Intelligent Smart Step Design for Aged Individuals with Stable Automation

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Abstract: **The fabrication of smart steps for aged individuals involves integrating pneumatic cylinder directional control valves into a sheet metal framework. These valves enable precise control of step elevation, enhancing safety and usability for elderly users. By utilizing pneumatic technology, the smart steps can adjust height dynamically, providing support and stability. The sheet metal construction ensures durability and lightweight portability, catering to various environments and mobility needs. This innovative design optimizes accessibility and promotes independent living for seniors, addressing challenges associated with traditional step systems.**

Index Terms**—smart steps, pneumatic technology, Lightweight, portability.**

I. INTRODUCTION

Smart steps for aged people can be fabricated by integrating pneumatic cylinders controlled by directional valves. The pneumatic cylinders, powered by compressed air, provide smooth and controlled motion, ensuring safety for users. Sheet metal working principles are employed to shape and assemble the components, offering durability and stability. The directional control valves regulate the airflow to the cylinders, enabling precise movement and stability assistance for elderly individuals. This design combines advanced technology with efficient fabrication techniques to create reliable and user-friendly smart steps tailored for the needs of aged individuals, enhancing their mobility and independence.

II. COMPONENTS

A. sheet metal

Sheet metal is metal formed by an industrial process into thin, flat pieces. It is one of the fundamental forms used in metalworking and it can be cut and bent into a variety of shapes. Countless everyday objects are fabricated from sheet metal. Thicknesses can vary significantly; extremely thin thicknesses are considered foil or leaf, and pieces thicker than 6 mm (0.25 in) are considered plate.

Sheet metal is available in flat pieces or coiled strips. Sheet metal is used in automobile and truck (lorry) bodies, airplane fuselages and wings, medical tables, roofs for buildings (architecture) and many other applications. Sheet metal of iron and other materials with high magnetic permeability, also known as laminated steel cores, has applications in transformers and electric machines. Historically, an important use of sheet metal was in plate armor worn by cavalry, and sheet metal continues to have many decorative uses, including in horse tack. Sheet metal workers are also known as "tin bashers" (or "tin knockers"), a name derived from the hammering of panel seams when installing tin roofs

Sheet metal is used to make the table.

Material -	Mild steel
Size	-40*15cm
Thickness	-1mm

B. Pneumatic cylinder

Pneumatic cylinders can be used to get linear, rotary and oscillatory motion. There are three types of pneumatic actuator:

1. Linear Actuator or Pneumatic cylinders
2. Rotary Actuator or Air motors
3. Limited angle Actuators

Pneumatic cylinders are devices for converting the air pressure into linear mechanical force and motion. The pneumatic cylinders are basically used for single purpose application such as clamping, stamping, transferring, branching, allocating, ejecting, metering, tilting, bending, turning and many other applications.

Based on the cylinder action

Based on cylinder action we can classify the cylinders as single acting and double acting. Single acting cylinders have single air inlet line. Double acting cylinders have two air inlet lines. Advantages of double acting cylinders over single acting cylinders are

1. In single acting cylinder, compressed air is fed only on one side. Hence this cylinder can produce work only in one direction. But the compressed air moves the piston in two directions in double acting cylinder, so they work in both directions.

2. In a single acting cylinder, the stroke length is limited by the compressed length of the spring. But in principle, the stroke length is unlimited in a double acting cylinder

3. While the piston moves forward in a single acting cylinder, air has to overcome the pressure of the spring and hence some power is lost before the actual stroke of the piston starts. But this problem is not present in a double acting cylinder

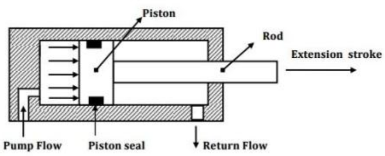

Figure: 1. Double Acting Cylinder

To achieve forward motion of the cylinder, compressed air is admitted on the piston side and the rod side is connected to exhaust. During return motion supply air admitted at the rod side while the piston side volume is connected to the exhaust. Force is exerted by the piston both during forward and return motion of cylinder. Double acting cylinders are available in diameters from few mm to around 300 mm and stroke lengths of few mm up to 2 meters

There are two types of double acting cylinders. Double acting cylinder with piston rod on one side.

i) Double acting cylinder with piston rod on both sides
ii) Double acting cylinder with piston rod on one side.

The operation of a double acting cylinder with piston rod on one side. To extend the cylinder, pump flow is sent to the blank end port as in Figure 1.8 (a). Fluid from the rod end port returns to the reservoir. To retract the cylinder, the pump flow is sent to the rod end port and fluid from the blank end port returns to the tank. A double acting cylinder with piston rod on both sides is a cylinder with rod extending from both ends. This cylinder can be used in an application where work can be done by both ends of the cylinder, thereby making the cylinder more productive. Double rod cylinders can withstand higher side loads because they have an extra bearing one on each rod to withstand the loading. Double rod cylinders are used when there is bending load and accurate alignment and maximum strength is required. A further advantage is that rod is precisely located and may be used to guide the machine member coupled to it, dispensing with external guides or bearing in many cases, most standard production models are available either in single rod or double rod configuration A disadvantage of double rod configuration is that there is a reduction in maximum thrust due to the blanking effect of the rod cross section on the piston area and a slightly larger size of cylinder is required for a given duty. The thus will be the same on the ingoing stroke as that of a single rod double acting cylinder.

DOUBLE ACTING PNEUMATIC CYLINDER:

- Stroke length : Cylinder stoker length 160 mm = 0.16 m
- Quantity : 1
- Seals : Nitride (Buna-N) Elastomer
- End cones : Cast iron
- Piston : EN – 8
- Media : Air
- Temperature : 0-80 º C
- Pressure Range : 8 N/m².

III. PNEUMATIC CYLINDER DESIGN

Design of Piston rod:

Load due to air Pressure.

Diameter of the Piston (d) = 40 mm

Pressure acting (p) = 5.886 bar

Material used for rod = C 45

Yield stress (σ_y) =353.16N/mm^2

Factor of safety = 2

Force acting on the rod (F)= Pressure x Area

= 739.6 N

Design Stress(σ_y) = σy / FOS

= $176.5 N/mm^2$

∴ Minimum diameter of rod required for the load = 2.3 mm

The poposed diameter of the rod = 15 mm

Length of piston rod:

Approach stroke = 160 mm

Length of threads = 40mm

Extra length due to front cover=12 mm

Extra length of accommodate head = 20 mm

Total length of the piston rod = 232 mm

By standardizing, length of the piston rod =230 mm.

CONNECTOR
- Max working pressure: 10×10^5 N/m²
- Temperature : 0-100 ° C
- Fluid media : Air
- Material : Brass

HOSE SPECIFICATION
- Max pressure : 10×10^5 N/m²
- Outer diameter : 6 mm = 6×10^{-3}m
- Inner diameter : 3.5 mm = 3.5×10^{-3}m

V. LIST OF MATERIALS

METAL FRAME:

The metal frame is generally made of mild steelbars for machining, suitable for lightly stressed components including studs, bolts, gears and shafts. It can be case-hardened to improve wear resistance. They are available in bright rounds, squares and flats, and hot rolled rounds.

ADVANTAGES:

Firstly, these steps are equipped with sensors and technology that detect motion, reducing the risk of falls and accidents. Secondly, they can provide real-time feedback and alerts, promoting better awareness of one's movements and potential hazards. Thirdly, smart steps can be integrated with other smart home devices, enhancing overall safety and convenience for seniors. Additionally, they can track activity levels and encourage a more active lifestyle, contributing to better health outcomes. Overall, smart steps empower aging individuals to maintain independence and safety in their own homes.

APPLICATION:

- The "Smart Steps" app revolutionizes elderly care by offering personalized support for mobility. Through AI-driven analysis of gait patterns and health data, it provides real-time feedback, exercise routines, and fall detection alerts. With intuitive interfaces and seamless integration with wearables, it empowers seniors to maintain independence and safety in their daily lives

CONCLUSION

In conclusion, the "Smart Steps" application stands as a beacon of innovation in elderly care, bridging the gap between technology and well-being. By harnessing the power of artificial intelligence, it offers a comprehensive solution for mobility support, fostering independence and safety among seniors. Through its user-friendly interfaces and seamless integration with wearable devices, it empowers older adults to navigate their daily lives with confidence. With a focus on personalized feedback and proactive fall detection, it not only enhances physical health but also provides peace of mind to families and caregivers. "Smart Steps" represents a transformative step towards a more inclusive and supportive future for aging populations.

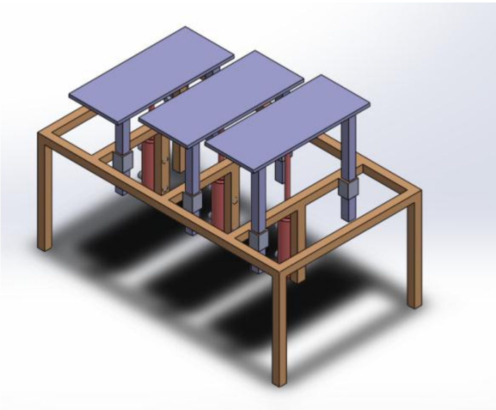

Fig. 2. Modelling of Smart steps.

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