in order to achieve good product delivery. To remain competitive, companies must eliminate production-disrupting factors while implementing practices that can help maintain production equipment in its full operating performance. Most of the companies often consider only the investment for product and not consider the production equipments which leads to poor productivity and loss. To overcome these issues, Digital Autonomous Maintenance System (DAMS) is proposed in this article. Using this proposed DAMS, all maintenance for machine can be done. Here, ticketing system plays a vital role for maintenance purpose. Ticketing system is generally called as help desk which is mostly used in IT Company and CRM based applications. It helps the service provider to rectify customer problems as soon as possible and it makes connection between customer and service provider. Additionally, it is easy to get complaints from the customer. So, DAMS uses ticketing system for machine maintenance within the internal organization in order to get cost efficient maintenance for machineries inside the companies.

The steps involved in DAMS tools to raise the ticket are as follows:

- Get the data from machine like daily basis or particular interval of time and entry all data into DAMS
- Compare data on previous and current to analysis the abnormal case
- Raise the ticket when abnormal case happened
- Try to solve the task which is in ticket as soon as possible and ticket will be closed after all the problems are resolved

Here analysis of data can be done by manually and all the data are stored in database. With the help of this ticketing system, the company can reduce the time to rectify the problem inside the industry and retrieve the data stored in database for future purpose.

2. Methodology

In existing project, the ticket system gives the details about the workers assigning time, image, machine family name, machine id etc. However, it needs to incorporate additional features to improve the system performance. The proposed system includes additional features that will give the clearance on the details for higher authority of companies so that they can note on the machine malfunction and how many days it took to finish the work. It also has the status on the ticketing system that will help them to check the machine status instantly. DAMS consists of visuals so that it is easier to monitor on the machines status so that they can get clear view about the machine problem areas. It also has the priority method in which the ticket was divided and assigned based on their priority. The proposed system also has estimated time period so that higher authority can get the update on or before the ticket was closed or finished. In addition to that, it has the task adding option to ensure that the task can be more than one for the single ticket.

2.1 System Overview

In this proposed system, C# is used with frame work Asp.Net core to connect the functions that are requested by the user to the database. Thus, the C# acts as the intermediate for the user to get the appropriate data from the database. This connection will give the user better understanding, the condition of database, and the backend working. The HTML, and CSS are used to create a web page that will be used to connect the user to the database that gets the command from the input to the backend and the data requested by the user to the frontend from database. Microsoft SQL (MSSQL) is used to maintain the data that is given by the user and store the data in the database and also manages the database. Typescript is used to eliminate the server side Blazor and gives the client side database and it is also used to create the interface between the user and the database. React.js is used to eliminate the usage of Blazor and also used to create an interactive web design. In proposed system, the data is typically collected in database that give us all the information that was entered by the workers about the details of machine and their ticket. Therefore, the higher authority can easily identify which machine becomes affected on which time and at which part it gets affected. By this method of ticketing process, the higher officials able to determine about the machines problem, and it facilitated the higher officials for further analysis on the machines working and the tickets that were raised for that machine. Moreover, the higher officials can predict in which time interval the machine has to replace. The actual system also has the task which also shows the status of the task and the task which has more than one ticket. It also has the description which shows the reason for ticket rising and then estimated time which was set by the employee and it also has the editable option and delete option. The system also includes the option to store the image in the database about the machinery parts. The image is stored as binary and it is converted into any acceptable format by using C#.

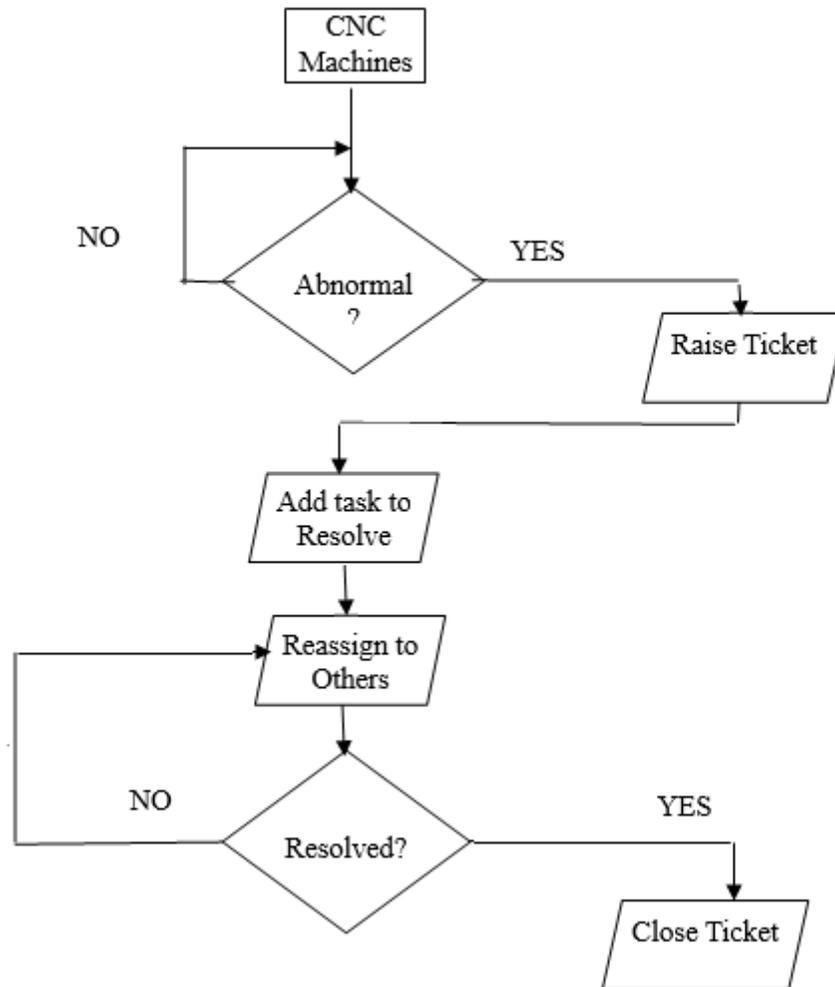


Fig.1 Flow diagram of proposed approach

2.2 Approach

The flow diagram of proposed approach is shown in Fig. 1. From the Fig.1, it can be seen that the readings taken from the CNC machines on daily basis is continuously monitored and the status of the machine is verified. The ticket will be raised in five categorize such as Lubricant Heating, Cooling etc., which are seen as the basic causes that will malfunction the machine which may cause the expenses. The processes involved in the proposed DAMS are given below.

- The CNC machine gives the details of the about the machine parts inside in it and gives the output as true or false as machine status.
- If true is received, then the ticket gets raised based on the number and the problem description is given like cooling problem in the container etc.
- If the machine is abnormal then the ticket gets raised, then task is added to resolve the ticket problem by assigning it to the employee who knows about the working of such faulty parts and its problem. If it doesn't handle by that employee, then it will be reassigned to other employee for immediate action.
- Finally, the problem is resolved by the reassigned employee and the ticket is closed. Otherwise, the reassinging process continues to resolve the problem.

3. Experimental Results and Discussion

Experiment is conducted on the client side that gives the better understanding for working of the system. The proposed system is based on the react.js which will reduce the complexity that is created by Blazor. The proposed system uses software such as Asp.net core which is used as the platform to be working in both the front end and back end. It is used in the visual studio which will be used to work with other languages. In front end, DAMS uses HTML, CSS, Typescript and formats form the Fabric UI components and Adobe XD. For back end, C# language is used and also the concepts of fluent Nhibernate that uses to map the input with front end text box. Fabric UI components are used in front end for better understanding. .

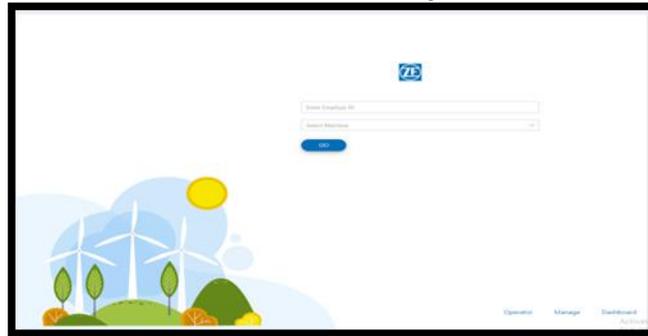


Fig 3.1 Login page for DAMS

The login page created in the proposed DAMS is shown in Fig 3.1. It gives the detail and design about how the login was created and it is given with the ZF. DAMS login consist of the employee Id and the password with the machine name that let the employee to login.

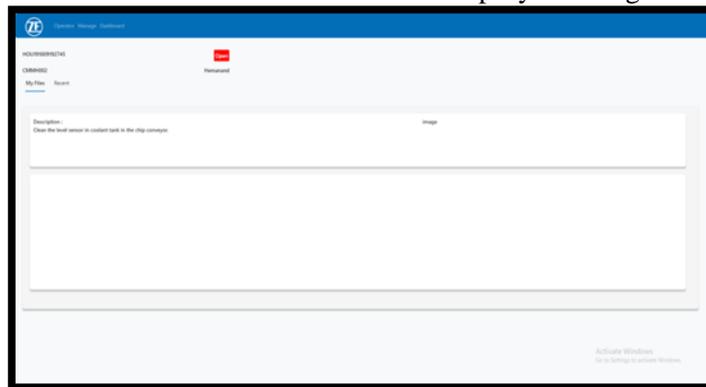


Fig 3.2 First page on DAMS

Fig 3.2 shows the first page created after the login page that gives about the description of the ticket and it includes the option to upload the image of the machine that raised the ticket as shown in Fig 3.3. From Fig 3.3, it can be observed that ticket page includes the machine id and employee id with the status of the ticket as the open or closed. The reassigning options are also available in the ticket page.

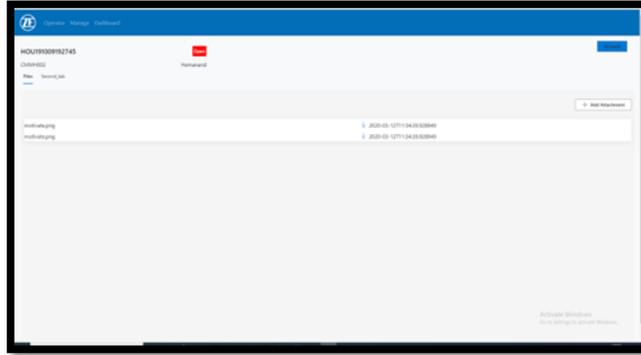


Fig 3.3 Image Uploading option

The reassigning options that is shown in Fig 3.4 gives us the better understanding on the reassigning options. With this reassigning option, the employee who has the ticket number can able to reassign their work to other employee with proper instruction. With the help of this page, the reassigned function can be monitored on the first page.

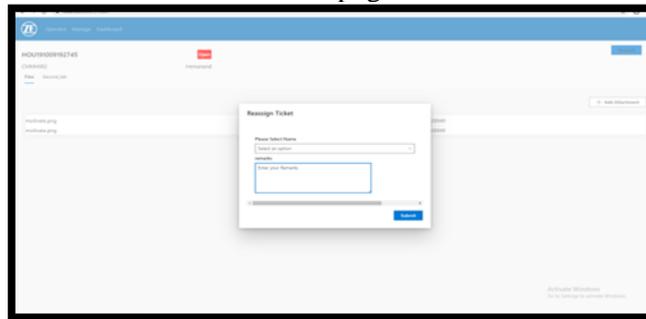


Fig 3.4 Reassigning option

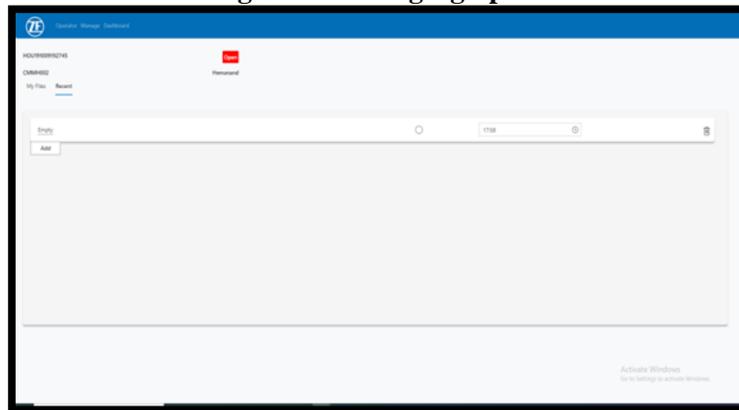


Fig 3.5 Task added option

The task adding option is shown in Fig 3.5. It can be seen that the proposed DAMS has the option to add the task in which the employee can add more than one task so that they can follow on the task to solve the problems when the machine gets malfunctioned. It also shows the status of the task that was added and also has the estimated time with the editing option. With the help of this page, the estimated time can be edited for the task at the time of inclusion under the ticket number. It also has the delete option that is used to delete the task that was added in the database. When the tasks get added to the database, then it can also be managed by the employee who added the task.

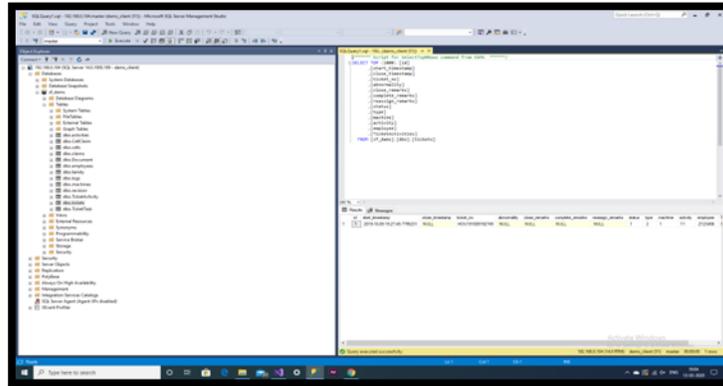


Fig 3.6 Data Stored in Database

The data that is given by the user or by the employee are stored in the database with the help of C# code which acts as the back-end coding. The stored database is shown in Fig. 3.6. This database gives the option to create a way to store that data in the respective table which can be used for UI. It also gives the details of the tickets that is to be stored and also used as good data storage by using MSSQL.

4. Conclusion

A new Digital Autonomous Maintenance System (DAMS) is proposed for efficient monitoring and inspection of machinery functions in Industries to speedy the resolving process when the machine gets malfunctioned. This system enables the employer to track the service process and thereby the proper maintenance is ensured for better productivity. DAMS allows the user to raise the ticket through interactive web design. When the issue arises, ticket is raised and it will be assigned to the experts of the company to resolve the malfunction. If it is not able to complete the service by the assigned experts, then expert can reassign the ticket to some other experts of the company through DAMS. When the service gets over, the ticket will be closed and the entire history is stored in the database for future reference. Experiment was conducted on the client in small scale industry and the performance was evaluated through the feedback given by the client. From the results, it can be concluded that the proposed DAMS performs well on the client service and it offers more advantages for the client such as speedy service, transparency in service history, database for future reference. In addition to that the employer can estimate the time to replace the machine based on the past service history.

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