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Design and analysis of gripper sensor

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ABSTRACT

Sensors a system whose sole purpose is to sense and give the output. It maybe of anything from normal measuring of speed, temperature to the in-depth sensing of motions or strains. One such type of sensor is being fabricated to measure the value of stress using strain gauges. Strain gauge is a sensor which has change in values when external force is applied Previously stress is found on a beam near the point of maximum bending but in here the stress are known from an object so as it helps in gripping of the object. The main purpose is to implement in the robot grippers. Considering it as a sensor the size is in centimeter range. From the design aspect it is of two parts namely base and struts. The struts are arranged in a regular array on the base plate. The major consideration would be the base as a fixed part and the pressure is applied on the strut top side. Simulation of design are done in ANSYS with consideration of basic properties of the material. It is done to determine the material used to fabricate.

INTRODUCTION

A sensor is an essential component in robots. With the help of it we infer what's happening in and around the robot whether it may be an industrial robot or a mobile robot. The elementary purpose of a sensor is to measure some parameters. Some of the commonly known and used sensors are temperature, proximity, light, humidity and etc. All these senses some value and gives it to the controller. A sensor has few rules such as,

- Sensitive on measured property
- Insensitive to other properties
- Does not influence measured value

Basically, there are some criteria by which the sensor is selected they are,

- Accuracy
  The difference in actual value and indicated value of the sensor
- Environmental condition
- Range
  This gives the measurement limit of the sensor.
- Calibration
  It is essential as the device measuring value will change with time
- Resolution
  This tells us the least movement detection
- Cost
  It should be affordable and not very high
- Repeatability
  To know the consistency of the sensor.

Robots are termed intelligent because of the work it does without any need of help from humans. To perform with such efficiency the sensors play a key role. It helps in positioning the robot, moving the joints, working of gripper and holding of objects. All

the works can be performed with the sensors and the controller working together. When it comes to holding an object the usual problem of slip and damage to the object exists. This new type of sensor which is being built helps in reducing or eliminating the problem.

[2]Chai-Hsing Pi, et al., has paper on the one-dimensional touch panel based on strain gauges gives the output by sensing only for a particular area. They ensured that the gauge factor of the strain gauges is equal. They used one of the famous methods to obtain the misalignment with rotation angle i.e. Mohr's circle. The sensor fixture was found by performing simulation in ANSYS. With the elementary beam mechanics, the force applied was found with the help of the reading from the strain gauge. One flaw they faced was the detection of the edges was less by the sensors. [1]IsmaelPayo and Vicenti Feliu did a comparative study of different sensors you use for the measurement in flexible beams. The deflection of the beam was calculated by Euler-Bernoulli equations. They also did a method known as curvature interpolation of beams for knowing the position of the strain gauges. Also, they presented the theoretical approach for the setup and implemented practically by optical setup and compared the results were compared with the calculations. [7]D.J. Pratt, et al., used the strain gauges for load measurement in orthopedics. They gave the practical aspect of the design, construction and the use in clinical purpose. Steps were followed to prepare the surface so as the gauges can be fixed. The paper explains the selection of each element required for the systems such as the type of strain gauge, gauge factor, amplifiers, wiring, bridge circuit.

METHODOLOGY

The sensor in general comprises of different things such as designing, modelling, fabrication and testing. When the problem statement is determined the initial literature survey that helped in getting key points for the designing. Analysis was carried out to find the output parameters in a virtual way so as to obtain the idea of the setup. Fabrication and the testing is followed by it.

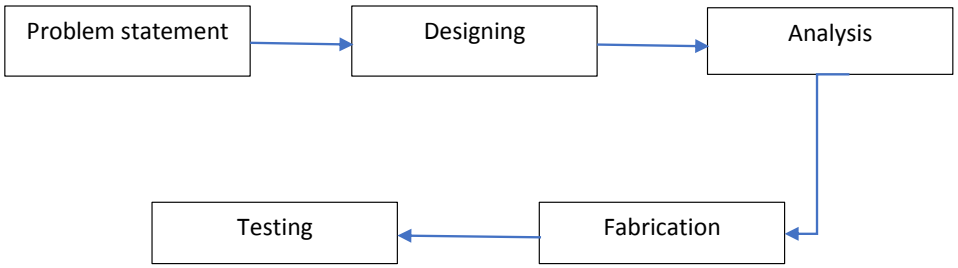

Figure 1 – Represents the methodology

DESIGN and MODEL

A sensor is a device which cannot be designed with leniency in dimensions. It has to be compact and should be able to perform the required task. It is one of the essential part as any slight variation in any parameter it is sensed by a sensor. This is said to be implemented as a gripper sensor but at first the product is designed as a normal sensor which can be fixed in a robot and tested. Basically, the model consists of two parts namely base and struts. Base are made in rectangular form and the struts are of square in shape with certain height to it. Dassault Systems SOLIDWORKS was used to design the model of the sensor. There are a total of 9 struts in the base plate for this design.

ANALYSIS

Materials are a critical factor when fabricating a product and it's the same case as well for the sensor. Few things had to be taken into consideration for selection in here. At first it was decided to consider having two materials one for the base and the other for the strut. When reflected on materials such as aluminum and iron there was a problem of combining it together to make it a model. After taking the problems into account it is inferred to make the whole model in one single material of good strength. With that we had so many options in materials. So, to narrow it down software analysis was done by ANSYS. Three upright materials were taken such as steel, cast iron, mild steel which are available in market and can be fabricated from it.

Few parameters were set in the software such as material properties of young's modulus and poisons ratio, setting the fixed end of the model and also selecting the area for the applying of load in this case its force and the simulation was done for a load of 5 N/m^2. As said the analysis was carried out for the three materials mentioned above, firstly it was done for steel which had values between -0.9 and 0.2 for the minimum and maximum. Next it was done for cast iron which gave values of -1 and 0.38. Lastly it was done for mild steel and the values yielded from -1.5 to 0.467. With the values obtained from the analysis the mild steel was selected as a material for fabrication as it has a range of vales better than the other materials tested.

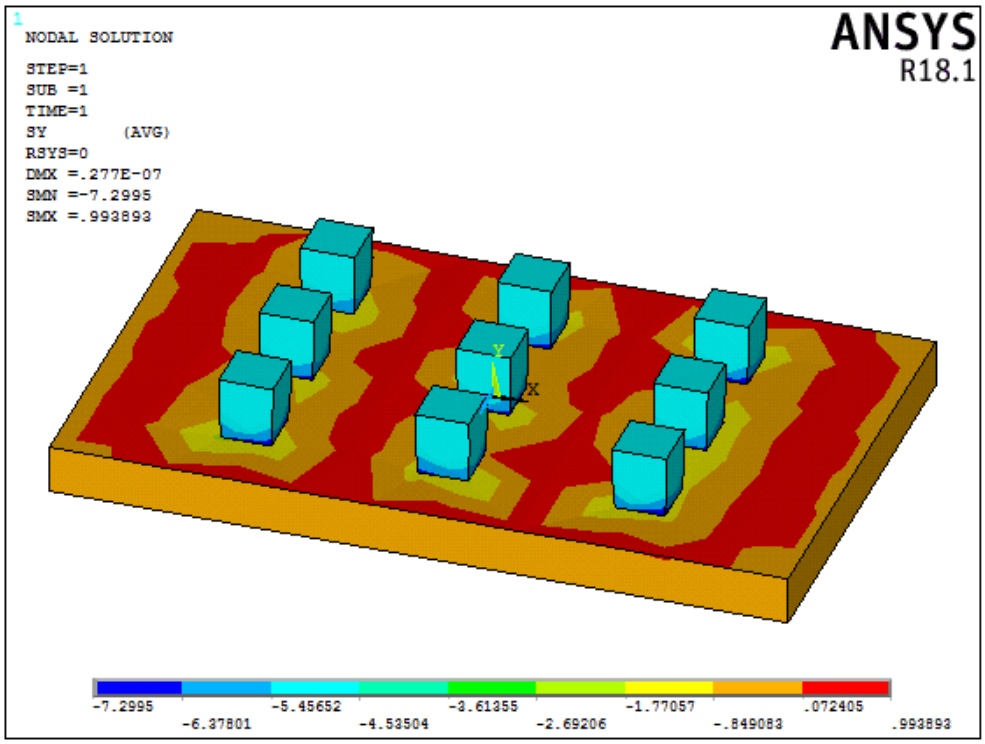

Figure 2 – Analysis result from ANSYS for mild steel

CALCULATIONS

With the load the stress formed is of compressive in nature. The well-known Euler's column theory is the concept behind it. The main two things are Critical buckling load and Critical buckling stress.

Critical buckling load,

$$P_{cr} = \frac{\pi.\pi .E.I}{L.L} \quad \text{..... Eqn 1}$$

With the material as steel and the length of the member being 0.013m we solve the equation.1 and the resultant critical buckling load is,

$$P_{cr} = 607.716KN$$

Critical buckling stress,

$$\sigma_{cr} = \frac{\pi.\pi .E.I.r.r}{K.K.L.L} \quad \text{..... Eqn 2}$$

Applying the vales from the material and the model we solve equation.2 and the critical buckling stress as,

$$\sigma_{cr} = 6.32KN$$

CONCLUSION

The mechanical structure is done using a design software. The material selection is done by analysis. With the material, the calculation

of critical buckling stress and critical buckling load is found. The fabrication is completed by using mild steel as material. The experimental part is carried out next with the help of fixing up strain gauges in the model and getting the output.

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