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Research paper

Optimization and modeling in assembly unit of manufacturing plant

Yashwardhan Choudhary [1] *, Mayank Bansal [1], Madhu Viswanatham V [1]

[1] School of Computer Engineering, VIT University, Vellore-632014, Tamil Nadu, India
**Corresponding author E-mail: cyashwardhan@gmail.com*

Abstract

In every developing manufacturing unit key objective is to reduce its cost of manufacturing, our work will help manufacture to make proper analysis and make better decision making power. Our work will help the executive to monitor the system in better way and if problem found decision can be taken instantly. In assembly plant of a manufacturing unit the data generated is then help in building of historical data and this data now can be used in decision making for our manufacturing unit. This historical data help to train our machine and test it with random case to calculate the error rate. In industry 4.0, particularly radio frequency identification (RFID) is used in large way to collect data from the assembly unit. This data comes from various sensor including temperature, humidity, ultrasonic sensor. Once data collected it use its mathematical formula to calculate the final product quality using (temperature, quality, humidity, time data). This data now use KNN classifier to train data frame and hence making meaningful analysis for the manufacture. Besides, a close enormous information approach is utilized to excavate concealed data and learning from the historical generated information.

Keywords: *Big Data; PIC16F877A Microcontroller; K-NN Classifier; Assembly Unit; Temperature Sensor.*

1. Introduction

The popular use of big data is to optimize the profit and reduce the components by using them more efficiently and smartly one can also use big data for job appointment of different work at different machinery and tools to optimize profit and get better output. All things considered, a Gartner Survey for 2015 demonstrates that over 75% of organizations are putting or want to put resources into big data in the following two years. This increment in the use of big data was shown from year 2012 where 58% companies wanted to or indented to use big data in assembly unit and other unit of plant. Big data is also used to know their costumer better this data can be produced through different source such as social media.
It is used in better understanding and analysis of business process. Retailer now can predict and stock up their inventory in prior so that it can match the user requirement and accommodate the changing rates of products and market price inflation .This can be applied to employees behavioural study too as in past company like bank of America notices that its top employees are taking leave together at specific time of year hence it instructed it as group break and improved 23% in overall performance not only the in industry but in machinery also can be implanted with Big data and make them work autonomous and more smatter example Google self-driven car, Xcel Energy installed smart grid that allow companies to predict the power usage of company by logging into their website. IOT (Internet of Things), its merging and OT, quick application improvement, digital twin simulation model, digital physical frameworks, propelled robots and cobots, added substance manufacturing, self-ruling creation, steady building over the whole esteem chain, exhaustive data gathering and provisioning, flat and vertical reconciliation, the cloud, big data investigation, virtual/expanded reality and edge figuring in the midst of a move of intelligence towards the edge (artificial intelligence for sure with a meeting of AI and IoT and different innovations): these are a portion of the basic mechanical segments of the fourth modern insurgency.

2. Main body

2.1. Related work

[1] J Lee, HA Kao, S Yang - Procedia Cirp, 2014 - Elsevier
In the present focused business condition, organizations are confronting challenges in managing huge information issues of quick basic leadership for enhanced profitability. Numerous manufacturing frameworks are not prepared to oversee enormous information due to the absence of brilliant systematic apparatuses. Germany is driving a change toward fourth Generation Industrial Revolution (Industry 4.0) in light of Cyber-Physical System-empowered manufacturing and administration development. As more programming and inserted knowledge are coordinated in mechanical items also, frameworks, prescient advancements can additionally entwine smart calculations with gadgets and tie free insight. These advancements will then be utilized to anticipate item execution corruption, and self-governing oversee what's more, enhance item benefit needs. These days, shrewd production lines centre generally around control-driven improvement and insight. In addition, more noteworthy insight can be accomplished by communicating with various encompassing frameworks that have an immediate effect to machine execution. Accomplishing such consistent connection with encompassing frameworks transforms customary machines into mindful and self-learning machines, and thus enhances general execution what's more, upkeep administration. Despite the fact that the self-governing figuring approach has been executed effectively in software engineering, self-taking in ma-

chines are still a long way from usage in current enterprises. Change from the present status into more canny machines requires further progression in the science by handling a few central issues.
[2] Shen Yin, Okyay Kaynak
The potential advantages to be picked up from the utilization of big data, and also the provokes it will posture, will normally vary from area to segment. It is normal that PC and electronic items and data parts, government parts and additionally back and protection, and government will pick up significantly from the utilization of big data. As a rule, terms, the utilization of big data can open noteworthy incentive in such zones as item and market advancement, operational proficiency, showcase request forecasts, choice making, and customer encounter also, faithfulness. Truth be told, in a current think about, the aftereffects of a review done showed that the useful destinations of the utilization of big data by the respondents were observed to be as takes after:

- Customer-centric outcomes 49%.
- Operational optimization 18%.
- Risk/financial management 15%.
- New business model 14%.
- Employee collaboration 4%.

It is seen that for a large portion of the respondents, the most vital outcomes
anticipated from the utilization of big data are the customer-centric ones. They might want to utilize data assembled in different ways and structures for customer investigation; to get it customer needs and envision future practices and in this way, give better administration to them. For instance, sensors inserted in brilliant items are normal to, using cyber physical frameworks, send specialty customer bits of knowledge back, for example, data on how they are being utilized by the customers, what sorts of usefulness are being favoured and what newer capacities would be welcome, and so forth. Besides, inventive after-deals administrations, for example, proactive upkeep can be offered by methods for which preventive measures occur prior to a disappointment happens. Along these lines, big data can be utilized to enhance the advancement of the up and coming age of items and administrations.
Before industry 4.0 manufactures have to go through many difficulties in keep their data intact as this data is relevant and hence can produce meaningful analysis. The generation of data was done manually and was stored in traditional file system where one hard-copy was the source of all the information regarding some subject. Now when we have implied the smart data capturing techniques using different sensors one can predict cost, processing time and requirement of the process in prior .this data can be structured and unstructured data and later can help in prediction and analysis an example of auto-generated data can be processing time of different workstation can be captured using IR sensor ,quality of material using Ultrasonic sensor before it all has to be done manually .RFID tag can be use in inventory to keep the records updated automatically as the trolley carrying the parts be assigned with RFID tag containing details about parts (Model ID, quantity , cost, job ID, validity).These entries can update automatically as trolley enters the RFID scanner area . Temperature and moisture sensor can help one to maintain temperature and moisture in specified range to maintain its quality. Previously
Data was not centralized as using cloud computing now the data is in hand of every superior authorities and this data can be viewed according to authority's level. Thanks to cloud computing, multiple factories can work together in an even bigger system, and they make decentralized decisions. It means that you, as a person, don't control "robots": you control the global system. And that changes everything.
All those pieces of information will be reported to the "global system", which will analyse, thanks to big data, and will be able to adapt production in factories. Using IOT Manufacturers in all areas are interfacing their processing plants to be more profitable and productive.
IOT arrangements in the space for the most part incorporates having sensors set on gear in processing plants with the goal that data can be gathered about the execution of the machine and frameworks. This empowers production line administrators to not just observe when a bit of hardware may require repaired, however it likewise gives understanding on the most proficient method to influence the whole framework to work all the more effectively.
For instance, a producer can utilize IOT answers for better track resources in the manufacturing plant and help unite control rooms.

2.2. System analysis and design

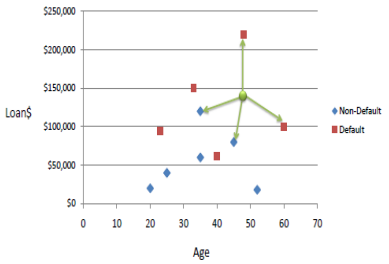
The Through hardware we get continuous value of data these values (Team no, Quality, Temperature, Humidity, Time) these values help in calculating the product standard. The product standard defines the final product quality depending upon these factors .To calculate the product standard we have defined formula =(400*100*50*E2)/(ABS($B2-18.5)*ABS($C2-28.5)*ABS($D2-40.5)*500) .After getting this product standard we now can predict the team no. which would work best and give best throughput in given variables as our historical data set contains set of data where product standard is defined with subsequent team no. which work on that product to give product of specified quality now with this model one can predict the team no. to assign the job under defined circumstance and given variable.
Machine learning is the study of inspiring PCs to act without being unequivocally programmed. In the previous decade, machine learning has given us self-driving autos, useful discourse acknowledgment, compelling web seek, and a boundlessly enhanced comprehension of the human genome. Machine learning is so unavoidable today that you most likely utilize it many times each day without knowing it. Numerous specialists likewise think it is the most ideal approach to gain ground towards human-level AI. In this class, you will find out about the best machine learning
procedures, and pick up work on actualizing them and motivating them to work for yourself. All the more essentially, you'll find out about the hypothetical underpinnings of learning, as well as pick up the down to earth know-how expected to rapidly and intensely apply these strategies to new issues. At last, you'll find out about some of Silicon Valley's accepted procedures in development in accordance with machine learning and AI. This course gives an expansive prologue to machine learning, data mining, and factual example acknowledgment. Points include:

i) Supervised learning (parametric/non-parametric calculations, bolster vector machines, portions, neural systems).
ii) Unsupervised learning (bunching, dimensionality lessening, recommender frameworks, profound learning).
iii) Best practices in machine learning (predisposition/change hypothesis; advancement process in machine learning and AI). The course will likewise draw from various contextual investigations and applications, with the goal that you'll additionally figure out how to apply learning calculations to building shrewd robots (discernment, control), content comprehension (web seek, against spam), PC vision, restorative informatics, sound, database mining, and different territories.

In our model, we will be using KNN (k-nearest neighbors' algorithm) classification algorithm. In pattern recognition, the k-nearest neighbors' algorithm (K-NN) is a non-parametric method used for classification and regression. In both cases, the input consists of the k closest training examples in the feature space. The output depends on whether k-NN is used for classification or regression.
The result is a class .an object is classified by its neighbors' vote, as it check k nearest neighbors and assign its class by judging most common among its k neighbor. the entity is assigned to its nearest neighbor when value is k=1. K-NN falls in the supervised learning family of algorithm. A case is grouped by a greater part vote of its neighbors, with the case being doled out to the class most basic among its K nearest neighbors estimated by a separation work. On the off chance that K = 1, at that point the case is essentially allocated to the class of its nearest neighbor.

Example:

Consider the following data concerning credit default. Age and Loan are two numerical variables (predictors) and Default is the target.



We can now use the training set to classify an unknown case (Age=48 and Loan=$142,000) using Euclidean distance. If K=1 then the nearest neighbor is the last case in the training set with Default=Y.

Fig. 1: KNN Classifier.

Distance functions

Euclidean $\sqrt{\sum_{i=1}^{k}(x_i - y_i)^2}$

Manhattan $\sum_{i=1}^{k}|x_i - y_i|$

Minkowski $\left(\sum_{i=1}^{k}(|x_i - y_i|)^q\right)^{1/q}$

Fig. 2: Distance Functions.

K-NN is used in our project as it has less calculation time and give more predictive power, ease to interpret output. It uses a technique to assign weights to the contribution of the neighbor as closer one have more impact on the average than to distant one.

Libraries used:

Scikit-Learn: is machine learning library for python programming language .it includes various classification, clustering, regression algorithm.

NumPy: Help in adding support for large, multi-dimension array and matrices along with high level mathematical function.

Pandas: Assist in including high performance data structure and data analysis tool for python programming language.

Seaborn: is python visualization library assist in drawing attractive statically graphics.

In this proposed system, we are using PIC16F877A as the prime controller. Here we are using the IR sensor as the obstacle sensor that help is calculating in-time for a section. These sensors are installed in every section to get data of in-time of each section. once the IR sensor is blocked by product carrying trolley it gives RFID reader to start and wait for its RFID tag product as products reach it shows its (Quantity, Product ID, Price) in PLX-DAQ software installed at executive system now, product reach in section 2(Assembly to parts section) where temperature ,moisture ,ultrasonic sensor is installed these then give its data to PLX DAQ software after it enter section 3(Assembly to product section) it is assembled into final product and then reach section 4 (verification section) where operator check product verification manually and then send message to the operator about its verification if it is verified or not and out time is noted these data is send to main PC where data accumulation is done and create a big historical data that help in machine training and this data is then used in jupyter notebook divide out data into train data(70%) and test data(30%) this then make meaningful analysis.

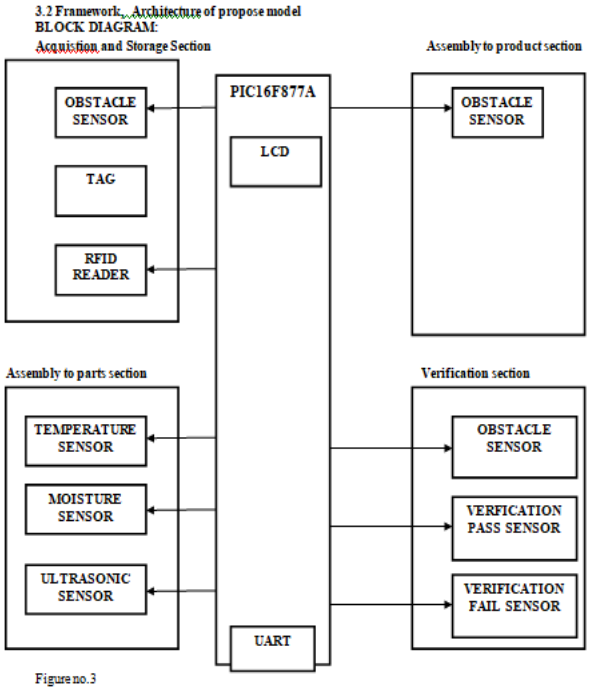


Fig. 3: Framework, Architecture of Proposed Model.

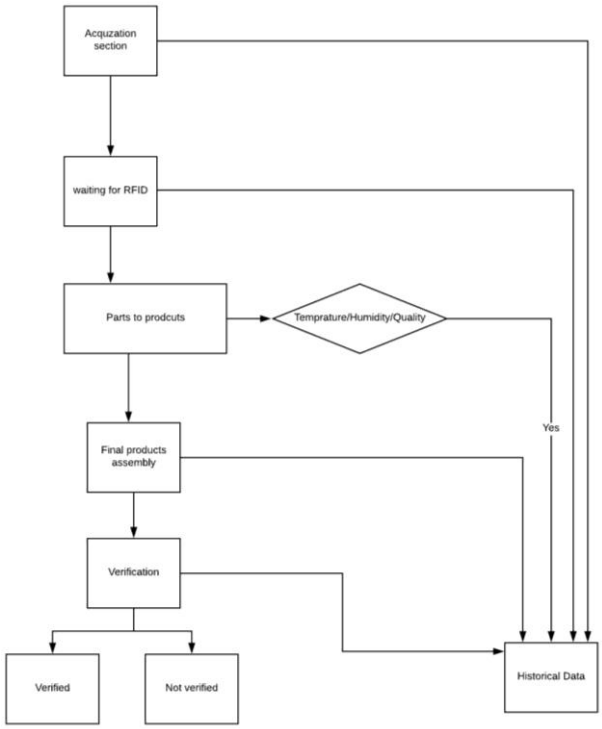


Fig. 4: Flow Chart of the Proposed Model.

This work will help manufactures to make more meaningful decision using analysis based on the data generated using our system. this data now will accumulate and make historical data of company it will be quite big in size to make meaningful analysis using big data approach. With this work the main executive can monitor the work more efficiently as using sensor data it can be stated work is done in which section of assembly unit and in the end the product is verification results are displayed on the executive screen and hence he can take meaningful decision according to the results.

Our work help in maintaining the quality as it keep record of data that is collected from ultra-sonic sensor and this data now can help in quality analysis of product in some specified time range whereas the temperature and moisture sensor help in regulating the range of temperature and moisture where our assembly line would work most efficiently.

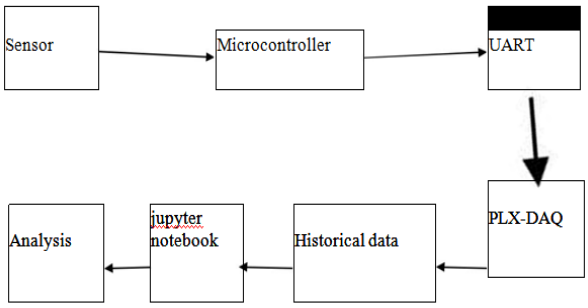


Fig. 5: Block Diagram.

2.2.1. Hardware description

2.2.1.1. PIC16F877A microcontroller

PIC16F887 is the latest microcontroller. It has wide usage, simple set and high calibration. It has wide applications such as, controlling various machineries in industry, machine controlled devices, estimations and so on. It has programming memory of 8k words, 368 Bytes of RAM, Operating frequency 0-20 MHz, 3 counters, A/D converter and Enhanced USART module.

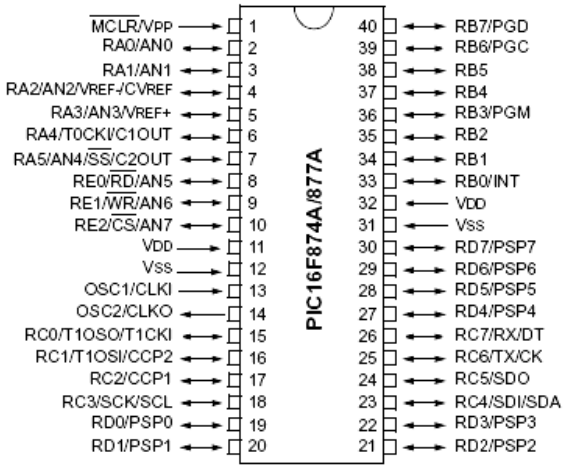


Fig. 6: Pin Diagram of PIC16F877A.

2.2.1.2. Liquid crystal display (LCD)

LCD is an optical device to electronically modulate the properties of liquid crystals. It is a flat screen display. Features include compact, low power consumption and high resolution display screen. Used in TV, monitors and display panels.

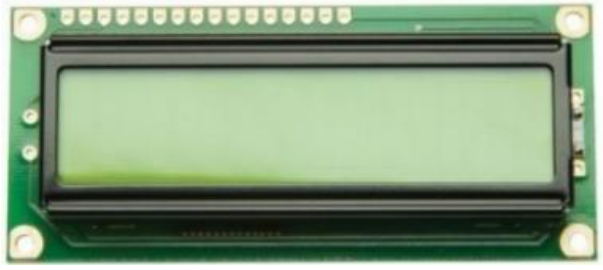


Fig. 7: LCD.

2.2.1.3. Humidity sensor

Electronic sensors measure humidity by estimating the capacitance or protection of air tests. For a capacitive hygrometer, the wind currents in the middle of two metal plates. The adjustment in air dampness straightforwardly corresponding to the adjustment in capacitance between the plates. In a resistive hygrometer, a clay or conductive polymer retains dampness which at that point influences its resistivity is associated with a circuit where the dampness influences the protection of the material. The relative humidity is then decided in view of the adjustment in current.

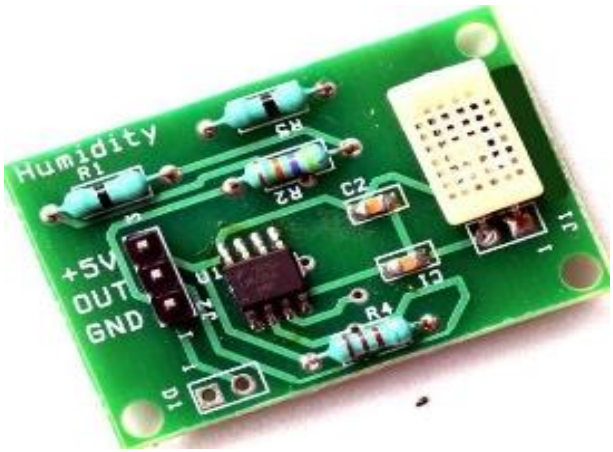


Fig. 8: Humidity Sensor.

2.2.1.4. Temperature sensor (LM35)

LM35 is a temperature measuring devices attached to the microcontroller. It is calibrated directly in Celsius, + 10-mV/°C scale factor, 0.5°C accuracy and rated for full −55°C to 150°C range. It is used for Battery Management and power supplies.

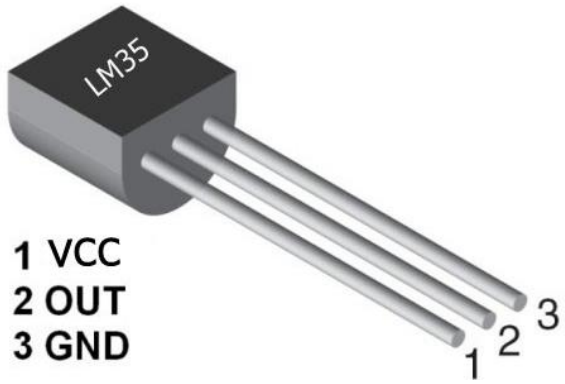


Fig. 9: Temperature Sensor.

2.2.1.5. RFID

A Radio Frequency Identification Reader (RFID reader) is a gadget used to accumulate data from a RFID tag, which is utilized to track singular items. Radio Frequency waves are utilized to exchange information from the tag to a reader. The RFID label it must be inside the scope of a RFID reader, with a specific end goal to be perused. RFID innovation enables a few things to be immediately examined and empowers quick identification of a specific item, notwithstanding when it is encompassed by a few different things.

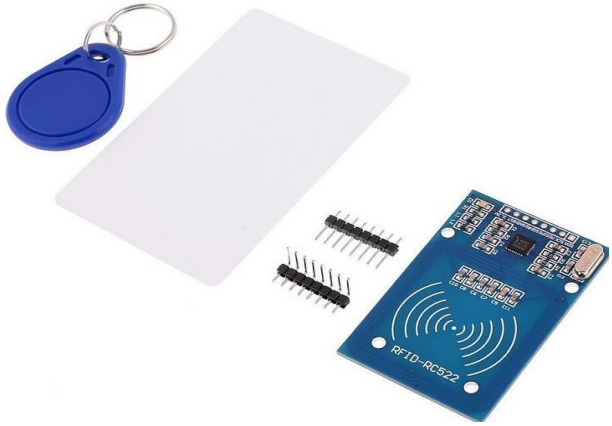


Fig. 10: RFID.

2.2.1.6. Ultra-sonic sensor

The Ultrasonic Sensor conveys a high-frequency sound heartbeat and afterward times to what extent it takes for the reverberate of the sound to reflect back. The sensor has 2 openings on its front. One opening transmits ultrasonic waves, (similar to a little speaker), alternate gets them, (similar to a modest mouthpiece).
The speed of sound is around 341 meters (1100 feet) every second in air. The ultrasonic sensor utilizes this data alongside the time distinction amongst sending and getting the sound heartbeat to decide the separation to a question. It utilizes the accompanying scientific condition:

Separation = Time x Speed of Sound divided by 2

Fig. 11: Ultrasonic Sensor.

2.2.1.7. IR sensor

In this task, the transmitter area incorporates an IR sensor, which transmits consistent IR beams to be gotten by an IR collector module. An IR yield terminal of the collector differs relying on its accepting of IR beams. Since this variety can't be dissected in that capacity, consequently this yield can be encouraged to a comparator circuit. Here an operational speaker (operation amp) of LM 339 is utilized as comparator circuit.

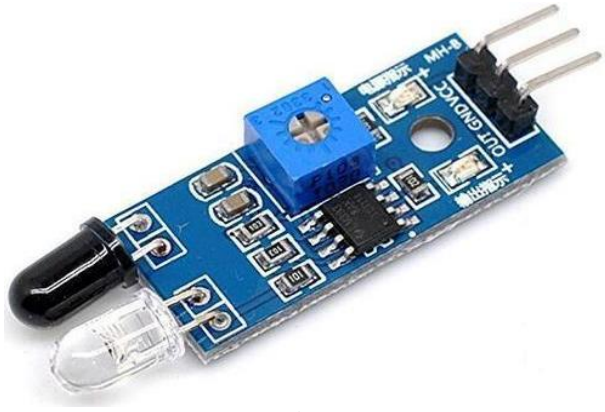


Fig. 12: Infrared Sensor.

2.2.1.8. Step down transformer

The transformers are of two types Step Down and Step up Transformer. Step Up transformer is used to step up the Voltage levels and step down transformers are used to step down the voltage values of the supply line. In our project a step-down transformer has been used to reduce the 230V AC voltage levels to reduced levels, as reduced voltages are required in various IC's used in this project. Primary and secondary coils are present in the transformer. The transformer is designed in such a way that the turns are less in its secondary core, so that the voltage can be reduced to lower levels. The outputs from the secondary coil which is center tapped are the ac values of 0v, 15v and 15v.The full wave rectifier unit is used to perform the conversion of these AC values and DC values.

Fig. 13: Step Down Transformer.

2.2.2. Software description

2.2.2.1. MPLAB

MPLAB is an IDE which is manufactured by the Microchip Technology it is an exclusive free software to do improvement and make application for the PIC controllers produced by Microchip Technology.

2.2.2.2. PLX DAQ

It is a Parallax Data Acquisition tool that help in transferring the data from PIC to laptop excel file and this data get transferred though UART. it can be understood as add-in for Microsoft excel and acquire up to 26 channel of data help in plotting the graph real time as data arrives, record up to 26 column of data, r/w any cell, support com 1-15.

2.2.2.3. Jyupter notebook

It is an open source web application to create that contain live code, equations, visualizations and narrative text and help them to share it. data cleaning, transformation are other uses.

2.2.2.4. Cloudera VM

2.3. Results and discussion

After training the network with data set we made test of machine by dividing it into 2 set of (70% training ,30%test)after testing the network it shown the 99% accuracy .hence we can rely on this network to predict the best team to the appoint job .
After training the we get the accuracy of K-NN classifier on training set :1.00 and accuracy of K-NN classifier on test set :0.99
Accuracy of academic reputation K-NN classifier on training set :1.00 Accuracy of K-NN classifier on test set :0.99
Assembly unit team no. Is [[0.000112]] :6

3. Conclusion

This work showcase an example of how data can be applied industry 4.0and make it more advance and ease the work by making every record in softcopy and storing it in right manner .This data can be then further use for making meaningful analysis .we have used Cloudera as virtual machine to accommodate this big processing further used Jupyter notebook to work with python language by installing few libraries that help in visualizing the data and K-NN classifier algorithm to classify the test input and Predict which class would work best under given circumstances and give best output. Our work will help manufacture to make better decision making and proper monitoring.

This will lead to cost cutting and ease of work and saving time at the same time. Our work will help manufacture to accumulate the data and making this data to train our machine for better analysis. In the meantime, it creates expanding generation information that are discrete, uncorrelated, and difficult to-utilize. In this manner, a proficient investigation strategy is expected to use the priceless information. This work gives a RFID-based generation information examination technique.

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