IoT in Practice: IoT in Astro Turf Industry

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Abstract
Astroturf or artificial grass is a growing component in landscape management projects like, housing complexes, sports complexes,etc. This increased the manufacturers to increase production, but the process is a very time taking and energy consuming process. This paper discusses how the manufacturing process can be optimised technologies such as IoT, data analytics to make the manufacturing process more streamlined and increase the operational efficiency.

1. Introduction

Many market researchers forcast that the synthetic grass market is going to reach approximately upto $4038,64 Millions, this estimate is based on the necessity to conserve water by growing natural grass. This forecast in the business has made manufacturers to make sure increase in the production to reach the demand. But increasing the manufacturing has increased the utilisation of electricity, water and material wastage. But as we all know we are in middle of a climate change, there is an essential need to optimise the process of manufacturing artificial grass.

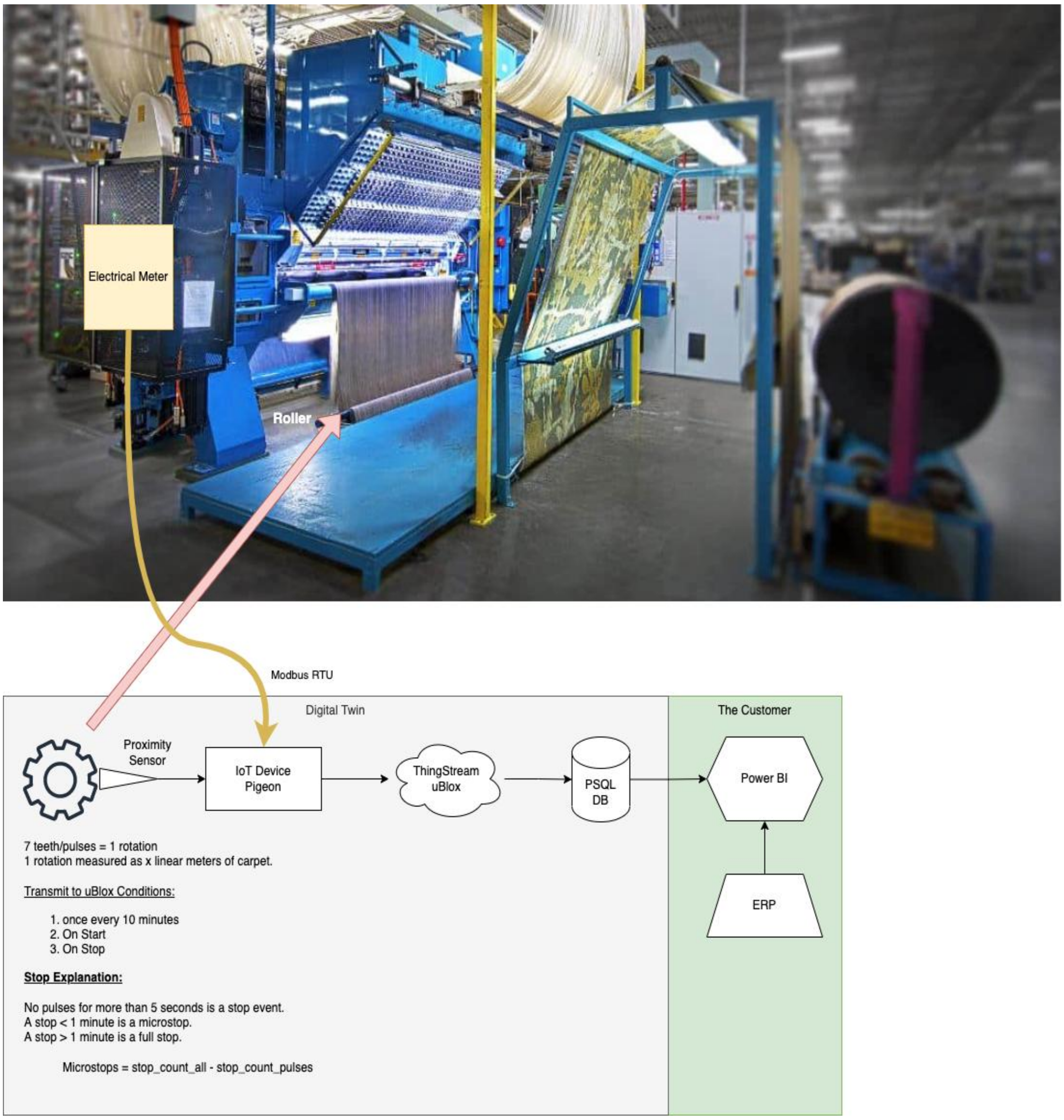
The above problems can be mitigated and optimised by utilising IoT, Iot or Internet of Things is a technology which is considered as a network of devices interacting with each other
As part of the industry 4.0, Industrial IoT or IIOT is considered to create an amalgamation of Production systems with internet technologies. IIOT can also be considered a mixture or overlap or Information Technology(IT) and Operational Technologies(OT)

The scope of this paper focuses on the extent of IIoT in artificial grass manufacturing industry. The complexities and challenges faced in this industry are: Energy consumption /

Electricity consumption, cost to manufacture to cost to maintenance of equipment etc.This study is motivated for addressing the increase in need and how manufacturing units can cope up with them by implementing IIoT.

2. Research methodology

By creating a SOC using Raspberry Pi to collect the Power Output and rotations for the spindle rotor using a pulse actuator as shown in the picture below, we can calibrate the necessary tracking on rotations and energy consumed by the man chine

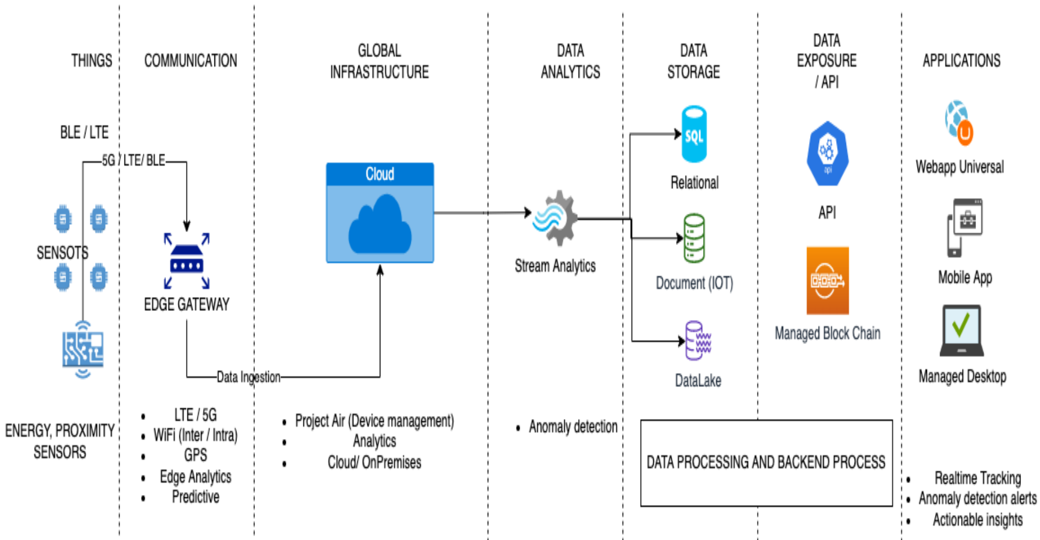


In the above machine the ELECTRIC METER collects the power consumed and the rotor sensor connected with a proximity sensor, collects the length of the manufactured carpet area, and correlates it with the power consumed.

This proximity sensor allows us to capture the total stoppage time, or pulsed stoppage time based on raw material breakage (String corrosion, needle replacement etc.)

The above solution can be used for different types of material, which provide manufacturers on operational efficiency of the machine and alerts on complete digitalisation of the process using modern technologies.

3. High Level IOT architecture for Astroturf Manufacturing



4. Research Methodologies

Major calculations for the measurement of various parameters calibrated in the result sets, are based on simple mathematics, ie. the amount of rolling or production on throughput for a carpet is based on the roll of the roller as part of the tufting machine.

Defect on outer race (Ball pass frequency outer)	$= \frac{n}{2} \quad \frac{\text{rpm}}{60}\left(1 - \frac{B_d}{P_d}\cos\phi\right)$
Defect on inner race (Ball pass frequency inner)	$= \text{undefined}\frac{n}{2} \quad \frac{\text{rpm}}{60}\left(1 + \frac{B_d}{P_d}\cos\phi\right)$
Ball spin frequency	$= \frac{P_d}{2B_d} \quad \frac{\text{rpm}}{60}\left[1 - \left(\frac{B_d}{P_d}\right)^2 \cos^2\phi\right]$
Fundamental train frequency	$= \frac{1}{2} \quad \frac{\text{rpm}}{60}\left(1 - \frac{B_d}{P_d}\cos\phi\right)$
P_d = Pitch Diameter	n = Number of Balls
B_d = Ball Diameter	ϕ = Contact Angle

5.Results

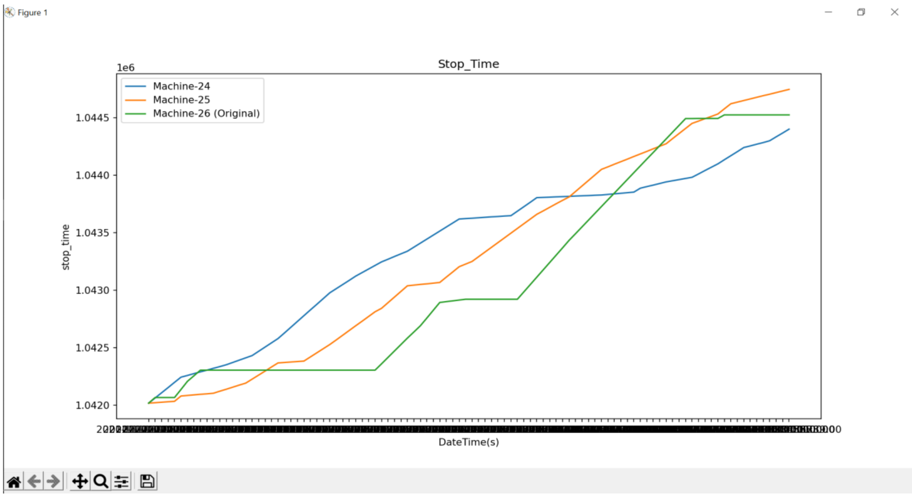
For example before the advent of IOT the machine metrics for rotations and thresholds wont be calibrated, for further analysis

Some of the data presented is an extract of the data gathers from the IoT sensors

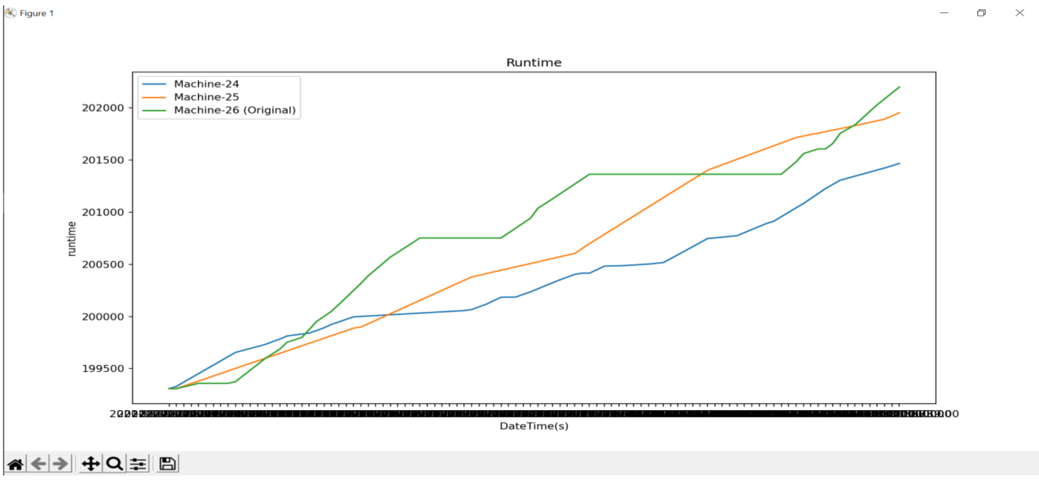
date	machine_id	runtime	stop_time	throughput_area	throughput_length	stop_count_all	stop_count_pulses	runstate	energy
2021-10-01 00:00:00	T26	199308.0	1042018.0	217498.96833333300	54104.22166666670	1646.0	1185.0	0.0	9690.81
2021-10-01 00:01:00	T26	199308.0	1042067.0	217499.17666666700	54104.27333333330	1646.0	1185.0	1.0	9690.851111111110
2021-10-01 00:02:00	T26	199325.0	1042067.0	217499.385	54104.325000000000	1647.3333333333300	1185.1666666666700	0.0	9690.892222222220
2021-10-01 00:03:00	T26	199342.0	1042067.0	217499.59333333300	54104.37666666670	1648.6666666666700	1185.3333333333300	0.0	9690.933333333330
2021-10-01 00:04:00	T26	199359.0	1042067.0	217499.80166666700	54104.42833333330	1650.0	1185.5	0.0	9690.974444444440
2021-10-01 00:05:00	T26	199359.0	1042137.5	217500.01	54104.48	1650.0	1185.75	1.0	9691.015555555560
2021-10-01 00:06:00	T26	199359.0	1042208.0	217503.54903225800	54105.36032258070	1650.0	1186.0	1.0	9691.056666666670
2021-10-01 00:07:00	T26	199359.0	1042256.5	217507.08806451600	54106.24064516130	1650.0	1186.0	1.0	9691.097777777780
2021-10-01 00:08:00	T26	199359.0	1042305.0	217510.6270967740	54107.12096774190	1650.0	1186.0	1.0	9691.138888888890
2021-10-01 00:09:00	T26	199375.0	1042305.0	217514.16612903200	54108.00129032260	1651.0	1186.0	0.0	9691.18

2021-10-01 00:10:00	T26	199430.25	1042305.0	217517.70516129000	54108.88161290320	1651.25	1186.0	0.0	9691.333333333330
2021-10-01 00:11:00	T26	199485.5	1042305.0	217521.2441935480	54109.761935483900	1651.5	1186.0	0.0	9691.486666666670
2021-10-01 00:12:00	T26	199540.75	1042305.0	217524.78322580600	54110.642258064500	1651.75	1186.0	0.0	9691.64
2021-10-01 00:13:00	T26	199596.0	1042305.0	217528.32225806500	54111.52258064520	1652.0	1186.0	0.0	9691.75125
2021-10-01 00:14:00	T26	199641.0	1042305.0	217531.8612903230	54112.40290322580	1652.0	1186.0	0.0	9691.8625
2021-10-01 00:15:00	T26	199686.0	1042305.0	217535.40032258100	54113.28322580650	1652.0	1186.0	0.0	9691.97375
2021-10-01 00:16:00	T26	199753.0	1042305.0	217538.93935483900	54114.1635483871	1652.0	1186.0	0.0	9692.085
2021-10-01 00:17:00	T26	199776.0	1042305.0	217542.47838709700	54115.04387096770	1652.5	1186.0	0.0	9692.19625
2021-10-01 00:18:00	T26	199799.0	1042305.0	217546.01741935500	54115.92419354840	1653.0	1186.0	0.0	9692.3075
2021-10-01 00:19:00	T26	199875.5	1042305.0	217549.5564516130	54116.804516129000	1653.0	1186.0	0.0	9692.41875
2021-10-01 00:20:00	T26	199952.0	1042305.0	217553.09548387100	54117.684838709700	1653.0	1186.0	0.0	9692.53
2021-10-01 00:21:00	T26	200000.5	1042305.0	217556.63451612900	54118.565161290300	1653.0	1186.0	0.0	9692.665833333330
2021-10-01 00:22:00	T26	200049.0	1042305.0	217560.1735483870	54119.445483871000	1653.0	1186.0	0.0	9692.801666666670

2021-10-01 00:23:00	T26	2001 14.0	1042 305.0	217563.712 58064500	54120.3258 0645160	1653.0	1186.0	0.0	9692.9375
2021-10-01 00:24:00	T26	2001 81.5	1042 305.0	217567.251 61290300	54121.2061 2903230	1653.0	1186.0	0.0	9693.0733 33333330
2021-10-01 00:25:00	T26	2002 49.0	1042 305.0	217570.790 6451610	54122.0864 516129	1653.0	1186.0	0.0	9693.2091 66666670



a.



b.

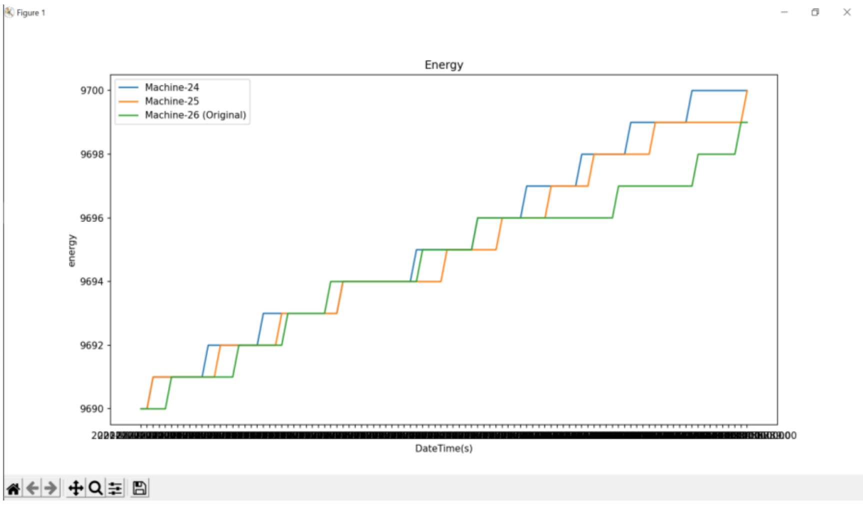


Figure 1
Energy
Machine-24
Machine-25
Machine-26 (Original)
energy
DateTime(s)

c.

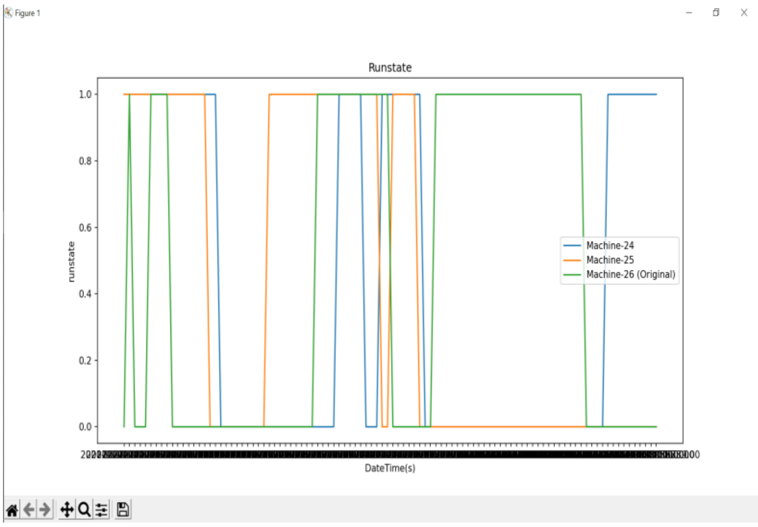


Figure 1
Runstate
Machine-24
Machine-25
Machine-26 (Original)
runstate
DateTime(s)

d.

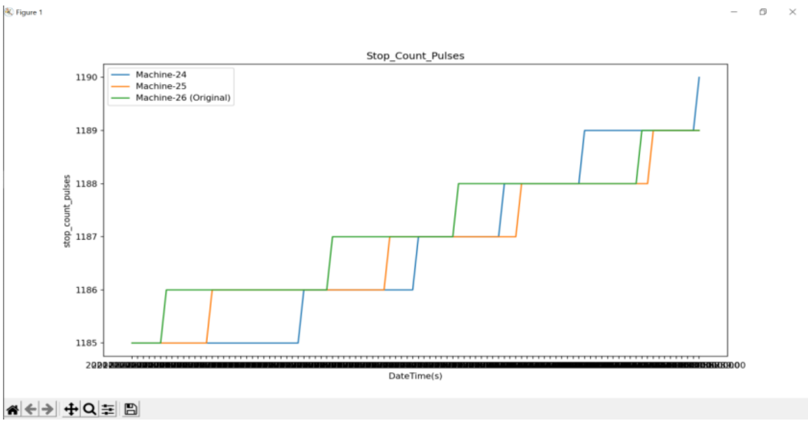
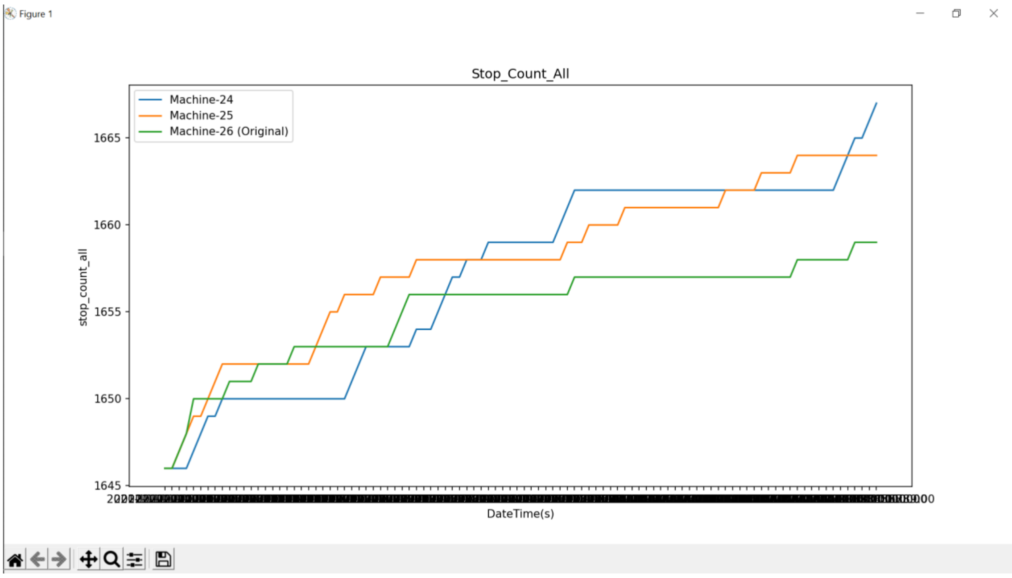
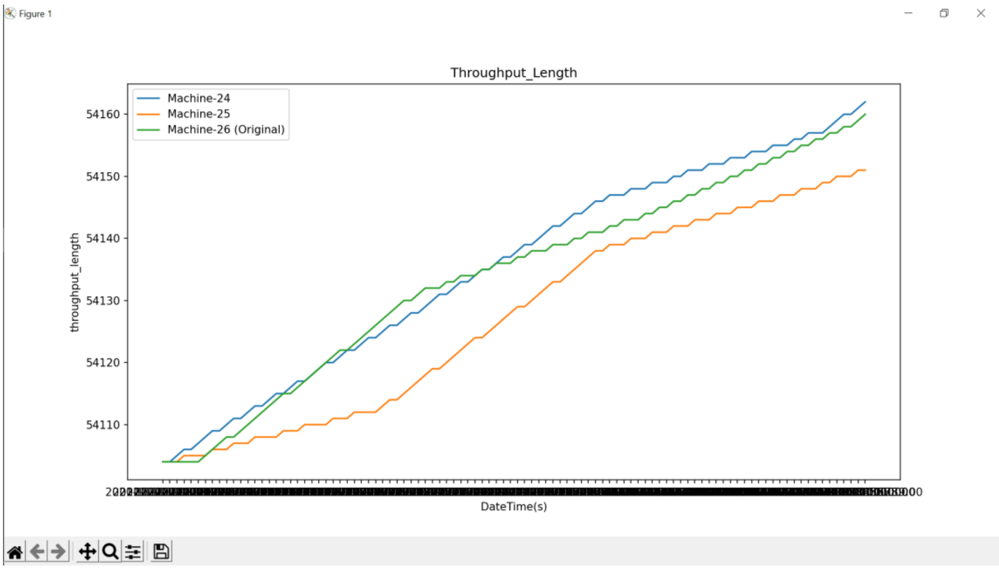


Figure 1
Stop_Count_Pulses
Machine-24
Machine-25
Machine-26 (Original)
stop_count_pulses
DateTime(s)

e.



f.



g.

5. Conclusions

With the inclusion of the metrics that monitor the displacement of tufting rollers, energy meters, temperature regulators etc. We can calibrate a better understanding of the behavior of the tufting machine. This data collected will be helpful to the analyze and frame the times when the machine works optimal and to calibrate the stoppage times for various reasons to be viz. Needle breakage, thread malfunction, to be understood. But this process of digitalization of an age old process will help in making sure, there are very little downage times for increasing the productivity of the spinning machine

6.References

1. Yu, Y., Wang, J., & Zhou, G. (2010). The exploration in the education of professionals in applied internet of things engineering. Paper presented at the 2010 4th International Conference on Distance Learning and Education, ICDLE 2010, October 3, 2010 – October 5, 74-77. Doi:10.1109/ICDLE.2010.5606038
2. Accenture. (2015). Winning with the Industrial Internet of Things. Retrieved on 20th October 2018 from https://www.accenture.com/us-en/insight-industrial-internet-of-things
3. Bartje, J. (2016). Top 10 IoT application areas – based on real IoT projects. IoT Analytics. Retrieved on 10th October 2018 from https://iot-analytics.com/top-10-iot-projectapplication-areas-q3-2016/
4. ISO 10782-1:1998. Definitions and attributes of data elements for control and monitoring of textile processes – Part 1: Spinning, spinning preparatory and related processes. ISO Standards.
5. Jammes, F., & Smit, H. (2005). Service-oriented paradigms in industrial automation. IEEE Transactions on industrial informatics, 1(1), 62-70.