A Novel Methodology for the Design of a Portable Ventilator

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Abstract: ***Ventilator device are external devices that are designed to assist a patient to perform a particular task. It is to keep up or improve a breathing ability of a person if he encounters problem in his own breathing. Ventilators play a vital role in human's life. It is a piece of equipment, software program or product system that is used to increase, maintain, or improve the functional capabilities of persons with disabilities in breathing period. This paper deals with the hardware design of a lab model ventilator. A prototype model of the ventilator has been designed and tested***

Keywords : Ventilator, Respiration, Arduino, portable, flowmeter.

I. INTRODUCTION

Respiratory maladies and damage incited respiratory disappointment comprise a noteworthy general medical issue in both created and less created nations. Asthma, incessant obstructive aspiratory infection and other perpetual respiratory conditions are boundless. These conditions are exacerbated via air contamination, smoking, and consuming of biomass for fuel, which are all on the ascent in creating nations. Patients with basic lung sickness may create respiratory disappointment under an assortment of difficulties and can be bolstered mechanical ventilation. These are machines which precisely help patients move and breathe out, permitting the trading of oxygen and carbon dioxide to happen in the lungs, a procedure alluded to as fake breath . While the ventilators utilized in current emergency clinics are exceptionally practically and innovatively complex, their obtaining expenses are correspondingly high. Staggering expenses render such innovatively advanced mechanical restrictively costly for use in asset poor nations. Also, these ventilators are regularly delicate and powerless during proceeded with use, requiring expensive administration contracts from the maker. In creating nations, this has prompted practices, for example, sharing of ventilators among emergency clinics and acquiring of less dependable revamped units. Since therapeutic assets in these nations are amassed in major urban focuses, now and again country and peripheral zones have no entrance at all to mechanical ventilators.The main contribution of the paper is design a portable ventilator model which can be used for measuring the respiration status of humans. A prototype is developed which is a cost effective one by placing the potentiometer and needle valve in place of flow analyzer. At initial stage our ventilator were be working with amount of 1bar in compressed air through the regulator, then moving to the solenoid valve for on & off condition. From solenoid end two ways are developed, one end is connecting in needle valve and potentiometer the other end is exhalation valve. After adjusting the flow of air through needle valve and potentiometer the tube was developed from 6mm to 8mm for the connection purpose of test lung bag. It were be used to show the inhalation and exhalation of patient. Finally, the total prototype was able to illustrate the major four parameter of ventilator.

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II. LITERATURE SURVEY

The execution of closed loop control of tidal volume parameter which is controlled in mechanical ventilators utilized at serious consideration units (ICU) and veterinary resources for exploratory examinations was actualized by H. Güler and F. Ata, which reduction the remaining burden of clinicians. L. D'Orsi, A. Borri and A. De Gaetano built up the firstversionofasimplebutrealisticphysiologicallungventilation mathematicalmodel. The patient-ventilator complex is considered by demonstrating the weight wave providedbythemechanicallungventilatorasanexternal(control) input.R. Robert, P. Micheau, O. Avoine, B. Beaudry, A. Beaulieu and H. Walti, planned a vigorous controller to perform weight managed expiratory stream and to execute it on the most recent fluid ventilator model (Inolivent-4) utilizing Numerical reproductions and reasoned that weight controlled ventilation incredibly streamlines the utilization of the fluid ventilator, which will surely encourage its presentation in escalated care units for clinical applications.
Borello has just proposed the structure of an adjustment plot for a steady and exact control of air and oxygen gas for ventilators. This new controller offers uniform following of dynamic stream reference flag over the full scope of patient burden from huge grown-up to little newborn child in this way requiring no manual (from the earlier) determination in the control structure or its additions to modify for patient size. Mustafa has gotten the mathematical models of known and used air flow and volume signals in clinical medicine, LabVIEW and MATLAB/Simulink condition based reproductions for a Pressure-controlled ventilator. Volyanskyy has built up a neuro-versatile control design to control lung volume and moment ventilation with information weight imperatives that likewise represents unconstrained breathing by the patient. A microcontroller based advanced control of a modern application is produced for the situating control of a ventilator cylinder in a fake breath gadget. A model mechanical ventilation arrangement of a lung test

system was proposed for trial ponder. Reproduction and experimental studies on the air flow dynamic of the mechanical ventilation framework were done by Yan Shi and the weight dynamic qualities of the mechanical ventilator framework were dissected. The ideal determination of mechanical ventilator settings that guarantee satisfactory oxygenation and carbon dioxide leeway while limiting the danger of ventilator-related lung damage (VALI) is a critical test for concentrated consideration clinicians and has been structured by Anup Das. Maria has dissected the contrasts among volume and weight controlled ventilation demonstrating that weight controlled ventilation allows a more reliable compensation of breathing circuit compressible volume. Toyama assessed the exactness of three unique ventilators to convey little VT during volume-controlled ventilation. Hussain proposed Synchronized Intermittent Mandatory Ventilation mode control utilizing Pulse Oximeter that is shabby, exact and simple to use to programmed state in a sensible spending plan improving wellbeing offices in poor nations like Pakistan.

III. HARDWARE DESCRIPTION

A ventilator is a machine that relaxes for the patient or encourages patient to relax. It is likewise called a breathing machine or respirator. The ventilator is associated with a PC with handles and catches that are constrained by a respiratory specialist, medical caretaker, or specialist. It has tubes that are associated with the individual through a breathing cylinder. The breathing cylinder is put in the patient's mouth or in an opening in the neck into the windpipe (trachea). This opening is known as a tracheostomy. It makes clamors and has cautions that alarm the social insurance group when something should be fixed or changed. An individual gets the medication to stay agreeable when associated with the ventilator, particularly when they have a breathing cylinder in their mouth. The prescription may make quiet too lethargic to even think about opening their eyes or remain conscious for in excess of a couple of minutes. Patient can't talk on account of the breathing cylinder. At the point when patient is alert enough to open their eyes and move, they can impart recorded as a hard copy. Quiet on ventilators have numerous wires and cylinders on them. That may look unnerving, however these wires and cylinders help the specialists to painstakingly screen them. Some patients may have limitations on them. These are utilized to keep them from pulling off any significant cylinders and wires.

Patients are put on ventilators when they can't inhale alone. This might be for any of the accompanying reasons:

- To ensure that the patient is getting enough oxygen and is disposing of carbon dioxide.
- After medical procedure, the patient may require a ventilator to inhale since they may have been given a few meds that reason them lethargic and their breathing has not come back to typical.
- A patient has a sickness or damage and can't inhale ordinarily.

More often than not, a ventilator is required distinctly for a brief span like hours, days, or weeks. Be that as it may, at times, the ventilator is utilized for a considerable length of time, or now and then years. In the emergency clinic, an individual on a ventilator is observed intermittently by medicinal services suppliers including specialists, attendants, and respiratory advisors. Patients who need ventilators for extensive stretches may remain in long haul care offices. A few patients with tracheostomy might almost certainly be at home.

Tolerant on a ventilator are watched cautiously for lung diseases. At the point when associated with a ventilator, a patient gets an opportunity of hacking out bodily fluid. In the event that bodily fluid gathers, the lungs can't get enough oxygen. The bodily fluid can likewise prompt pneumonia in patient. To dispose of bodily fluid, the method called suctioning is required. This is finished by bringing a little slender cylinder into the patient's mouth or neck opening to vacuum out the bodily fluid. At the point when the ventilator is utilized for in excess of two or three days, the patient may get nourishment through cylinders into them either a vein or their stomach. Since the patient can't talk, exceptional endeavors are should be made to screen them and furnish them with some other approaches to communicate. The block diagram of the a ventilator is shown in Figure.1.

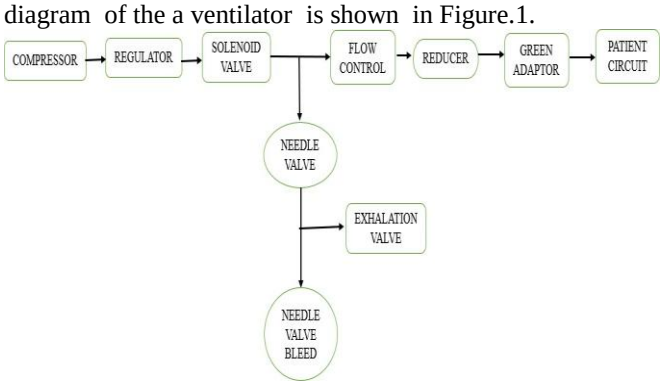

Figure 1. Block diagram of a Ventilator

attached which were be acting as diaphragm, the major working principle of diaphragm is interlocking the inhalation air within the test lung bag through closing exhalation valve holes which is near by diaphragm, at another condition of exhalation state the diaphragm is completely opened to leave a way the air which is intake at the state of inhalation period. The amount of air at inhalation period and exhalation period is same amount. Figure 2. shows the pressure sensor board developed.The hardware components were fixed on a table mount board and the setup is shown in Figure 3.

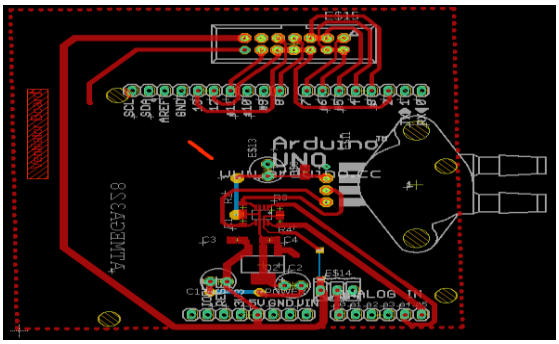

Figure 2. Pressure Sensor Board

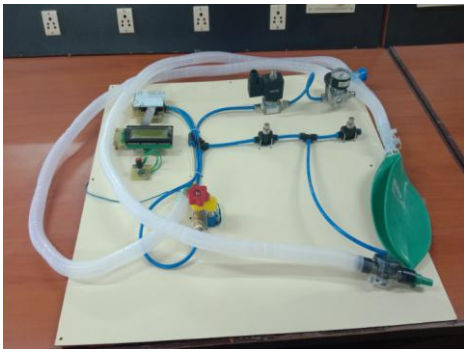

Figure 3. Hardware setup

In this model the atmospheric air/compressed air is given into the tube of 6mm which is connected to the regulator, then the regulator is adjusted at 1 bar through the connection of gauge in regulator. Next the same 6mm tube which is extended from compressor and regulator is connected to the solenoid valve, connected solenoid valve is processed by the Arduino board which acts as on and off condition, thereby controlling the flow of air through the condition of atmospheric air/compressor. Next to the solenoid the T-connector is placed to deliver the air in two directions. In one direction the flow control valve is placed and in another side needle valve is attached. In the flow control valve direction, line needle valve and potentiometer is placed in replacement of flow analyzer but in another direction needle valve is used for controlling the amount of air to enter. After attachment of 6mm tube to the flow control valve the tubing connection has upgraded from 6mm to 8mm for the connection of patient circuit with green adapter. Through patient circuit connection, two leads are provided for connection. At one end the test lung bag is placed for denoting the process of inhalation and exhalation state, in another end the exhalation valve is connected. From the other end of T-connector needle valve is connected through 6mm tube. Again T-connector is used for interconnection of another needle valve which is used

IV. RESULTS AND DISCUSSION

The results and discussion of the calibration of needle valve is represented here. The position of the needle valve is adjusted and the corresponding digital voltage and flow were recorded. The readings are given in Table 1. In this graph, the curve fitting is performed and the equation relativity flow and digital voltage is obtained. The calibration graph is shown in Figure.3.

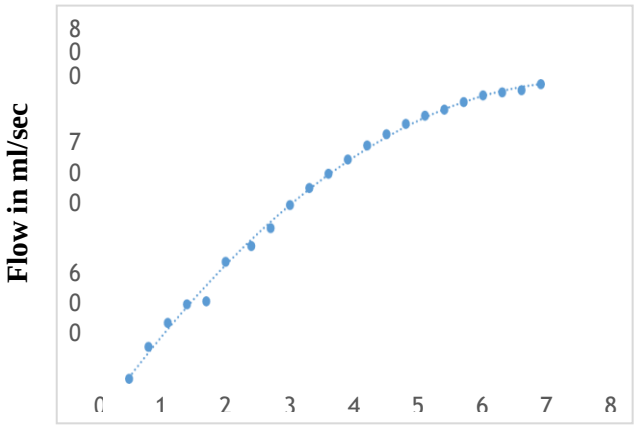

Figure 4 . Calibration Graph

Table 1. Position of the control valve and flow

Position Of Needle Valve in term of resistance (KOhm)	Flow in Digital Voltage	Flow in LPM	Flow in ml/Sec
9.95	5	0.5	8.33
9.92	8	4.8	80.0
9.89	11	8.0	133.3
9.86	14	10.5	175.0
9.83	17	13.9	181.67
9.80	20	16.2	270.0
9.77	24	18.3	305.0
9.74	27	20.7	345.0
9.71	30	23.8	396.6
9.68	33	26.1	435.0
9.65	36	28.0	466.6

9.62	39	29.9	498.3
9.59	42	31.8	530.0
9.56	45	33.3	555.0
9.53	48	34.7	578.3
9.50	51	35.8	596.6
9.47	54	36.6	610.0
9.44	57	37.6	626.67
9.41	60	35.5	641.67
9.38	63	38.9	648.3
9.35	66	39.2	653.3
9.32	69	40.0	666.68

IV. CONCLUSION

In this paper, a prototype device to assist the patients who can partially breathe by their own is developed. This device is provided with very basic design and reliable structure that is easily acceptable by the patient. Main focus in this paper is to minimize the components and increase the efficiency of the device, so that while using this device to the patient, they should feel as comfortable as the normal ventilator. In this paper needle valve is used along with the potentiometer for replacing the flow analyzer so that the entire setup is cost effective. Arduino UNO board is used because it is easy to program. This research has led to the development of lab model ventilator.

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