Design and Development of Strain Gauge Dynamometer

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Abstract

This paper manages improvement of Strain Gauge Dynamometer. A Strain Gauge is a gadget used to quantify the strain of an object and the cutting strength estimation is performed by the device isn't much expensive and can machine materials with some constrained criteria. This connection is created to gauge cutting strength. Dynamometers are gadgets used to gauge cutting strength in machining task. The cutting strength can't be distinguished or evaluated specifically however their impact can be detected utilizing Transducer. For instance, a strength which can neither be seen nor be held yet can be distinguished and furthermore measured individually by its impact and the measure of those impacts (on some material) like versatile diversion, disfigurement, weight, strain and so on. These impacts, called signals, frequently require legitimate molding for simple, exact and dependable recognition and estimation. This connection is likewise increment productivity and precision of strength estimation by device redirection in less time without yielding exactness of the item.

Keywords: *strain gauge dynamometer, transducer, microcontroller.*

INTRODUCTION

A dynamometer is a machine used to quantify torque and rotational speed (rpm) from which control delivered by a motor, engine, pump or other pivoting prime mover can be figured. Keeping in mind the end goal to put the examination of the metal cutting task on a subjective premise, certain perceptions must be made previously, amid and after a cut.

G. Byrne et al. [1] states in their research work that the utilization of sensor frameworks for instrument condition observing in machining and granulating is winding up more ordinary to improve profitability. Numerous methodologies have been proposed to achieve instrument condition checking and some of these are effectively utilized in industry.

J. S. Field [2] says that the reducing forces generated in metallic slicing have a direct influence on era heat, tool wear or failure, nice of machined surface and accuracy of the work piece. on this look at, a turning dynamometer that could degree static and dynamic cutting forces through the usage of stress gauge and piezo-electric accelerometer respectively has been designed and built. The orientation of octagonal rings and pressure gauge places has been decided to maximize sensitivity and to reduce move-sensitivity.

G. H. Gautschi, A. Gibson, and H. Kobler, [3] proposed that present day research centered at the assessment of metallic machining process parameters and on the development of adaptive manage, shows that device overall performance, work-piece and device fabric selections, tool existence, best of machined surfaces, the geometry of reducing device edges, and cutting conditions are closely associated with the reducing forces. This statistic is of superb interest to slicing tool manufactures and customers alike. over time there were tremendous tendencies and enhancements inside the device used to monitor such forces.

D. Li, and J. Mathew [4] derives that although a huge sort of device failure sensing strategies has been evolved through the years, few of them were utilized in industries efficaciously. This paper offers an evaluate of the several strategies and methods of tracking device wear in particular in turning operations. via and large, those techniques appear to be “single-minded” in that they are capable of detecting and diagnosing tool put on and failure relating to specific training of faults. A typical

method which can hit upon the very many failure modes in device circumstance tracking has nonetheless no longer been devised.

S. S. N. Murthy [5] anticipated that in machining procedure, phenomena that can be measured consisting of cutting force, vibration, acoustic emission, torque, floor finish, sound etc. usually passed off. Slicing force could be very vital as it relates to the design of tools, energy intake, vibration, gadget design components, precision components, and so forth. This study affords an evaluation of the utilization of reducing pressure evaluation in tool condition monitoring (TCM) in machining operations to estimate the tool put on, device breakage, chatter and so forth. the ideal of sign processing for analyzing slicing pressure in TCM also mentioned. There are two approaches of pressure dimension technology in particular used nowadays; piezoelectric and strain gauge-based sensors.

T. Ohtani [6] says that the hardening of metallic instead lowers the cutting forces in many cases. this is the end result of high shear angle and the noticed-toothed chip formation because of the terrible ductility of tough substances. Reinforcement of Al alloy with fiber also decreases the reducing forces. however, the difficult materials put on the reducing device rapidly and growth the forces, particularly thrust force which reasons size mistakes. The profile of machined floor of hardened steel reflects the profile of cutting aspect.

J. L. Stein, and K. Huh, [7] shows that the importance of tracking the cutting pressure inside the turning procedure has been nicely diagnosed in industry in addition to within the open literature. This paper proposes a reducing force tracking approach that does not utilize force dynamometers but instead estimates the reducing pressure based totally on the spindle motor contemporary and speed in addition to a version that relates these measurements to the reducing pressure. Motor modern-day and pace can't best be inexpensively and reliably measured however, similarly, may be shown, together with the nicely chosen model for the model-primarily based estimator, to correctly estimate the cutting pressure. Such system is used for preventing leakages of liquid, gases, vapour, etc. during the process. In this system shaft seals and stuffing boxes are used.

1. MAIN COMPONENTS:

1.Microcontroller

2.Tool holder

3.Tool

4.Strain gauges (Nos 2)

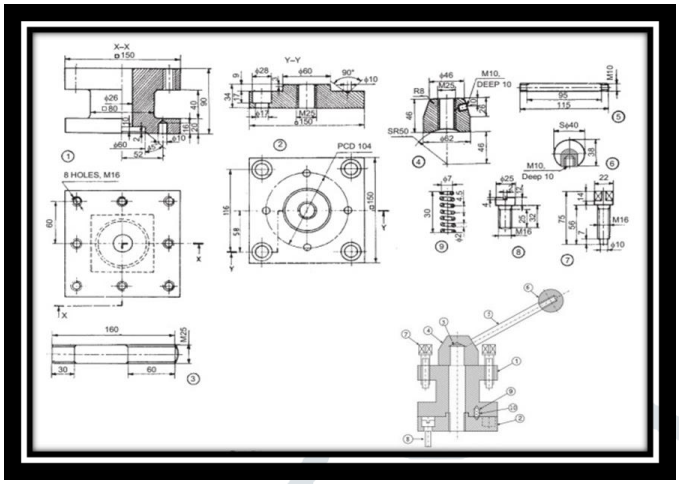
1.1 Microcontroller:

Arduino is a PC equipment and programming organization, venture, and client group that outlines and makes small scale controller packs for building computerized gadgets and intelligent articles that can detect and control protests in the physical world. The sheets are outfitted with sets of advanced and simple info/yield (I/O) sticks that might be interfaced to different extension sheets (shields) and different circuits. The microcontrollers are regularly customized utilizing a tongue of highlights from the programming dialects C and C++. Notwithstanding utilizing customary compiler toolchains, the Arduino venture gives an incorporated advancement condition (IDE) in light of the Processing dialect venture.

1.2 Tool Holder:

We have utilized square apparatus post as in device holder. This is utilized to hold four unique apparatuses at once. The device holder might be turned and cinched to encourage the utilization of any of the apparatuses at once. The subtle elements of the square apparatus post are appeared in picture. The device holder 1 is situated on the base plate 2 by methods for the stud 3. It can be settled to the base plate in any position unbendingly by the clasping nut 4 and handle 5. The handle 6 is fitted to the handle for smooth activity. The devices are held in the apparatus post by methods for the set

screws 7. Each device can be recorded promptly by turning the device holder on the base plate and situated in the right position by the spring 9 and the ball 10. The ball is situated in the V-groove, accommodated this reason in the base plate.



Part No	Name	Material	Qty
1	Tool Holder	MS	1
2	Base Plate	MS	1
3	Stud	MS	1
4	Clamping Nut	MS	1
5	Handle	MS	1
6	Knob	Ebonite	1
7	Set Screw	MS	8
8	Grub Screw	MS	4
9	Spring	Steel	1
10	Ball Ø 9	MS	1

Fig-1. Square Tool-post Dimensions Table-1: Bill of Material of Square Tool-post

1.3 Tool:

In a circumstance of machining, a cutting device is any device that is utilized to expel material from the workpiece by methods for shear disfigurement. Cutting might be expert by single-point or multipoint device. Single-point apparatuses are utilized as a part of turning, forming, arranging and comparative activities, and expel material by methods for one front line. Processing and boring apparatuses are regularly multipoint device. Granulating devices are likewise multipoint devices. Each grain of grating capacities as a minuscule single-point front line and shears a little chip. Cutting device must be made of a material harder than the material which is to be cut, and the apparatus must have the capacity to withstand the warmth produced in the metal-cutting procedure.

1.4 Strain-gauge:

A strain gauge is a case of aloof transducer that changes over a mechanical relocation into a difference in opposition. A strain check is a thin, wafer-like gadget that can be appended to an assortment of materials to gauge connected strain. The larger part of strain checks is thwart composing, accessible in a wide selection of shapes and sizes to suit an assortment of utilizations. They comprise of an example of resistive thwart which is mounted on a sponsorship material. They work on the rule that as the thwart is subjected to pressure, the obstruction of the thwart changes definably.

2. Objectives:

2.1 Methodology Adopted:

The examination relies on philosophy selected the procedure as it chooses the method for gathering the information, control, preparing lastly the show of the outcomes:

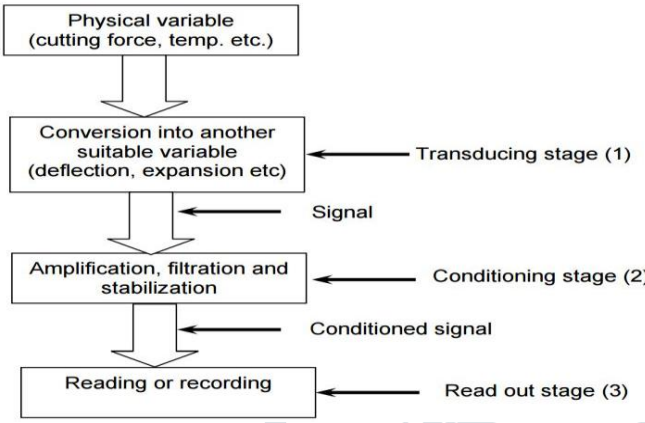
1. Estimation of cutting strength by utilizing diversion compose dynamometer is the best method accessible.

2. The machining parameters will be considered amid the machining concerning cutting strength and encourage powers by anticipating the cutting execution, for example, profundity of cut, bolster/rev. what's more, speed.

3. The regular recurrence of the device holder of machine apparatus dynamometer will be figured.

4. Stress estimation will be completed for the protected plan of machine device dynamometer.

2.2 General principle of measurement:



2.3 Detail Drawing:

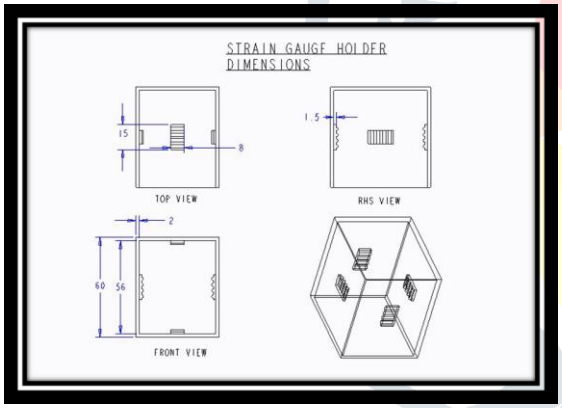


Fig-2. Assembly drawing cross-section

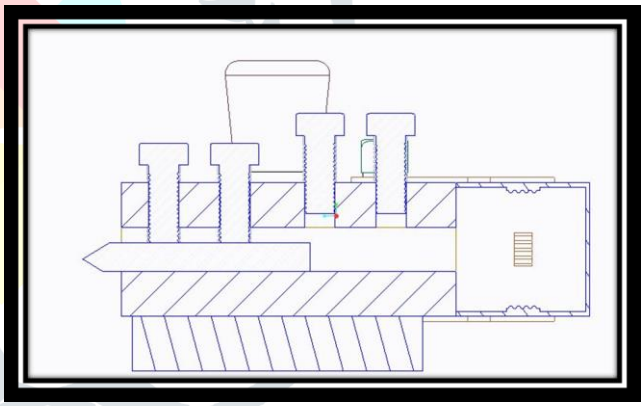


Fig-3. Strain-Gauge Dynamometer Setup

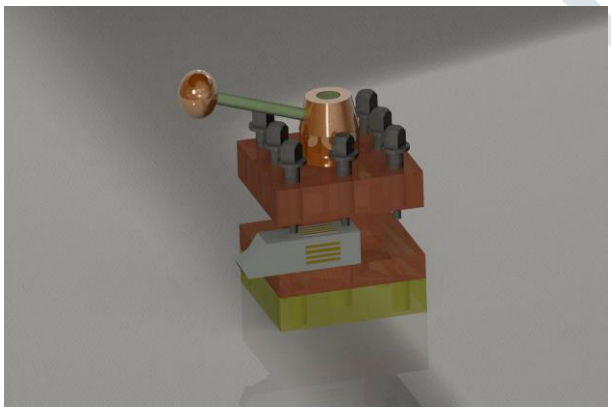


Fig-4. Assembly Model

2.3.1 Technical Specification:

Table:1: Technical Specification

Sr. No.	Component	Material / Use	Dimensions or Specification
1.	Tool	SS	Standard Dimensions
2	Workpiece	SS & Aluminium	25 mm Diameter, 80 mm Length
3.	Tool post	Square tool post	Standard Dimensions
4.	Strain gauge	Cu-Ni	For 200 kg load

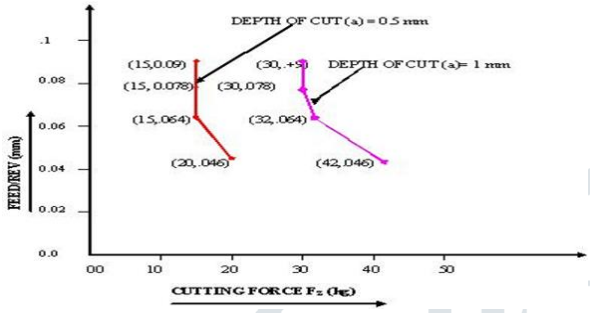
3.1 Operating parameters:

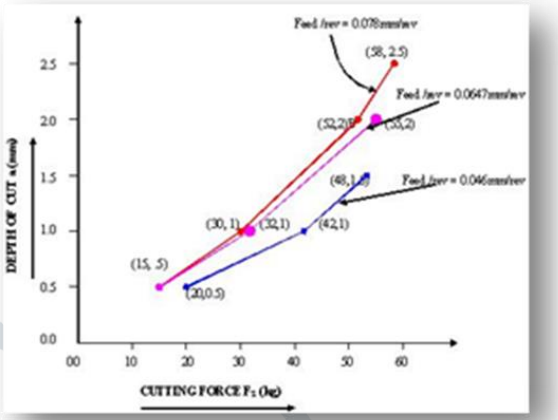
1. Depth of cut
2. Feed per revolution
3. Speed

3.2 Results Table:

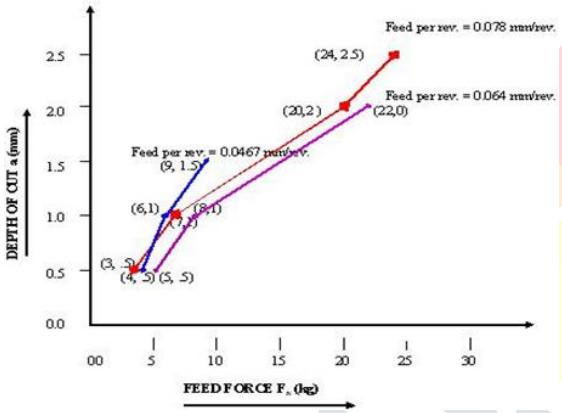
Depth of cut, a(mm)	Feed per revolution (mm)	Dia, d(mm)	Cutting speed, V=πDn (m/s)	Forces			Speed (rpm)
				Cutting force F_z(kg)	Feed force F_x(kg)	Resultant force $\sqrt{Fx^2 + Fz^2}$ (kg)	
0.5	0.0781	21.78	23.25	15	3	15.29	340
1.0	0.0781	20.78	22.19	30	7	30.81	
2.0	0.0781	18.78	18.78	52	10	55.71	
2.5	0.0781	14.78	14.78	58	24	62.76	
0.5	0.046	23.04	20.25	20	4	20.39	280
1.0	0.046	22.04	19.38	42	6	42.43	
1.5	0.046	18.96	16.67	49	9	49.82	
0.5	0.0647	15.90	16.67	15	5	15.8	340
1.0	0.0647	21.04	21.04	32	8	32.98	
2.0	0.0647	23.04	24.59	55	22	59.23	

3.3 Graphs:





Graph 1: Feed per revolution vs Cutting forces **Graph 2:** Depth of cut vs Cutting forces



Graph 3: Depth of cut vs Feed forces

According to perception recorded, the sustain powers and profundity of slice is specifically corresponding to cutting powers (Graph-1). All the examination is appeared in the diagrams which demonstrates that on expanding the profundity of slice prompts increment in cutting and bolster constrain i.e. roughly straight. Additionally, cutting powers rely on bolster rate of hardware so the cutting powers increment as nourish rate increments (Graph-2). Cutting powers is likewise diminishes as mm/rev. increments. Additionally, recurrence and stress create in apparatus of dynamometer inside given criteria of safe outline (Graph-3).

4. Conclusion:

We conclude that, compared to other method, it is advisable to quantify the cutting strength by utilizing electrical strain gauge. According to cutting strength investigation, it has presumed that the cutting and nourish powers are specifically corresponding to perceptiveness of cut and bolster rate of hardware and conversely relative to feed/rev. Characteristic recurrence and stress created in instrument of dynamometer has been planned to give the reasonable furthest reaches of the sheltered outlines. So, the outline is protected inside given parameters, for which the instrument is made.

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