# AUTOMATED VACUUM CLEANER USING VLSI DESIGN

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## ABSTRACT

The first attempts to provide a mechanical solution to floor cleaning were begun in England in1599.Before vacuum cleaners, rugs were hung over a wall or line and hit repeatedly with a carpet beater to pound out as much dirt as possible. The Project deals with development of an automated vacuum cleaner that monitors various parameters such as dust availability, space limit ,presence of light and obstacle[4] detection. The Space can be measured using a survobot . An System on Chip is developed for the same using VLSI Design and a Verilog code[7] is written for the same .The code is simulated on XILINX tool and Altera Quartus II .Also the synthesized output is observed for the desired System On Chip.

**KEYWORDS:** SoC , Survobot , Xilinx.

## I. INTRODUCTION

Vacuum cleaners,which are used in homes as well as in industry,exist in a variety of sizes and models-small battery-powered hand-held devices,wheeled canister models for home use,domestic cental vacuum cleaners,huge stationary industrial appliances that can handle several hunderd litres of dust before being emptied,and self-propelled vacuum trucks for recovery of large spills or removal of contaminated soil.Specialized shop vacuums can be used to suck up both dust and liquidsSystem on Chip [1] is one such emerging methodology where the components of a computer or other electronic systems are integrated into a single chip. High performance, good process technology, size reduction, efficient battery life time and cost effectiveness result in use of System on Chip design[7] and help in achieving highest level of integration. Due to complexity, designers had to come up with higher level of design abstraction [5].

Due to consumer demands for cost effectiveness and high performance, multiple complex components into a single chip are integrated by a semiconductor manufacturing industry. The requirement for a greater telecommanding capability and efficiency arises with the increased complexity of the remotely located physical devices.

## II. HISTORY OF VACCUM CLEANER

On June 8,1869, [2] Chicago inventor,Ives McGaffey patented a "sweeping machine".This was the first patent for a device that cleaned rugs,however,it was not a motorized vacuum cleaner.McGaffey called his machine the Whirlwind and it was the first hand-pumped vacuum cleaner in the United States, a wood and canvas contraption.

## III. DESIGN OF VACCUM CLEANER

### *A) Block Diagram Of SOC for Vacuum Cleaner*

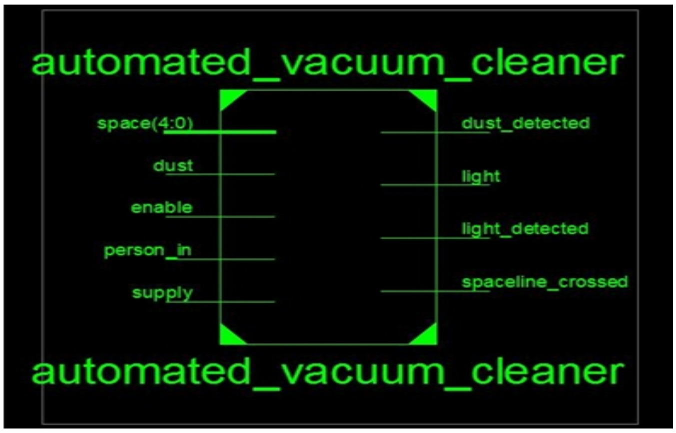


**Fig.1 SoC for Vaccum Cleaner**

### *B) Dust Sensors in Vaccum Cleaner. [6]*

A vacuum cleaner with a dust sensor comprising a light-emitting element and a light-receiving element for receiving light emitted from the light emitting element.The dust sensors is provided in a suction passage between a suction nozzle and a dust collector of the vacuum cleaner for detecting dust in air drawn through the suction nozzle to generate a current corresponding to the detection result.A manual switch decreases sensitivity to dust detection while a rotatable member cleans a carpet.

This prevents variations in dust detection from influencing operation of the rotatable cleaning member.

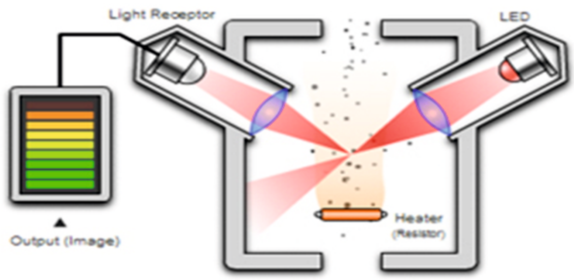


**Fig.2 Optical Dust Sensor**

Description known is a vacuum cleaner with a dust sensor provided in an air passage between a suction opening and a dust collecting device. When dust is included in the drawn air, the dust sensor senses the dust and indicates the presence of the dust by means of an indication lamp, for example,and heightens the rotational speed of an electrical blower for a predetermined time period.

However, for adequate cleaning, the adjustment of the sensitivity of the dust sensor is required in accordance with the kind of object to be cleaned by vacuum cleaner.

For example, when cleaning a shaggy carpet, the dust detection sensitivity is required to be lowered as compared with the sensitivity for a board floor, because the dust sensor tends to detect the pile of the shaggy carpet as dust.

### *C) Obstacle Detection In Vacuum Cleaner*

Obstacle detection is an important task for many mobile robot applications. Most mobile robots rely on range data for obstacle detection. Popular sensors for range-based obstacle detection systems include ultrasonic sensors, laser range finders, radar, stero vision, optical flow, and depth focus.

A real-time obstacle avoidance method for mobile robots which has been developed and implemented is described. This method, named the vector field histogram (VFH), permits the detection of unknown obstacles and avoids collisions while simultaneously steering the mobile robot toward the target. The VFH method uses a two-dimensional Cartesian histogram grid as a world model. This world model is updated continuously with range data sampled by onboard range sensors. The VFH method subsequently uses a two-stage data-reduction process to compute the desired control commands for the vehicle. Experimental results from a mobile robot traversing densely cluttered obstacle courses in smooth and continuous motion and at an average speed of 0.6-0.7 m/s are shown.[9]

***D) Survobot Implementation [10]***

The purpose of this system is to how it helps to trounce the limitations of conventional land surveying methods. The construction and working of Survobot is explained below.

I) Construction The Survobot as seen in figure is a 2 wheeled robot which has an omni-directional wheel attached to the front portion. The body material of the robot is made of ply wood which is of 12mm thickness, having dimensions of 15 x 5 inches.

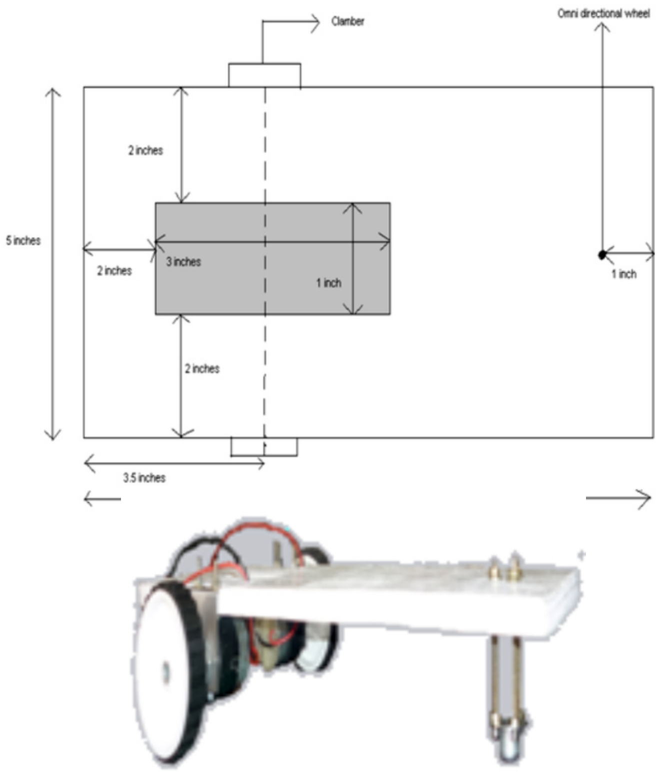


**Fig.4 Side view of the Chasis**

Here, the ply wood of such a dimension is used to neatly place the micro controller which provides the control mechanism, Zigbee module for transmission and the various drivers used to driver their respective motors. Also it provides a suitable space to insert the marker used in subdivision of plot. We have a rectangular slot of dimension 3 x 1 inches which has been cut in as shown in figure. This slot serves as an opening wherein we place a marker that will be later used, when we have to divide the plot into subplot. In the front portion on the Survobot, three holes are drilled 1 inch from the side of the ply wood, which is used to hold the omni directional wheel using three screws. Here this omni directional wheel is used to provide direction to the Survobot, that is, it enables the robot to take turns at an easier pace. At the rear end, pair of clampers is connected at opposite sides. It is used to hold the chassis wheels and the DC motors onto the plywood. The geared DC motors is used to provide controlled motion for the Survobot.

***ii) Control Mechanism***

For area measurement and sub-division of plots there is a need to control the motor appropriately.

To control the Survobot's movement in appropriate direction, a controlled operation of wheels and geared DC motor is required. The condition of motors under various movements

**1) Forward motion**: Forward motion is obtained by connecting the motors to power so that both motors make the wheels move forward. Motor M1 is connected to the power supply to turn the motor in positive direction; motor M is connected to the power in reverse.

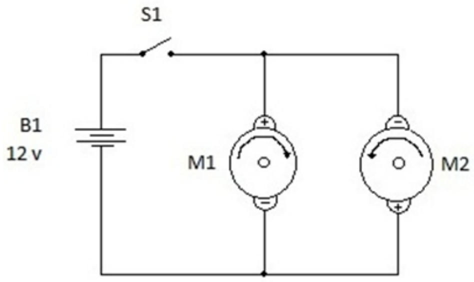


**Fig.5 Forward motion**

**2) Backward motion**: Backward motion is obtained by connecting the motors to power so that both motors make the wheels move backward.

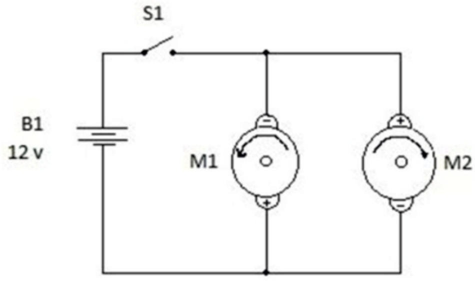


**Fig. 6 Backward Motion**

***E) Light Sensor [8]***

The APDS-9003 is a low cost analog-output ambient light photo sensor in miniature chipLED lead-surface mount package. It consists of a spectrally suited photo sensor, which provides excellent responsivity that is close to the response of human eyes.The APDS-9003 is ideal for applications in which the measurement of ambient light is used to control display backlighting.

Mobile appliances such as the mobile phones and PDAs that draw heavy current from display backlighting will benefit from incorporating these photo sensor products in their designs by reducing power consumption significantly.

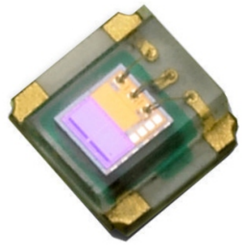

**Fig.7 APDS-9003 Light Sensor**

**IV. SIMULATION RESULTS**

In order to experimentally verify the proposed scheme, the desired System on Chip components are is implemented in Xilinx 14.7 and Altera Quartus II Softwares. The algorithm is described in VHDL code[6][7][8].The code is tested for data input of 8 bits and synthesized for SPARTAN 6 FPGA[3] Devices and Spartan 6 FPGA[3] Devices and on Cadence Tool.

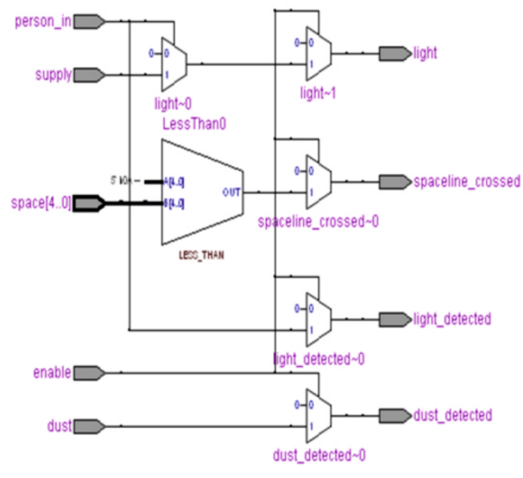


**Fig .8 Top level Entity for Vaccum Cleaner SOC**

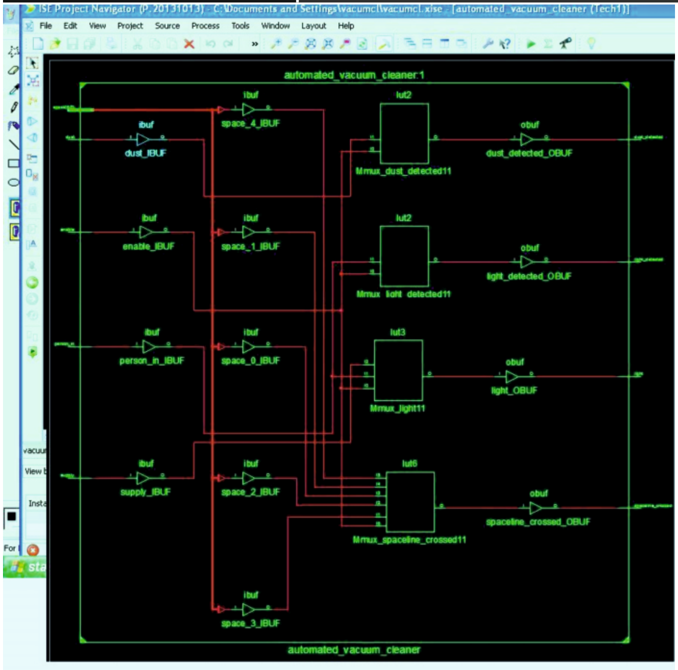


Fig .9Top level Entity for Vaccum Cleaner SOC

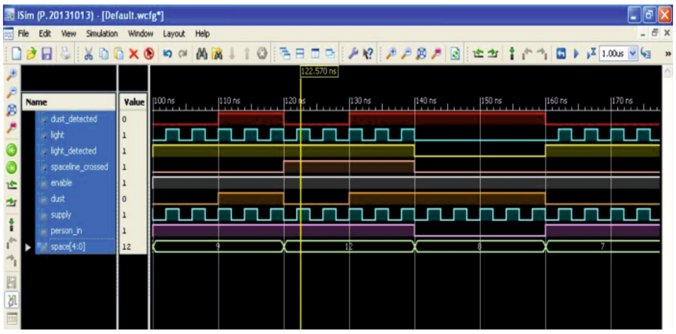

Fig.10 Simulation result of Top level RTL

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===========================================================================
Timing Report

NOTE: THESE TIMING NUMBERS ARE ONLY A SYNTHESIS ESTIMATE.
      FOR ACCURATE TIMING INFORMATION PLEASE REFER TO THE TRACE REPORT
      GENERATED AFTER PLACE-and-ROUTE.

Clock Information:
------------------
No clock signals found in this design

Asynchronous Control Signals Information:
----------------------------------------
No asynchronous control signals found in this design

Timing Summary:
---------------
Speed Grade: -3

   Minimum period: No path found
   Minimum input arrival time before clock: No path found
   Maximum output required time after clock: No path found
   Maximum combinational path delay: 5.622ns
```

Fig.11 Timing Report1

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Timing Details:
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All values displayed in nanoseconds (ns)

=========================================================================
Timing constraint: Default path analysis
  Total number of paths / destination ports: 13 / 4
-------------------------------------------------------------------------
Delay:               5.622ns (Levels of Logic = 3)
  Source:            enable (PAD)
  Destination:       spaceline_crossed (PAD)

  Data Path: enable to spaceline_crossed
                                Gate     Net
    Cell:in->out      fanout   Delay   Delay  Logical Name (Net Name)
    ----------------------------------------  ------------
     IBUF:I->O             4   1.222   1.048  enable_IBUF (enable_IBUF)
     LUT6:I0->O            1   0.203   0.579  Mmux_spaceline_crossed11 (spaceline_crossed
     OBUF:I->O                 2.571          spaceline_crossed_OBUF (spaceline_crossed)
    ----------------------------------------
    Total                      5.622ns (3.996ns logic, 1.626ns route)
                                       (71.1% logic, 28.9% route)

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Cross Clock Domains Report:
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Fig.12 Timing Report2

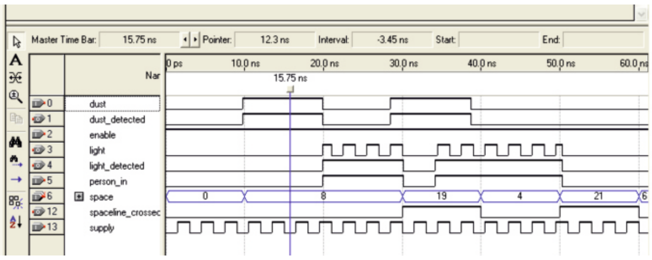


Fig. 13 Simulation Results of Vaccum Cleaner in Quartus II

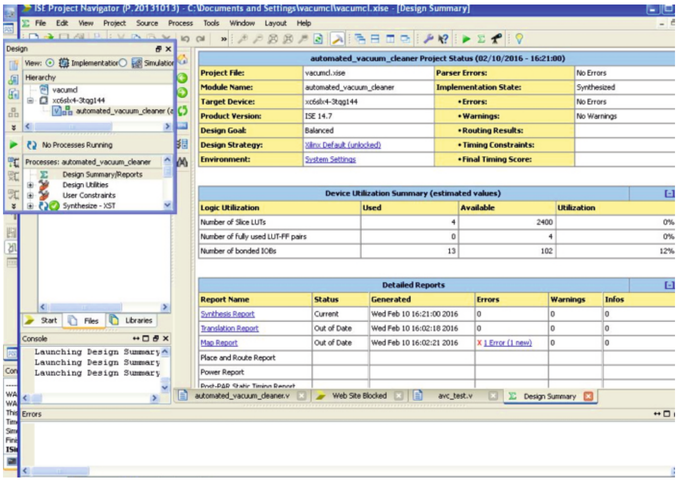


Fig .14 Spartan 6 device utilization summary for SoC

## IV. CONCLUSIONS

The role of the SoC designer is to integrate different components onto a single chip to implement complex functions instead of implementing each of these components separately. The simulation of each system is done separately and then integrated to produce final output. Design Summary and synthesized output is generated for the same using XILINX Tool and Altera Quartus II .

## ACKNOWLEDGMENT

We wish to acknowledge HKBK College of Engineering for providing the Infrastructure to carry out the process of developing a SoC for an Automated Vaccum Cleaner in VLSI Using Xilinx Tool and its implementation on FPGA .

## REFERENCES

1. Development of SoC for Network Address and Error Correction Using Parity Bit at Transport Layer in VLSI Using Cadence Tool Ms. Subiya Yaseen,Mr.Shaik Aleem Ur Rehaman,Christ University,Feb14,2015
2. https://en.wikipedia.org/wiki/Vacuum_cleaner
3. A Practical Path Planner for the Robotic Vacuum Cleaner in Rectilinear Environments , Author(s)NakjuLettDoh Korea Univ., Seoul Chanki Kim ; Wan Kyun Chung
4. H. Lee , Research roadmap of intelligent robots , pp.224 -225 , 2005 :Foundation of Korea Industrial Technology
5. Ground Station to Spacecraft Telecommand System SoC Development Using FPGA, International Conference KSIT.
6. Vacuum cleaner with device for adjusting sensitivity of dust sensor.Inventor(s) Yoshinori Takashima, Toshiichiro Tanaka
7. Chapter 7, "Logic and Computer Design Fundamentals", Mano And Kime 2000,Printice Hall.
8. APDS-9003, Avago Technologies datasheet URL:http://www.avagotech.com/docs/AV01-0238EN
9. The vector field histogram-fast obstacle avoidance for mobile robots,Author(s) Borenstein, J. Adv. Technol. Lab., Michigan Univ., Ann Arbor, MI, USA Koren, Y.
10. Design And Implementation Of Survobot, Ms. Shruthi Harindran,Ms.Subiya Yaseen, Mrs.Sumaiya Fathima