Design And Fabrication of Remote Controlled Portable Vacuum Gripper

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Abstract- *Biosafety labs are exposed to hazardous pathogens. In this paper, the study is an innovative approach of a gripper for handling small size, shape and weight of products. In this paper, a portable vacuum gripper is developed for pick and place operation by a worker. It works on Bernoulli principle. Overall observation and calculation is used to demonstrate and obtain the advantages and restrictions of the portable vacuum gripper. By analyzing those results a prototype of a simple and economic gripper is refined that manifest an efficient machine in the labs. It is designed for the specific application.*

Keywords- Gripper, vacuum generator, vacuum cup, suction, Bernoulli principle.

I. INTRODUCTION

The vacuum gripper is a type of transportable gripper for handling variable size, shape and weight of flat objects. It operates on the principle of Bernoulli for generating a high-speed flow between the gripper plate and the product surface thereby creating vacuum which lifts the product. Portable vacuum gripper is a device that actually grips an object and moves it with the help of motors. Motors are placed at the bottom of the frame. A gripping technology with vacuum gripper design system consideration for related components, such as two-dimensional modules and three-dimensional modules. The system comprises of frame, lifting rod, compressor, solenoid valve, double acting cylinder, battery, pressure switch, vacuum generator, suction sup, motors, wheels, tubes, silencer, fasteners and connectors, camera, camera holder, arduino microcontroller, mobile app used for the movements.

The Vacuum suction is the key operation which is carried out by the vacuum suction cup, for which research and studies had to be carried out as to choose a suitable vacuum suction cup to act as a gripper.

A study was made by having an innovative approach of a gripper for handling variable size, shape and weight of flat objects i.e., vacuum gripper of robot [3].

The collaboration of the gripper mechanism and vacuum suction mechanism working as a single pick and place robotic arm was observed in [2].

The significant insight regarding vacuum suction grippers was done by [1] and its application in the biosafety labs is an objective to achieve the threats and accidents with respect to biosafety labs.

Some 395 reported potential release events of select agents occurred in U.S. government laboratories between 2003 and 2009, the University of Minnesota's Centre for Infectious Disease Research and Policy (CIDRAP) reported. Select agent is government-speak for a biological agent or toxin that is considered to pose a severe threat to human, animal or plant health-or livestock and agricultural products. Special approval from the government is required to handle these agents and toxins, and that can only happen in specially equipped labs. Not all labs, of course, are of the Contagion and Outbreak biosafety level-4 can handle mega killers such as Ebola and smallpox. But there are plenty of other organisms studied in government labs that can easily infect and sicken humans if an accidental release occurs.

Some major incidents that could have been prevented are given below:

May-2014: 62 Employees from the Centre for Disease Control and Prevention Atlanta, US were exposed live Anthrax bacteria after potentially infectious samples were sent to labs unequipped to handle them. Another 2 weeks after the incident the lab accidently contaminated a relatively benign flu sample with bird flu.

October 2015: At the Surrey-based Animal Health and Veterinary Laboratories Agency (AHVLA) UK, scientists were handling anthrax when something went badly wrong. They meant to send harmless samples, killed by heat, to nearby AHVLA labs and others in York and Belfast. But somehow the tubes got mixed up. Instead of sending out dead material, the anthrax they sent was alive and dangerous. The staff who made the mistake were safe enough. They worked in

a high-security lab built to contain lethal agents. But some of those who received the bugs did not. In Belfast, the anthrax was handled in a higher containment lab, meaning that staffs were safe. In York, the samples were never opened. But at another AHVLA site, scientists opened the tubes in a less secure lab and got to work on the open bench. The incident at the AHVLA is one of the more serious biological accidents that has happened in the UK in recent years. But it was far from being the only one.

December-2014: On Dec 22, a worker at CDC's biosafety level 4 lab in Atlanta where scientists wear spacesuit-like, full-body protective gear that filters the air they breathe accidently confused some specimens and sent an un-killed sample from an Ebola experiment to a lower-level lab with minimal protections. When the mistake was discovered, CDC scientists thought there may be live virus in the specimen, and an unprotected lab technician who received the un-killed specimen had to undergo 21 days of monitoring over the holidays for possible Ebola infection. No illness resulted.

II. PROBLEM STATEMENT

In Biohazard containment laboratories, when standard laboratory practices are not sufficient to control the hazards associated with a particular agent or laboratory procedure, additional measures may be needed. A lot of risk is involved in transferring the bio agents from one Biosafety cabinet (BSC) to another. BSC's are enclosed containers which are designed to remove or minimize exposures to hazardous biological materials. BSC is the principal device used to provide containment for biosafety level 2 & 3 infectious droplets or aerosols generated by many microbiological procedures.

A lot of incidents have occurred which could have been avoided by adding extra measures. A small mishap or incident may have been catastrophic results. For the protection of the researchers involved the public and the specimen itself. Any possible procedure need to be incorporated to reduce the risk.

III. METHODOLOGY

For the Design and Fabrication of a remote controlled portable vacuum gripper the following methodology was adopted: -

- Literature Review
- Calculations and design parameters
- Purchasing components
- Fabrication of parts
- Assembly of parts
- Control and programming
- Testing and trouble shooting
- Conclusion

IV. DESIGN PARAMETERS

Weight of the arm arrangement, **W1** = 700 gram
Maximum weight to be lifted, **W2** =100 gram
Total weight, **W** = **W1** + **W2**
= 700 + 100
= 800 g
= 0.8 Kg
= 7.848 N

Diameter of the piston, $\mathbf{d_1}$ = 20 mm
Diameter of the rod, $\mathbf{d_2}$ = 8mm
The pressure required to lift total weight is calculated to be, **P= 0.2498 bar**
The force required by the cylinder to lift total weight**:**

$$\mathbf{F_{ext} = 31.4159\ N}$$

Keeping these parameters, the model was created. Fig 1 shows the 3D model of the portable vacuum gripper.

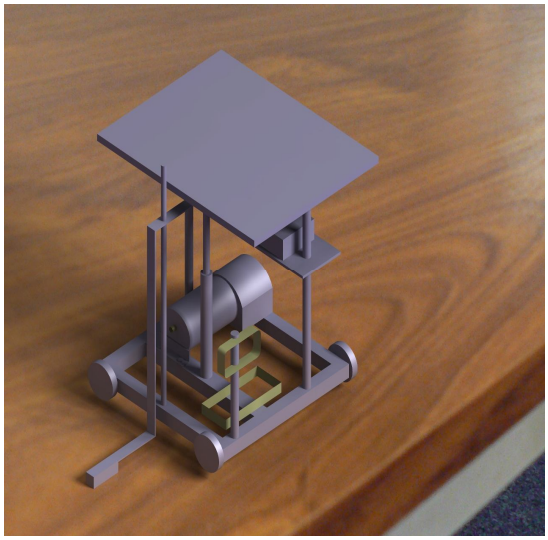

Fig. 1: 3Dmodel of the RC-PVG

The above design had been made with respect to the design constraints to achieve sustainable pick and place operations.

V. VACUUM GENERATION PRINCIPLE

The vacuum suction takes place due to the vacuum generator to which the suction cup is attached.

The vacuum generator used to produce the vacuum suction mechanism operates per the venture principle. It is shown in Fig.2.

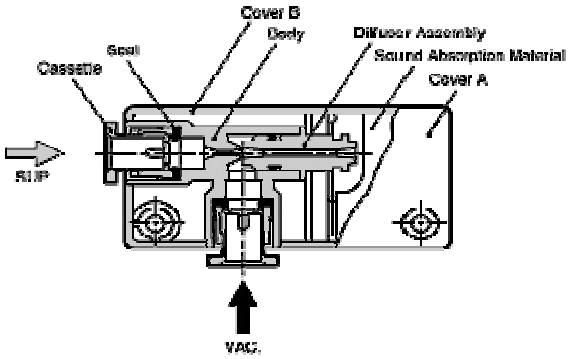

Fig.2: Section view of Vacuum Generator.

The compressed air flows from the pressure supply port into the ejector. The constriction in the venture nozzle increases the flow velocity of air to much higher speed. After exiting the venture nozzle, the air expands and flows through the receiver nozzle into the outlet port (silencer). In the process, a vacuum is created in the chamber between the venture and the receiver nozzles, which air to be drawn in from the vacuum port. The vacuum created between the gripper and object causes a pocket to hold the object. The vacuum and exhaust air both leave through the outlet port (silencer). Fig .3 shows the image of completely fabricate and fully functional remote controlled portable vacuum gripper.

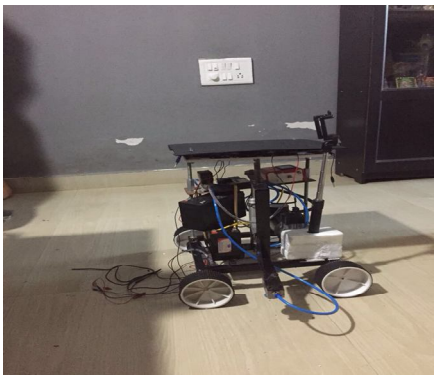

Fig.3: Remote controlled portable vacuum gripper

VI. CONCLUSION

In this paper, vacuum Gripper in industrial robot applications has been discussed exclusively with gripping of different variety of materials. The end effectors must typically be designed for the specific application. By comparison to the human hand, a robot's

Vacuum gripper is very limited in terms of its mechanical complexity, practical utility and general applications. Vacuum gripper is fruitful for the objects of very different shape, weight & fragility can be gripped. This diversity of abilities may make the gripper well suited for use in unstructured domains for tasks in lab.

The prime interest of this paper is to explore the utilities and advantages of vacuum gripper with its applications.

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