An Automatic Intelligent Wall Climbing Robot: Wallbot

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Abstract: The main objective of designing this robot is simplify the challenge of climbing on the high buildings, trees, etc. which is almost impossible for humans. Our target is to build a wall-climbing robot that can climb walls, walk on ceilings, crawl through pipes and traverse on floors for which we have used a different technology of Attraction Force caused due to Bernoulli’s effect. This paper proposes a new suction method based on a mechanism utilizing hook-like claws and presents the design of a robot system for inspecting rough concrete walls. We present a method for describing the degree of concrete surface roughness that is attachment and detachment of the suction vacuum pump based on Bernoulli Effect. The results indicate that the low-cost system endows the robot with enhanced climbing stability and satisfies the inspection requirements for tower constructed by water brush stone or bricks.

Keywords: Suction Pump, Microcontroller AT89S52, Vacuum, Bernoulli’s Effect, Attraction.

1.0 INTRODUCTION

Robotics is the branch of technology that deals with the design, construction, operation, and application of robots, as well as computer systems for their control, sensory feedback, and information processing. The design of a given rover will often incorporate human effort, though it may not look much like a human being or function in a human like manner. These types of intelligent systems having robust and feasible model with a number of integrated functionalities is the demand of future in every field of technology, for the betterment of the society.

In our work, the whole action is controlled by an 8-bit microcontroller AT89S52. The Wall Climbing Robot (WCR) having capability that it can stick on a vertical as well as inclined surface and can easily move over the surface. The targeted capability to stick with surface can be achieved by either suction cups or electrostatic chucks. Suction cups create a vacuum pressure used to stick with vertical or inclined surface. Electrostatic Chucks create a controlled adhesion by means of some intermolecular or charged force. The movement on the surface can be achieved by stepper motor wheel or a balanced movement of suction cup legs.

### 2.0 ATTRACTION FORCE DUE TO BERNOULLI EFFECT

Bernoulli Effect dictates a relationship between pressure, velocity, and position or elevation in a flow field. The original equations are very complex and can only be solved in very special conditions. Therefore, in most problems assumptions are made to simplify the equations which are omitted in this paper. These assumptions are applicable to experiments involving the wall climbing robot. The Bernoulli principle states that in an ideal fluid (low speed air being a good approximation) with no work being performed on the fluid, an increase in velocity occurs simultaneously with a decrease in pressure. This principle is a simplification of Bernoulli equation, which states that the sum of all forms of energy in a fluid flowing along an enclosed path (a streamline) is the same at any point in that path.

\[
\frac{V^2}{2} + \frac{p}{\rho} + gh = \text{const}
\]

Where \( g \) is acceleration of gravity \([m/s^2]\), \( p \) static pressure \([N/m^2]\), \( v \) velocity of the air along the streamline \([m/s]\), \( \rho \) density of the fluid \([kg/m^3]\), and \( h \) elevation or height of the point of consideration in the streamline \([m]\).

The constant value can be different for different streamlines. Comparing two points on one streamline, the following equation is obtained:

\[
\frac{v_1^2}{2} + \frac{p_1}{\rho} + gh_1 = \frac{v_2^2}{2} + \frac{p_2}{\rho} + gh_2
\]

If there is no height difference between the two points, the following equation stands:

\[
\frac{v^2}{2} + \frac{p}{\rho} = \text{const}
\]

This equation shows that for an ideal fluid travelling along a horizontal streamline, the pressure decreases with a simultaneously increasing velocity. Consequently, the pressure drop leads to an attraction force. This principle has been used in some industrial applications such as non-contact wafer transportation and food handling.

A non-contact end effector for robot handling of non-rigid materials has been developed by F. Erzin canli and J.M. Sharp in 1998 [3]. They studied the radial outflow between two disks and considered laminar as well as turbulent. The air pressure distribution between two disks, upper one with a perpendicular hole and lower disk plain, starts with a high pressure in the middle which creates a force against the second disk and lowers the total adhesion force of the device before it decreases under the ambient pressure, as shown in Fig. 1.
The stronger one of their devices was built out of nine radial nozzles with 10.8 mm outer diameter and an orifice diameter of 2.7 mm. This device can only lift jelly blocks up to 175 grams at a gauge pressure of 100 kPa with an air flow rate around 200 l/min.

Another interesting device which delivers a more satisfying force is the Bosch Rexroth non-contact transport system (NCT) [1, 2]. The advantage over Erzincanli’s and Sharp’s end effector is the deflection of the air stream to the sides of the device as shown in Fig. 2.

3.0 PROPOSED DESIGN
3.1 BLOCK DIAGRAM

![Block Diagram](image)

3.2 WORKING FLOWCHART

![Flow Chart](image)
4.0 SOFTWARE DEVELOPMENT

4.1 SOFTWARE CODING

```c
#include<reg52.h>
void delay (int ms);
int step_seq1[7]={0x78,0x7c,0x74,0x76,0x72,0x73,0x79};
int step_seq2[7]={0x79,0x73,0x72,0x76,0x74,0x7c,0x78};
volatile int step=0;
volatile int stepstop=50;
unsigned int cnt=0;
void relayall();
void leg1();
void leg2();
int main()
{
    P0 =0xFF;
P1=0x00;
P2=0x00;
P0=0xFF;
P1=0xFF;
P2=0xFF;
    while(1)
    {
        if(P0==0xFE)
        {
            relayall();
        }
        if(P0==0xFD)
        {
            leg1();
P0=0xFE;
            relayall();
        }
        if(P0==0xFB)
        {
            leg2();
P0=0xFE;
            relayall();
        }
    }
    void relayall()
    {
        do{
            P1=0x7F;
delay(10);
P2=0x7F;
delay(10);
        }while(P0==0xFE);
    }
    void leg1()
    {
        step=0;
cnt=0;
        for(;step<stepstop;cnt++)
        {
            P1=step_seq1[cnt];
delay(50);
        }
    }
```
void leg2()
{
    step=0;
    cnt=0;
    for(;step<stepstop;cnt++)
    {
        P2=step_seq2[cnt];
        delay(50);
        if(cnt>=4)
        {
            cnt=0;
            step++;
        }
    }
    delay (int ms)
    {
        char k;
        while (ms)
        {
            for (k=0; k<120; k++);
        }
    }

4.2 SOFTWARE SIMULATION AND DEBUGGING

The above C code is simulated successfully in µVision4 Software and debugged as shown in Fig. 5 and Fig. 6.
5.0 APPLICATIONS

A Wall-Climbing Robot system has wide applications include remotely monitoring hazardous environments, reconnaissance, defects inspection, and firefighting. However, for current needs in areas such as biomedical, aerospace, environmental and military systems, walking or climbing autonomous robots are needed. Object manipulation and surveillance are crucial for many applications, and in many cases, require an ability to climb walls.

6.0 REFERENCES