SMART STATION IMPLEMENTATION FOR SMART MANUFACTURING - RIGHT AT FIRST TIME

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Abstract

Smart station is the implementation of Industry 4.0 to a manufacturing company to make the system transparent and interlinked at each stage which reduces error to zero level, develops a user friendly interface and communicates with operator and other machine. It mainly works on the concept of Internet of Things(IOT)which means whole system is interlinked by internet connectivity with which all incoming data and outgoing data is recorded and shared with other systems in line. Smart station is guiding system of process flow of industry and acts as pika-pika system of a manual work station which guides what to pick and which one to pick first (material),eliminating the chances of error and rework. It monitors the process flow of the work station, improves productivity by estimating time of each process completion, manages multiple data sharing with other system, records the information of process and product also information transparency, provides mapping of real time performance and productivity, and displays statistical evaluation of all output and points of improvement and preventive actions.Smart station can also be referred as one quality system which assures quality at first time by single quality method with the help of sensors, display system, gauges etc.

Keywords: Smart, system, Internet of things, quality, machine, smart factory.

1. Introduction

Industry 4.0 has become a new industrial stage in which several new developing technologies are converging to provide digital solutions for one quality system as studied by Walster (2013) [4]. These new developing technologies include smart manufacturing, smart factory, smart product, smart supply chain and smart working with base technologies consisting internet of things, cloud service applications, big data analytics and machine human communication according to Frank(2019) [1].Wang (2016) described the fact that for Industry 4.0toarisetrue,itisvitaltoimplementthehorizontala malgamation ofinter-corporationvaluenetwork,theendwiseincorporationofengineeringvaluechain,andtheverticalintegrationofmanufacturing factory inside [2].The smart factory is a boundless exposure of future developments in manufacturing and production facilities [3].

1.1 What is smart station?

Smart station is the concept of 'Right at first time' and all errors are controlled with a system that communicates with operator with sensing and monitoring tools and guides him to do right task in right time in right way.Smart Station is the integration of manufacturing operations and Industrial internet of Things (IIOT), to monitor the process flow, improve productivity, manage multiple data sharing and store the information of process and information transparency. With smart station, performance can be mapped in real time and evaluated for better and improved production output.

2.Elementsof Smart Station

Constituents of smart station are the elements whichassociate to make smart station systemthatare described as hardware systems.

2.1 Touch screen

The monitor or display which will be screening all data related activities, parts and tools to be used in the operation, operator info, dashboard and various work related info like activity completed, which activity needs to be completed at what time or the info as demanded by the client. Touch screen adds the flexibility for the user to operate it and see the required information.

2.2 Scanner

Scanner is the 2D barcode scanner for the parts which contain barcode and QR code, and laser scanner for the parts on which laser marking is done for its unique identity. With the scanning of the unique identity of the part the system get all details regarding the activities related to it that is to be performed and its brotherly components.

2.3 Sensor

Sensor is the device which observes and experiences the change in physical environment regarding temp, distance, vibration etc. and converts it into specific attribute [5].

2.3.1 Photoelectric Curtain sensors

A photoelectric sensoror a photo sensor is an apparatus used to determine the distance, nonappearance, or existence of an object by using a photo light transmitter, with infrared, or a photoelectric receiver. They are mostly used in industrial manufacturing. Three types are: a through beam type, retro-reflective type, and diffused type.Curtain sensor is the through beam type photoelectric sensor, which glows for indication of part picking and detection of obstruction incoming.

2.3.2 PIR sensor

Passive infrared sensor is the motion sensor that is used to determine the presence and positioning of tool placed. All substances with a temperature above absolute zero, emits heat energy in the form of radiation. Typically this radiation isn't visible to the human eye because it radiates at infrared wavelengths, but it can be distinguished by electronic devices intended for such a purpose.

The word passive in this occasion refers that PIR devices do not emit energy for detection or revealing purposes. They work absolutely by perceiving infrared radiation emitted by or reflected from objects.

2.3.3 Level sensor

Level sensors sense the level of oil, fuel and other fluids. The substance to be measured can be inside a vessel or can be in its ordinary form. The level dimension can either be continuous or point values. Continuous level sensor measures level within a definite range and conclude the exact amount of matter in a certain place or vessel, while point-level sensor only specify whether the fluid is above or below the sensing point. Normally the latter one detects levels that are excessively high or low.

2.4 Machine Vision Camera

Machine vision is the inspection or examinationtechnology and quality system used to deliver image-based automatic inspection, analysis and evaluation for such applications as automatic inspection, process quality control, and robot supervision, usually in industry. Machine vision is a term uniting a large number of technologies, hardware and software products, integrated systems, methods and expertise. Machine vision as a systems engineering castigation can be considered diverse from computer vision, a form of computer science. It attempts to assimilate existing technologies in new ways and apply them to solve real world problems [8].

2.5Tower light

Stack lights or tower light or warning light are generally used on apparatusor machine in manufacturing plant and progression control environments to deliver visual and audible signs of a machine working or non-working state or process status to machine operators, in-charge technicians, area manager, production manager and industry personnel. Divisions of stack light in any grouping of (normally) red, yellow, green and blue are actuated independently and are either total off, continuous-on or blinking.Towerlight is a passive device that may be controlled straight by programmable logic controllers, PC control systems, distributed control systems or hardwired to system controls such as timers, sensors, limit switches and latching relays.

3. Implementation of smart station

3.1 On screen SOPs Display

A screen (touch or non touch) is provided for the display of SOPs(standard operating procedure) along with the option to see the OPL(one point lesson) and safety instructions on need. With the linking of ERP to the smart system, the data from previous process is fetched out and screen starts displaying the operating procedure for current product to be made on the station.

3.2 Controlled selection of material and tools

Smart station consists of rack which is in the form of shooter. Rack contains bins of different sizes sometimes as required containing parts of the product. Each bin is provided with photoelectric sensors at the sides. Curtain sensors are used for controlling the picking of material from right bin according to sequence.If the material is not picked or wrong picked as per notification, then alarm will generate and line will stop. Indicators are provided with tool holding board along with position sensor which guides the operator which tool is to be picked and when is the right time to use [6]. Display of SOPs and OPL will guide the operator to do the right work in right way at right time.

3.3 Streamlining the ANDON system

Station status information is shown based on real time problem at the station allowing production manager to quickly identify and resolve operational challenges.Andon is the system for alarming the status of the station whether working or non-working, which is identified by stack light. Stack light also known as tower light is a three colored light which is interlinked to the conveyor line and stops the line from moving when station is under some issue, which may be maintenance, logistics or any other material related delay. Streamlining the ANDON system will give result of all stations at a conveyor line which can be monitored at control room [7].

3.4 Online travel card

Travel card is a physical paper information of the product which consists specific product requirements which has to be completed during whole manufacturing process of the product in the plant. It travels with the product which needs to be validated and signed by the operator. With the online travel card, the data will automatically be validated at the system and no human intervention will be needed.

3.5 Work monitoring

The processes done at the station can be monitored on real time basis by sitting at a control centre, thus process can be analysed and work balancing can be improved.Real-time monitoring is possibleforequipment and machine to forecast possible quality issues and evaluate performance.

3.6 Guiding operator

Sensors are used to guide the operator for part picking and make sure the operation has been completed. Sensors senses the presence of human hand in its range and proceeds the opertion further. In this we will be using two types of sensors: photoelectric and infrared sensors.

3.7 Inventory status tracking

Sensors to track real-time movements and locations of raw materials, work-in progress and finished goods, and calculate value of tooling if any tool is on maintenance or any other status. Inventory can be tracked by placing detectors at the incoming which auto-scans the material and record it in the system. Analytics is done to optimize inventory on hand and automatically generate signal for replenishment or delay.

3.8 Assuring Quality

Quality testing using optical-based analytics and machine vision based evaluation along with real-time equipment and machine monitoring to forecastpossible quality issues. Using machine vision type inspection systems assures the quality of the product.

3.9 Preventive and Predictive Maintenance

Augmented reality to assist and guide maintenance personnel in repairing and maintaining equipment and to see the potential causes of failure and their preventive measures. Sensors mounted on equipment or system to initiate predictive, preventive and cognitive maintenance analytics.

3.10 WorkSafety

Work safety is ensured by sensors to defensetreacherous equipment from functioning in close proximity to personnel and sensors on

staffs to monitor environmental circumstances, lack of motion, or other potential threats.

4. Conclusion

Smart station is the first time right solution for manufacturing plant to obtain zero defect and zero rework manufacturing. Each work station can be linked to a central control system to observe the status and data of production, and other required features. Smart station provides automation i.e. sequencing and controlling the operations, monitoring i.e. Performance can be monitored and evaluated leading to transparency, tracking i.e. availability and capacity can measured. Key points achieved by the implementation of smart station are:

- Defective material can be count.
- Rework can be identified and reduced.
- Proper sequence of operations is maintained on real time basis.
- Skipping of operations is eliminated.
- Line balancing is improved.
- Material requirement on the station can be tracked.
- Predictive maintenance.
- Any problem on the station related to quality or tool repair can be identified and recovered.
- More safety will be obtained.
- Asset management.

Thus, implementing a system equipped with sensors and wireless network connections will benefit the manufacturing factory, increase the profit and will lead to goal achievement of Industry 4.0 equipped industry or smart factory.

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