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Spine in Robot: Designing of Lightweight robot with the spine to provide balancing and load bearing capability

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Abstract:

Humanoid robots are so attractive; in many public areas robots are serving and also attract the public not only by their incredible efficiency but also by their design. But for startups the manufacturing of a humanoid robot comes with high cost, so it is necessary to manufacture a light weight robot to reduce the cost without affecting the performance of robot.

This cost reduction will be helpful for the new startups but with this benefit there is an issue also arise that to balance the robot while navigation and bearing load. This research paper is proposing cost effective design of the serving robot in restaurants and hotels with spine. For cost effectiveness it is required to make light weight body, and spine will be helpful in balancing the lightweight robot and can also bear the load while serving public.

1. Introduction:

Talking about inventions of latest technologies in robots is no more restricted to a particular domain of persons, as now it is too common to all levels of people. Here domain means people connected by robotic technology by any mean and level refers to the class of public (lower middle class/upper middle class/rich people). Kids are not only enjoying the robots in movies but in toys also, youth are not only restricted by attending the seminar and visiting the automobile industry to understand the robotic technology but also they are experiencing them in their gadgets and experimenting them in their college/university labs, senior citizens are no more unaware with these inventions in robotic services even these robotic technologies are helping them in many ways like in medical field.

In short, we are accepting and adopting the robotic service very easily and getting very familiar and the experience of surrounded by robotic services are wonderful.

Whenever we are talking about robots, the first picture in mind is a human like machine standing and can do anything that may be impossible for a human. The first thing that attracts towards robots is its design. In movies we saw heavy humanoid robotic

body (mostly in the Robocop movies) but in real, a startup really needs to manufacture the cost effective robot and for this we need the light weight body of a robot.

The issue arise with the light weight robot is the balancing and bearing load. This paper is proposing the spine. This concept of spine comes from the structure of a human body. In our body God make our body fully dependent on spine, this is the part which needs to be work perfectly otherwise it makes a human to take rest and can't be able to perform well. Likewise in robot also the spine will give the support to the whole body of robot.

1.1. Background:

Manufacturing the heavy steel body of robot is too expensive that need too much fund. For the cost effectiveness there is the need of light weight material for the manufacturing of robot body. Then how that light weight body can balance itself and can bear the load. From that point we started the body of robot with human body and came with idea of introducing the spine. A human body is too versatile to perform various tasks but a little wrong posture may let the human to rest for long. After examining, doctors ask them to take rest that cure the spine. With the same concept, a robot can also have the spine that will support the complete robotic body.

2. Design of robot's body:

Designing seems like a very easy term but it consist of many questions that is how our robot will be differ from other? How acceptable the design will be? How much cost it required to manufacture? And so on… Designing is the most important part as it directly connect to public. But at the time of designing, it is essential to be known about some essentials like the material, dimensions etc.

Before start with the design of spine let's first understand our objective behind designing a cost effective serving robot body.

We focused on two objectives while designing of robot:

- Make a cost effective body along with strength.
- Make an interactive design that will be differ from others (existing serving robots).

2.1. Software:

Design of robot is perform on Autodesk Inventor. [1] Autodesk Inventor is 3D mechanical solid modeling design software developed by Autodesk to create 3D digital prototypes. It is used for 3D mechanical design, design communication, tooling creation and product simulation. This software enables users to produce accurate 3D models to aid in designing, visualizing and simulating products before they are built.

With Autodesk Inventor we can simulate the 3D design. This will also confirm the functionality of robot before manufacturing and will help to manufacture the correct product with absolute material and dimensions. Basically it gives the appropriate image to designer that how it will look like after the production.

Figure 1: Design of Body of Robot on Inventor

After completing the design of body on Inventor, the next step is to start making the body of robot that seems exactly same with same dimensions as designed on Inventor. As we had already discussed to make a cost effective robot, for that we found 3D printer as a best option.

2.2. 3D printing:

This is the known technique to make three dimensional objects. This process of attaining 3D object by a soft file is an additive process [2].

To make the body of serving robot on 3D printer we use Acrylonitrile butadiene styrene (ABS) filament.

Reason behind choosing ABS is its strength, flexibility and inexpensive. This is an easy task of converting the digital file into a real 3D object. This will reduce the costing of preparing die also. In many industries, they are using 3D printer for the mass production also. This also reduces the cost per part.

"With the nine machines we have, we can produce 1,500 parts per day," says Mark Neilson, CEO of In'Tech.

We print the body part of serving robot by 3D printer to understand how the robot will then looks like after completion. After applying putty on it, it seems actually like a final product with strength.

Here we make a prototype body of serving robot by 3D printer (image below).

Figure 2: 3D Body of serving robot after printing

As the robot is of light weight, the support is needed to balance the body while navigating and to bear the load while serving food to customer.

3. Spine in robot:

As like in human body, we are proposing spine in a robot which gives it support as same as given by the spine in human.

Here is the image of spine designed and tested in Autodesk Inventor. This spine is made of stainless steel (SS) and having two fixtures on both ends. The top fixture is attached with the head and the lower fixture is attached with base of robot. Both ends are on same point vertically that gives the

Center of Gravity (CG). This will centralized the complete load on center of base of robot.

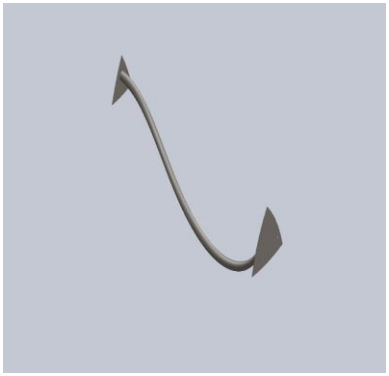

Figure 3(a): Spine in SS

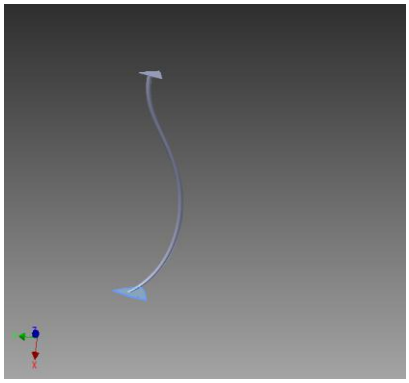

Figure 3(b): Design of Spine in Inventor

The reason behind simulating spine in Autodesk Inventor is to understand how it perform when it integrate with robot and serve to public.

3.1. Drafting of Spine:

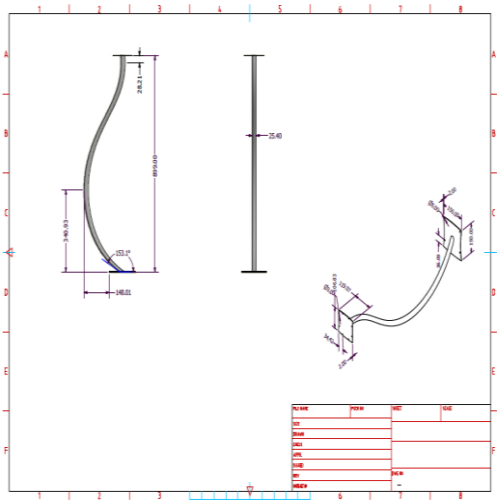

Figure 4: Drafting of Spine

3.2. Simulation of spine:

We simulate the load bearing on Inventor. Units system used on spine is:

Unit system:	SI (MKS)
Length/Displacement	Mm
Temperature	Kelvin
Angular velocity	Rad/sec
Pressure/Stress	N/m^2

Table 1: Unit System

Force of 200N has been apply on the fixture of head side (a) and then found that the stress is bearable on spine (b).

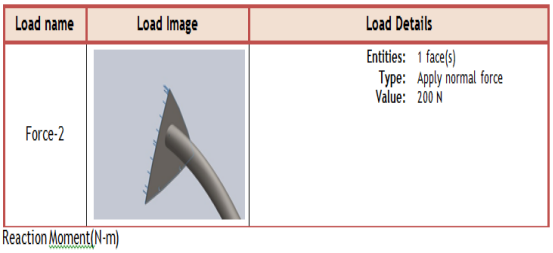

Figure 5: Load Apply on Spine

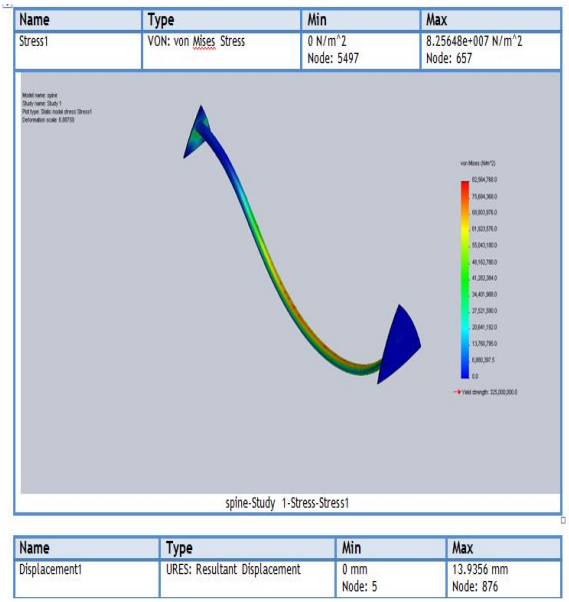

Figure 6: Stress Analysis of Spine

4. Base of robot:

Lower fixture of spine needs heavy support. This support is provided by heavy base made of iron. Below are the images of lower and upper part of base (a) (b) respectively.

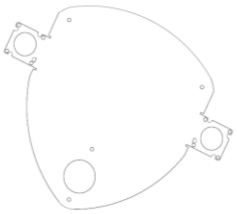

Fig. 7(a): Lower Part of Base

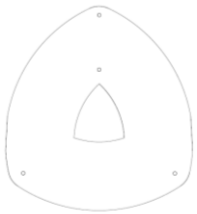

Fig. 7(b): Upper Part of Base

5. Drafting of prototype of robot:

We draft a prototype of serving robot. Here is the drafting image of our serving robot.

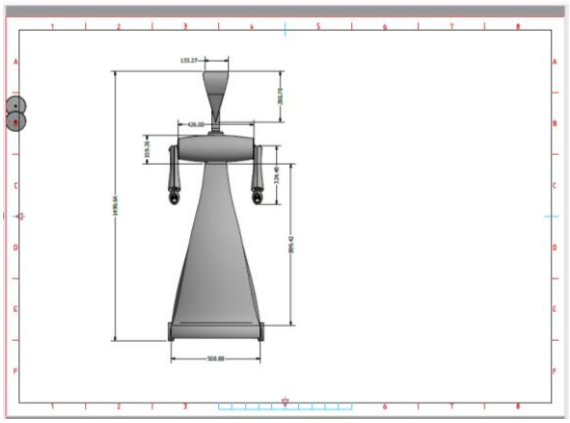

Figure 8: Drafting of serving robot

6. Conclusion:

Human body is a masterpiece by God, and to give support to this master piece he designed backbone or spine in body. With the same concept we propose a spine support in a robot.

In this paper, we focus on lightweight robot to serve public and propose spine in a robot that give support to the complete body to serving robot to balance and bearing load.

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