AS220483.docx

by

Submission date: 21-Apr-2023 06:03PM (UTC+1000)
Submission ID: 2071131817
File name: AS220483.docx (519.58K)
Word count: 3437
Character count: 18995

ADVANCED MEASUREMENT SYSTEMS AND DATA ANALYSIS

Table of Contents

1. Introduction

This project is based on advanced measurement systems as well as data analysis. Typically, the technique of "data analysis" can describe the process of accumulating raw data. This raw data can be converted into information, which is very useful for the users to make decisions. The advanced measurement approach can include various factors such as ***"internal loss data and external loss data"***, ***"business environment as well as risk scenarios"*** and even ***"internal control factors"*** that can be addressed via risk as well as ***"control self-assessments"*** and ***"Key risk indicators"***.

Different tasks can be performed in order to fulfil the entire criteria, which are provided in this project. In this particular project, the assignment describes the substantial investments within the automated machine implements in the specific company. This company can make a plan regarding developing a smart factory in order to change its manufacturing procedure for ***"future industry 4.0".*** The present scenario of the company relies on "measurement technology" and to improve this technology the company can employ cooperative robots with different sensors as well as smart devices which can be used on a specific n Industrial platform of the ***"Internet of Things"***.

2. Task 1

The assignment of the project describes the present scenario of the company, which is substantial investments within the tools of the automated machine. This specific company can produce an effective plan concerning developing the smart factory in order to modify its manufacturing process for ***"future industry 4.0".*** Moreover, the current scenario of the company depends on the specified "measurement technology" as well as to enhance this technology the company can utilise cooperative robots along with additional sensors as well as smart devices which can be utilised on a specific platform of the ***"Industrial Internet of Things"*** in order to upgrade the entire activities of the company. To perform the entire task or activity the company is required an efficacious technology for gathering the information, which is associated with the company (Huang *et al*. 2021).

The company has discovered an effective solution to resolve several issues as well as developed a primary measurement solution, which can help the company completely. The company has selected very efficacious technology, which is CMM technology that can assist to solve several issues. A ***"coordinate measuring machine",*** also comprehended as a ***"CMM"***, exists as a part of the equipment, which can calculate the geometries alongside the physical objects (Flores *et al*. 2019). Moreover, “CMMs” can utilise a specific “probing system” in order to identify the discreet points, which are based on the textures of the distinct objects. “CMMs” are included three major components such as the “machine itself”, the “calculating probe”, as well as the computing or control of the entire system along with proper measuring software. Therefore, by identifying the work piece which can be indicated on the specific machine table, the probe can be employed in order to compute various points which depend on it with the help of the mapping of the ***“x, y, z coordinates”***.

The total coordinate computing machines can work in an identical way: as well as the probe connects the different attributes of the particular entity to be calculated, and even the work alongside the structure exists recorded. The ***“Managing Director (MD)”*** of the company has provided a specific task, which can develop the modern ***“CMM technology”*** as well as can show the various types of this technology and even describe the working process of this technique. Hence, the ***“Capability Maturity Model (CMM)”*** of this technology can deliver a specific framework for managing these kinds of evolutionary stages into 5 maturity levels which can lay subsequent foundations for successive process advancement (Urban *et al*. 2020). The benefit of the “coordinate measuring machine (CMM)” is nothing but measuring objects that are tough to gauge with different measuring engines with higher precision. For instance, it is complex to measure the 2D coordinates linked to a detailed point

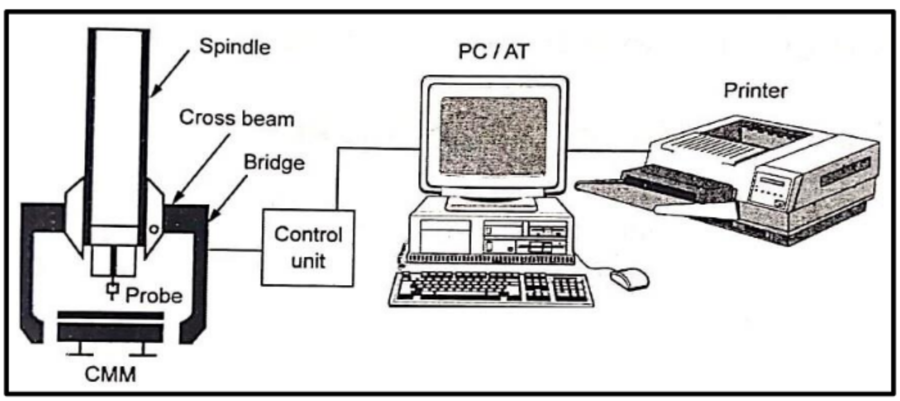

Figure 2.1: CMM technology

(Source: Härtig *et al*. 2019)

This “CMM” can produce its appearance within the stipulated time, which is the 60s. Accordingly, a ***“coordinate measuring machine (CMM)”*** can operate in an identical way to the finger of a human when it can imprints map coordinates; as well as its 3 different axes can build the coordinate system of the machine. By changing a finger, the "CMM" can utilize a particular probe in order to estimate points, which rely on the workpiece. However, each point, which can be shown on a work piece, exists as unique to the coordinate system of the machine (Ma *et al*. 2019).

The major benefit of ***"a coordinate measuring machine (CMM)"*** is to compute various items, which are complex in order to estimate and can compare with different machines in order to check high accuracy. With the help of the "***coordinate measuring machine (CMM)" technology,*** it can be measured the most extensive general linear dimension which is based on different components that can be manufactured by this specific company and the dimension limit is ***"400 mm".*** In the company***,*** the primary products exist turned as well as milled elements, along with batch dimensions within the hundreds as well as the substantial numeral of attributes with patience within the specific region, which a value is ***"25 μm"***. Besides these, the ***"surface roughness (Ra)"*** can show a specific range from ***"12.5 to 0.025 μm".*** With the help of effective measurement techniques, the ***"CMM technology"*** can enhance the total measurement as well as product quality in the company (Härtig *et al*. 2019).

3. Task 2

As per the requirement of the project, this part of the project is responsible for making an analysis of the implementation of the "Sensors for manufacturing process" and "Industrial Internet of Things" for demonstrating its key principle, and operational procedure along with providing an explanation for the typical performance and limitations (Ghahramani *et al*. 2020).

3.1 Sensors for manufacturing process

3.1.1 Overview

Manufacturing sensors are responsible to be operated in fact accession to gauge material necessities on a device. They comprise a contrivance that acquires or gauges inputs and begets an output in data. This information is able to be utilized to initiate a machine response, or it is able to be operated to gather data for reckoning and dealing with the repository. Industrial sensors are responsible for getting existing for a comprehensive capacity related to the dimensions classes.

3.1.2 Operating Principles of Sensors

The sensing principle associated with a manufacturing sensor is established on modifications in the distinguishing optical indication related to a visual platform resulting from interchanges with “analyte molecules”, which are further deciphered into qualitative or quantitative measurements. Today, smart detectors are able to disseminate data to the boundary of the cloud where it acts as a competent appliance or platform that can deal with and investigate it, preceding it being transmitted to the cloud (Kalsoom *et al*. 2020).

3.1.3 Characteristics of the Sensors

Necessary static features of sensors comprise resolution, sensitivity, zero drift, linearity, and range, full-scale drift, reproducibility and repeatability. Sensitivity is nothing but the dimensions linked to the modification in the output of the detector compared to a unit transformation in the input. This data is able to be enabled with its action ability, whether that is able to be colonizing a display dashboard, activating a supervision entreaty, or thoroughly gathering data for chronological breakdown.

3.1.4 Example of applications

Some common examples are the Piezo accelerometer, Microphone, Hall, magnetometer, search coil, MEMS accelerometer, Infrared thermography and Particle monitor. Among them, some are capable of detecting debris related to wear along with handling other tasks (Gaikwad *et al*. 2020).

3.1.5 Limitations

- Data are able to be misconceived, guiding deceitful maintenance entreaties,
- It is expensive to designate an exclusive IoT technique using sensors, transmission expenditures and estimation when handling this kind of sensor.
- Predictive analysis sensors might not assume contextual details into a narrative, like a tool's age or weather,

3.2 Industrial Internet of Things

3.2.1 Overview

The “Industrial Internet of Things” guides corresponding instruments and sensors along with other contraptions networked concurrently with devices’ industrial machines, comprising energy and manufacturing surveillance. With the utilization of IIoT, industrial enterprises will become able to digitize their operational processes, remake company models, and enhance interpretation and productivity, while lowering waste (Malik *et al*. 2021).

3.2.2 Operating Principles of IIOT

- Be passionately compulsive about consumer ventures.
- Creating flawless knowledge across all channels and scaffolds.

- Identifying characteristics that might beget while keeping the most acceleration in developing "upward growth patterns".
- Disrupting the "value chain" with the help of making exploration of the "HOT products" along with its services.
- The IIOT systems are responsible for performing a lot of commissions, like computation, communication, and sensing along with actuation, which is demanded to gather and manage data inside the IoT backdrop (Serror *et al*. 2020).

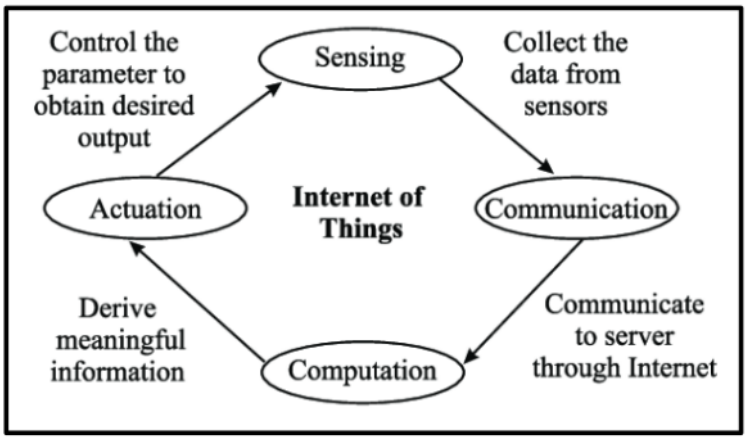

Figure 3.1.2: Attributes of IIOT

(Source: Härtig *et al*. 2019)

3.2.3 Characteristics of the IIOT

- This is responsible for managing accurate management of operating processes.
- Further, it is responsible for providing enormously protected implementations.
- These devices are fast while flexible as well.
- IIOT devices provide almost zero lag during dealing with the response time.

3.2.4 Example of applications

The numerous preeminent examples associated with the "Industrial Internet of Things" devices in the process of manufacturing are "mechanization", "remote monitoring", "supply chain optimization", "digital twins", and "predictive maintenance". Robots, computers, administration procedures and ERP are specifically a few of the instances related to industrial technology.

3.2.5 Limitations

IIoT systems are responsible for usually relying on “proprietary technologies and protocols”, driving it problematic for dissimilar systems in order to make communication and exchange facts. This is capable of limiting the flexibility and scalability associated with IIoT approaches and advancing the expense of executing and sustaining them. This is mentionable that, the more additional devices are being connected to the Internet, the greater the menace to dealing with virtual invasions. These incursions are able to compromise crucial and prudent facts and even control machinery from performing entirely (Qiu *et al*. 2020).

4. Task 3

This part of the project is responsible for making an analysis on the basis of the implementation of the Matlab platform in order to deal with the scenario of the incorporating least squares algorithm. This part of the project is indicating about the scenario, in which this is inevitable that the calculation of the centre and radius associated with the circular features have been accomplished. This is mentionable that, the “least squares method” is nothing but a statistical procedure that is able to discover the most suitable fit for a group of information points by reducing the aggregate of the residuals or offsets of attributes from the devised curve. Apart from that, Least squares regression is employed in order to indicate and prognosis the behaviour related to the dependent variables.

Depending on the need, certain code is executed in the script window in order to perform the task as per the requirement of the project. As per the requirement, the standard uncertainty associated with the variables named x and y coordinates has been taken as 15 μm. On the other hand, the code is able to generate the required graph based on the current scenario, which can further analyse the code.

```
%% Curve fitting with least square method and \
close all; clearvars

xx = (0:10)';
yy = [2.29 1.89 1.09 0.230 -0.801 -1.56 -2.18 -2.45 ...
    -2.29 -1.75 -1.01]'; plot(xx, yy, 'linewidth', 2), hold on

EE = [ones(size(xx)) sin(0.4*xx)  cos(0.4*xx) ]; a = EE\yy;
YY = [ones(size(xx)) sin(0.4*xx)  cos(0.4*xx)]*a; plot(xx, YY, 'kh-')
title('Curve fitting with LS method')
JJ=sum((EE*a-yy).^2); SS=sum((yy-mean(yy)).^2); R_s_q=1-JJ/SS;
clear xx; syms xx; a1=num2str(a(1)); a2=num2str(a(2)); a3=num2str(a(3));
R_s_q=num2str(R_s_q); yt=a1+a2*sin(0.4*xx)+a3*cos(0.4*xx) %#ok
gtext({'yt=a1+a2*sin(0.4*x)+a3*cos(0.4*x)'})
gtext({'a1 ='}); gtext(a1)
gtext({'a2 ='}); gtext(a2)
gtext({'a2 ='}); gtext(a2)
gtext({'R^2 ='}); gtext(R_s_q)
legend('Raw data', 'Fit model', 0), hold off
```

Figure 4.1: Fitting with the Least Square Method

(Source: Self-Created using Matlab Platform)

On the basis of the need, in the forest step, the curves get fitted with the implementation of the LS method while in the further step, the model has been fit into the platform in order to generate the required graph.

```
%% Combinatorial curve fitting
clearvars, close all
tt = [0 0.25 0.75 1.05 1.50 2.25 2.5 2.75 3.0 3.25]';
yy = [1.85 1.75 1.66 1.63 1.58 1.52 1.45 1.5 1.56 1.64]';
EE = [ones(size(tt)) exp(-tt) exp(-2*tt)]; c = EE\yy
TT = (0:0.125:3.25)'; YY = [ones(size(TT)) exp(-TT) exp(-2*TT)
plot(tt,yy,'o', TT,YY,'-'), hold on, legend('Data', 'Fit model
JJ=sum((EE*c-yy).^2);
SS=sum((yy-mean(yy)).^2);
R_s_q=1-JJ/SS;
clear tt; syms tt
c_1=num2str(c(1)); c_2=num2str(c(2)); c_3=num2str(c(3));
R_s_q=num2str(R_s_q); yt=c_1+c_2*exp(-tt)+c_3*exp(-2*tt)
gtext({'yt=c1+c2*e^-^t+c3*e^-^2^t;'})
gtext({'c1 ='}); gtext(c_1)
gtext({'c2 ='}); gtext(c_2)
gtext({'c3 ='}); gtext(c_3)
gtext({'R^2 ='}); gtext(R_s_q)
clear tt
```

Figure 4.2: Combinatorial Curve Fitting

(Source: Self-Created using Matlab Platform)

In the further step, the curve gets fit depending on the scenario, in which the data get implemented to fit the model.

```
%% Power fit model
tt = [0 0.25 0.75 1.05 1.50 2.25 2.5 2.75 3.0 3.25]';
yy = [1.85 1.75 1.66 1.63 1.58 1.52 1.45 1.5 1.56 1.64]';
EE = [ones(size(tt)) tt tt.^3.5]; c = EE\yy
YY=[ones(size(TT)) TT  TT.^3.5]*c; plot(tt,yy,'o',TT, YY, 'md:'), legend('Data', 'Fit model')
JJ=sum((EE*c-yy).^2); SS=sum((yy-mean(yy)).^2); R_s_q=1-JJ/SS;
clear tt; syms tt
c_1=num2str(c(1)); c_2=num2str(c(2)); c_3=num2str(c(3));
R_s_q=num2str(R_s_q); yt=c_1+c_2*tt+c_3*tt^3.5
gtext({'yt=c1+c2*t+c3*t^3^.^5 ;'})
gtext({'c1 ='}); gtext(c_1)
gtext({'c2 ='}); gtext(c_2)
gtext({'c3 ='}); gtext(c_3); gtext({'R^2 ='}); gtext(R_s_q)
```

Figure 4.3: Power Fit Model

(Source: Self-Created using Matlab Platform)

Depending on the need, a concise IDL operation is devised to fit the attributes associated with the model operating full covariance details, without or with handling the covariance matrix.

```
%% Polynomial fit model
tt = [0 0.25 0.75 1.05 1.50 2.25 2.5 2.75 3.0 3.25]';
yy = [1.85 1.75 1.66 1.63 1.58 1.52 1.45 1.5 1.56 1.64]';
EE = [ones(size(tt)) tt.^2 ]; a = EE\yy
YY = [ones(size(TT))  TT.^2]*a;
plot(tt,yy,'o',TT, YY, 'kh--'), legend('Data', 'Fit model'),
JJ=sum((EE*a-yy).^2); SS=sum((yy-mean(yy)).^2);
R_s_q=1-JJ/SS;
clear tt; syms tt; a1=num2str(a(1)); a2=num2str(a(2));
R_s_q=num2str(R_s_q); yt=a1+a2*tt^2
gtext({'yt=a1+a2*t^2;'});
gtext({'a1 ='}); gtext(a1); gtext({'a2 ='}); gtext(a2)
gtext({'R^2 ='}); gtext(R_s_q)
legend('Data', 'Exponential', 'Power', 'Polynomial', 0)
title('Curve fitting with LS method')
```

Figure 4.4: Polynomial Fit Model

(Source: Self-Created using Matlab Platform)

Furthermore, the code has been added in order to perform the task for the development of the polynomial fit model. Based on the need of the project, the delivered values have been added in order to test the model while as well checking the generated graph.

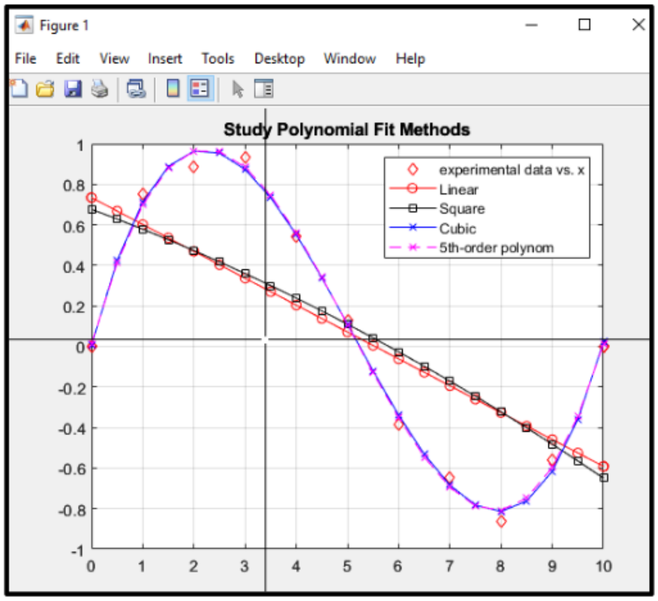

Figure 4.5: Generated Curve

(Source: Self-Created using Matlab Platform)

Here, in this part of the project, the output graph has been generated based on the provided data. This is mentionable that, the graph is primarily based on studying the Polynomkial Fit model depending on the given scenario.

5. Discussions

The Previous task, which is related to the company's substantial investment, has been shown within the automated machine implements. The Managing director has taken the help of effective CMM technology in order to develop the entire task of the company. The company has used this exhaustive platform of the ***"Industrial Internet of Things"*** in order to boost the entire activities of the company with the help of the "additional sensors as well as smart devices". With the help of the CMM technology, it can be checked higher accuracy of the various components that have been analysed with different machines. A ***"coordinate measuring machine (CMM)"*** has been operated in an equivalent way to the finger of a human when it can tracks map coordinates; as well as its 3 additional axes can produce the coordinate system of the machine.

By adjusting a finger, the "CMM" can employ a particular probe in order to evaluate points which lean on the workpiece. With the help of the ***"coordinate measuring machine (CMM)"*** technology, it has been estimated the most extensive available linear dimension that is founded on distinct components that can be fabricated by this exhaustive company. The second task has analysed two major different topics "Sensors for manufacturing process" and "Industrial Internet of Things" that have described the functional procedure as well as a key principle of these two topics. It has utilised "Manufacturing sensors" which exist accountable for getting performed in fact acquisition to the gauge material essentials on the device. Such kind of information exists able and have utilized in order to start a response of the machine, and it exists as capable to be conducted to accumulate data for numbering as well as dealing along with the warehouse.

Moreover, Industrial sensors exist accountable for acquiring existing comprehensive abilities, which are associated with the dimensions classes. The sensing regulation, which is associated with a "manufacturing sensor", exists as specified on transformations within the specific optical indication, which is related to the visual platform and can show the result from interchanges along with ***"analyte molecules"***, which exist additional deciphered into the quantitative as well as qualitative measurements. The ***"Industrial Internet of Things"*** has been guided by interconnected instruments as well as sensors along with further devices networked together along with devices which are industrial machines, including energy as well as manufacturing surveillance.

The IIOT has been shown different functional parts as it has created perfect knowledge regarding all channels as well as scaffolds. It has been identified that, different characteristics that can beget but have kept the useful acceleration in materialising ***"upward growth patterns".*** Consequently, the IIOT systems exist accountable in order to perform plenty of commissions, such as sensing, communication, and computation as well as actuation, which exists demanded in order to accumulate as well as manage information within the "IoT backdrop" (Khalil *et al*. 2021). The last task of this assignment is accountable for producing an effective analysis, which is based on the performance of the "Matlab platform" to negotiate with the present scenario alongside the incorporating most biased squares algorithm. It has been analyzed the "least squares method" to perform the whole task as well as the "statistical Procedure" is explained in order to find the group of effective information in order to reduce the entirety alongside the residuals and offsets of the features from the improvised curve.

Further, in task 3, this is inevitable that the analysis related to the centre and radius associated with the circular elements have been executed. The "least squares method" is nothing but a statistical methodology that is capable of discovering the most appropriate fit for a gathering of information points by lowering the aggregate associated with the residuals or offsets of attributes from the devised curve.

6. Conclusions

In a nutshell, this can be mentioned that the overall task has been performed with the help of proper understanding and gets demonstrated as per the requirement in this report work. In the first step, depending on the provided scenario, the usage of the CMM technology has been documented while the implementation depending on the reliability inside the company also has been discussed. Furthermore, in task 2, IIOT and Sensors for the manufacturing process have been discussed. The section has demonstrated the Piezo accelerometer, Microphone, Hall, magnetometer, search coil, MEMS accelerometer, Infrared thermography and Particle monitor are some common examples of the sensors.

On the other hand, for both cases, the operation principles along with their attributes as well have been explained. Apart from that, for IIOT this has been identified that there are some limitations associated with it as IIoT systems are dealing with "proprietary technologies and protocols", perhaps they limit the flexibility and scalability associated with IIoT approaches. Furthermore, task 3 is responsible for dealing with the development of a "least squares algorithm" in the Matlab platform. Here, the software platform gets utilized in order to meet the requirement with the reduction in the measurement uncertainties. As per the necessity of this particular project, there are two major implementation topic is required to complete the task. These two topics are ***"Sensors for manufacturing process"*** and ***"Industrial Internet of Things"*** which can describe the operational part as well as key principal of the company in order to make an effective "measurement technology".

References

Flores, R.M., Wang, G., Qin, D., Xi, Y. and Rukstales, L.R., 2019. Advancing CMM drainage, quality, and utilization with horizontal directional-drilled boreholes in Duanshi Coal Mine, southern Qinshui Basin, China. *International Journal of Coal Geology*, *209*, pp.1-13.

Gaikwad, A., Yavari, R., Montazeri, M., Cole, K., Bian, L. and Rao, P., 2020. Toward the digital twin of additive manufacturing: Integrating thermal simulations, sensing, and analytics to detect process faults. IISE Transactions, 52(11), pp.1204-1217.

Ghahramani, M., Qiao, Y., Zhou, M.C., O'Hagan, A. and Sweeney, J., 2020. AI-based modeling and data-driven evaluation for smart manufacturing processes. IEEE/CAA Journal of Automatica Sinica, 7(4), pp.1026-1037.

Härtig, F. and Stein, M., 2019. 3D involute gear evaluation–Part I: Workpiece coordinates. *Measurement*, *134*, pp.569-573.

Huang, T.W. and Sheu, D.Y., 2020. Micro ball-ended tips stylus fabrication with pipe-electrode by micro-EDM process. *Procedia CIRP*, *95*, pp.590-593.

Kalsoom, T., Ramzan, N., Ahmed, S. and Ur-Rehman, M., 2020. Advances in sensor technologies in the era of smart factory and industry 4.0. Sensors, 20(23), p.6783.

Khalil, R.A., Saeed, N., Masood, M., Fard, Y.M., Alouini, M.S. and Al-Naffouri, T.Y., 2021. Deep learning in the industrial internet of things: Potentials, challenges, and emerging applications. IEEE Internet of Things Journal, 8(14), pp.11016-11040.

Ma, G., Tan, S. and Shang, S., 2019. The evaluation of building fire emergency response capability based on the CMM. *International journal of environmental research and public health*, *16*(11), p.1962.

Malik, P.K., Sharma, R., Singh, R., Gehlot, A., Satapathy, S.C., Alnumay, W.S., Pelusi, D., Ghosh, U. and Nayak, J., 2021. Industrial Internet of Things and its applications in industry 4.0: State of the art. Computer Communications, 166, pp.125-139.

Qiu, T., Chi, J., Zhou, X., Ning, Z., Atiquzzaman, M. and Wu, D.O., 2020. Edge computing in industrial internet of things: Architecture, advances and challenges. IEEE Communications Surveys & Tutorials, 22(4), pp.2462-2488.

Serror, M., Hack, S., Henze, M., Schuba, M. and Wehrle, K., 2020. Challenges and opportunities in securing the industrial internet of things. IEEE Transactions on Industrial Informatics, 17(5), pp.2985-2996.

Urban, J., Beranek, L., Koptiš, M., Šimota, J. and Košťák, O., 2020. Influence of CMM scanning speed and inspected feature size on an accuracy of size and form measurement. *Manufacturing Technology*, *20*(4), pp.538-544.

AS220483.docx

ORIGINALITY REPORT

1%	1%	0%	1%
SIMILARITY INDEX	INTERNET SOURCES	PUBLICATIONS	STUDENT PAPERS

PRIMARY SOURCES

1	www.coursehero.com Internet Source	1%
2	Submitted to University of Greenwich Student Paper	<1%
3	www.conference.ase.ro Internet Source	<1%

Exclude quotes	On	Exclude matches	Off
Exclude bibliography	On		