Quality control challenges post covid-19 crisis: an integrated IoT and IoP approach

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Abstract. The Covid-19 is arguably the biggest pandemic in history and there are a lot of challenges that must be dealt with. One of the biggest challenges post Covid-19 is to tackle quality control challenges. This research paper discusses some of these challenges and solutions using an integrated internet of things (IoT) and internet of protocols (IoP) based approach and further showing its implementation in the industry world and hence, proving to be a solution for damage assessment. With the help of IoT-enabled quality control system, six-sigma rule is also analysed. Post Covid crisis, it is important for every institution to gain back customer trust so quality of materials should be maintained and IoT enables us to do the same. The unification of industrial IoT (IIoT) and industry 4.0 is also discussed as it leads us to understand that this unification is the next evolution of smart manufacturing and digital technologies. This methodology can lead us to accelerated innovation in applications for overcoming the eventual challenges post Covid in the near future. Also, small-scale/ large-scale companies making use of the above research methodology can adhere to six-sigma criterion.

1. Introduction

The researcher intends to build upon the base pre-pat incident assessment model developed in prior publication [1]. Image segmentation technique was used to classify faulty and non-faulty products. To create an integrated internet of things (IoT) and internet of protocols (IoP) based approach to tackle quality control challenges post Covid-19 pandemic and propose its implementation on industrial front and thereby being a pillar of damage assessment use case. It is step in the direction of unification of industrial IoT (IIoT) and Industry 4.0. Our IoT project can be of use to industrial sector and help the industry reach minimal defects. The existing model uses an internet of everything approach discussing the indispensable role of human beings in quality control. It puts forward a smart home system for fail prevention and activity monitoring. It also discussed challenges and solutions of IoT systems at different Open Systems Interconnection (OSI) layers. The existing model is essentially relating to fail-prevention and activity monitoring. Working on a similar but more elaborate model, our project aims to implement quality control in industrial sectors and uploading the quality data over the cloud for further investigation by quality control team. Post Covid-19 crisis, to ensure customer trust and satisfaction it is necessary for conglomerates as well as startups to implement Quality-Control based integrated IoT & IoP approach. The proposed methodology is being referred to as Internet of people (IoP) approach as it incorporates data collection, modelling of the collected data and has wide range of applications in quality control departments. The ultimate objective should be to achieve a zero-defect at the batching plants. Therefore, to adhere to six-sigma rule the industries would find this integrated IoT approach useful. Digitization is essentially need of the hour and we just cannot overlook it. Companies like Larsen & Toubro
have been successful in developing mature IoT solutions such as UbiqWeise™ and iBEMS™ in emerging technology areas for supporting their customers.

2. Literature Review

Even though there exists a widened understanding of the standards of the metadata at both device as well as webwork level, significant obstacles in translating and accessing standards at information and implementation levels have not been taken into consideration. This research paper discussed some of these hurdles and possible explications for IoT based systems in various parts of OSI to understand issues that affect the standards of the system as a whole. With the assistance of IoT-enabled digital applications, the researcher investigates the contribution of semantics in quantifying system data standards, as well as the integration of multi-media data for clinical choice support. The paper also discusses the expansion of IoT on user internet all by installing a human-in-the-loop to increase factuality of the system in consideration. This prototype shift through sensory integration and data analysis could lead to an increase in innovation in overcoming the hurdles of current systems, leading to unparalleled opportunities in management sector [1].

As technology progresses in the classroom step by step, and internet access to the ends of the globe will happen more easily, so the end of the IoT is certainly brighter. Achieving an outstanding network requires development in the current world; in this way, IoT has become an important tool for connecting gadgets. Here, we will discuss the construction of IoT and gateway with detailed description of IoT applications and research projects in the real-world. Also, the formation of layers on wireless sensor networks (WSN). And finally, an overview of the future work on IoT and its use cases will be discussed [2].

IoT is paving the way for a lot of opportunities for numerous implementations that promise to improve the quality of our lives. IoT allows the sense of control across different items with the aid of a network framework in place [3]. Data censuses show that IoT will consist of 50 billion objects or surplus by 2020. Unification of internet to various entities will have unique IP addresses associated with them by which the connection will be established. Embedded entities will have truncated costs, low hardware as well as sparse resources. IoT based structures are not only accountable for sensing items but also for retaliating to any received instruction or carrying out actions. IoT based structures have less complexity with better space parameters and uncomplicated framework. It plays a crucial role in providing dependable and safe environment and it also assists in maintaining expected living expectations [4].

The challenges and opportunities of National Dedicated Ethernet will be discussed within the new ecosystem of physical production systems, IoT and big data management. New production techniques, for example 3D printing will allow for timely production of low numbers of different customized parts for the needs of any customer. The factors of NDE fidelity and the effect of a human factor should be reconsidered. New handheld devices based on tablet computers will be used to make NDE available and accessible to anyone. As a benefit, product testing at home can be an additional tool to monitor a product’s life cycle. This could significantly increase NDE acceptance by solving new testing problems for the full-day service. NDE will switch to NDE 4.0 for Industry 4.0 [5].

While there are many definitions of IoT, those related to industrial use explicitly specify the types of smart devices incorporated into common objects so that those devices can be counted as IoT devices, and form elements of cyber-physical systems (CPS). The three correct explanations are:

- The definition of an IoT can be "a group of infrastructure, connecting and connecting objects, data mining and access to the data they produce" where the connected objects are a "sensor (s) and / or actuator (s) specific function that can communicate with other devices". [6]
- The terms ‘Internet of Things’ and ‘IoT’ refer mainly to “expanding network connectivity and computer use to objects, devices, sensors, and objects that can be considered computers in general. The above discussed “smart things” require negligible human intervention to produce, exchange, and use data; often include connections to remotely collect information, analysis, and administration”
- “IoT represents a state in which everything or 'something' is embedded in the senses and is able to automatically connect its state to other objects and systems within the environment. Each item represents a location in the virtual network, continuously transmitting large amounts of data about it and its surroundings” [6].
3. Methodology

**FIG 1: Process Flow**

**STEP 1:** Carrying out the MATLAB analysis which supplies us with a binary defect value of 1 or 0 depending on whether the pixels mapped onto reference image or not. [1] The entire process flow is depicted in figure 1.

**STEP 2:** Inputting the binary value into the tinkercad circuitry using a simple slide switch and displaying it on 16*2 LCD display as depicted in figure 2. When the slide switch is “OFF”, the LCD display shows optimum item upon testing and simultaneously the value fed to ESP8266 module is “1”. Now, slide switch is turned “ON” which turns on the red LED (defect indicator). The relay module is utilized for control switching. The backlight of the LCD module is turned “ON” and it indicates defective item. The ESP8266 WiFi module is fed with value “0” which can be visualized in ThingSpeak cloud channel.

**FIG 2: Tinkercad circuit**
STEP 3: Uploading the data on ThingSpeak cloud using the ESP8266 WiFi Module utilized in the project.

STEP 4: The tinkercad circuitry for varying positions of slide switch is depicted in figure 3 and figure 4. This is "App development phase" where the researcher aims to show the output obtained in ThingSpeak cloud in the form
of a simple application which requires login credentials and once the personnel is logged in they may view the defect data. Also, they may send SMS notification to the quality control team. The app developed using App Inventor is easily able to fetch the data uploaded on cloud on a periodic basis. It also ensures data security by asking the user for login credentials to view defect data.

4. Results and Discussion

We can conclude that optimum results have been obtained as per initial expectations. The results obtained in Tinkercad, ThingSpeak cloud, Matlab and Appdev are synonymous with expected outputs. For an assembly of products, as per experimental results the researcher concludes that based on image segmentation technique and cloud analytics the methodology can correctly identify defective products with close to ninety-five percentage accuracy, thereby adhering to quality-control objectives. The defect value analysis for the prototype can be understood from kink-shaped curve obtained in figure 6. Our IIoT and IoP based project can be of use to industrial sector and help the industry reach minimal defects. The challenges that we faced during this project are as follows:

1. Using PROTEUS software may not be ideal as ESP8266 WiFi Module is not provided inbuilt as part of the software.
2. The circuit may cease to work even if there exists a minute error in wire connections in Tinkercad.
3. App development phase is relatively challenging and at every subsequent step debugging is required. Here, two apps were developed: first one using flutter(java) and other one using “app inventor.” As the latter one gave better results and turned out to be bug-free we went ahead with it.

![FIG 6: Quality Control app results and SMS notifier](image)

5. Conclusion

In this paper, smart quality check for industrial manufacturing processes is proposed which is the advancement technology of the literature survey works. It will assist the users, manufacturers and the second-hand buyers who require feedback on their product or to check whether their defect value falls within the upper control limit (UCL) and lower control limit (LCL). In future, this methodology can be used for detecting defects in an assembly of products and uploaded data can be analyzed by the quality control team at the respective plant. The proposed quality control system can be operated by anyone who holds knowledge about matlab software and cloud analytics.

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