الأكاديمية العربية للعلوم والتكنولوجيا والنقل البحري
Arab Academy for Science, Technology & Maritime Transport

Proposal Details

Title:
Design and **I**mplementation of a **M**obile **V**entilator

Short Title or Acronym:
DIMV

Keywords:
COVID19- ARDS- Invasive Ventilation-Non-Invasive Ventilation- Ventilation Modes- CO2- O2- FiO2- PPV- SIMV- RR- Vt- EtCO2- MV- PEEP-PIP-ICU-GUI

Funding and Duration:
Proposal Type CRP

Proposal period 12 Months.

Total cost:
The estimated total cost of the project is about 500,000 EGP.

Research Theme:
Our research theme is Engineering (Biomedical)

Contents

Arab Academy for Science, Technology & Maritime Transport

Proposal Summary

One of the most serious problems that faced hospitals all over the world including Egypt since the outbreak of the COVID-19 virus, is the shortage of ventilators which occurred due to the acute increase in number of patients who needs the assist of ventilators to breath. Our objective presented in this proposal is to design and implement a mobile ventilator prototype that will allow the manufacturing of a reduced price ventilator to be used in AASTMT clinics and in public hospitals. The technology transfer here could offer a local ventilator that might be in the future an alternative to imported expensive ventilators that have prices ranging from 300,000 to 350,000 EGP.

Following the main design concepts published in April 2020 by Medtronic ventilator model PB 560, we are going to build a prototype of a mobile turbine ventilator with a battery. The ventilator will support the most important invasive and non-invasive ventilation modes commonly used in commercial ventilators. We will design and implement our own software, an embedded system board that control all ventilator pneumatic and electronic parts, in addition to a user friendly GUI touch screen with menus and charts to control and monitor all parameters.

3D printing technology as a fast response solution to print all possible connectors and spare parts as well as the outer case of the ventilator. The whole design and manufacturing stages will be held in the Industry Service Complex inside the AASTMT Campus. Further tests and validation will be held by clinicians in order to obtain reviews and make modifications.

الملخص

من أهم الأزمات التي واجهت المستشفيات في جميع أنحاء العالم بما في ذلك مصر منذ انتشار جائحة كورونا، هي نقص أجهزة التنفس الصناعي والتي حدثت نتيجة الزيادة الهائلة في أعداد الإصابات والمرضى الذين في احتياج الى أجهزة التنفس الصناعي. هدفنا المقدم في هذا الاقتراح هو تصميم وتنفيذ نموذج أولي لجهاز تنفس صناعي ليكون نواه فيما بعد لتصنيع جهاز تنفس بسعر مخفض لاستخدامه في عيادات الأكاديمية والمستشفيات العامة. الفائدة التي سوف تعم من عملية انتقال التكنولوجيا هي وجود جهاز تنفس صناعي محلي قد يكون في المستقبل بديلاً لأجهزة التنفس المستوردة باهظة الثمن والتي تتراوح أسعارها من300,000 إلى 350,000جنيه مصري.

استرشادا بمبادئ التصميم الرئيسية والتي تم نشرها في أبريل 2020 بواسطة شركة Medtronic وذلك لأحد أجهزة التنفس الخاصة بها Medtronic PB 560، سنقوم ببناء نموذج أولي لجهاز تنفس صناعي متحرك ببطارية ويعمل بواسطة مضخة هواء. سوف يدعم جهاز التنفس أهم أوضاع ومتطلبات التشغيل الشائعة والمتوفرة في أجهزة التنفس. سنقوم بتصميم وتنفيذ برنامج تشغيل بالكامل خاص بنا، والذي سيعمل من خلال نظام مدمج للتحكم في جميع الأجزاء الهوائية والإلكترونية لجهاز التنفس الصناعي، بالإضافة إلى شاشة تعمل باللمس. مع وجود واجهة للمستخدم سهلة الاستخدام مع قوائم ورسوم بيانية للتحكم ومراقبة جميع أوضاع التشغيل.

سوف يتم استخدام تقنية الطباعة ثلاثية الأبعاد كحل سريع لطباعة جميع الموصلات وقطع الغيار الممكنة بالإضافة إلى الهيكل الخارجي للجهاز. سوف تتم جميع عمليات التصميم والتصنيع بالكامل في ورش ومعامل مجمع خدمة الصناعة داخل الأكاديمية. والاختبارات النهائية والتشغيل سوف تتم بمساعدة العاملين في المجال الطبي للحصول على الآراء وعمل التعديلات اللازمة.

Introduction/Background

Since December 2019, the novel Corona Virus also known as (coronavirus disease 2019 [COVID-19]) resulted in an infection that spread to all parts of the world. Patients initially suffer from fever and sometimes respiratory problems which later develops into degrees of pulmonary abnormalities. The virus attacks the lower respiratory system and may cause other symptoms in addition to fever such as dry and persistent cough, myalgia and shortness of breath[1]. Approximately 15% to 20% of cases are considered severe, which means that they require assisted oxygenation during treatment[2].In these severe cases the virus causes damages to the lungs causing the immune system of the body to react by expanding the blood vessels, and the fluid to enters the lungs and cause difficulty in breathing and reduction in oxygen levels[3].If lung functions are disrupted due to COVID-19 or any other injury, patients may need a ventilator to breath or have a breath during a surgery. Ventilators cannot treat an illness but assist in keeping the patients alive during an infection or during the healing stage[4]. In developing countries the medical resources are concentrated in large cities where rural areas have no access to all ventilators which may lead hospitals to share ventilators [5].

The main reason for mortality among COVID-19 patients is the unavailability of ventilators [6].Since the beginning of the pandemic in 2020, many countries around the world including the united suffered from a shortage of ventilators. In March 2020, the US former President Donald Trump ordered General Motors to produce ventilators for the Covid-19 patients, in addition to the American and European manufacturers who stated that they couldn’t speed up production enough to meet the increasing demand [7].In March 2020, Medtronic plc which is the global leader in medical technology, released the design specifications for the Puritan Bennett™ 560 (PB 560) to enable participants across industries to evaluate options for rapid ventilator manufacturing to help doctors and patients dealing with COVID-19 [8].

Referring to the WHO, the number of confirmed cases of COVID-19 in Egypt, from Jan 3 to 10 February 2021, have been 170,780 with 9,751 deaths [9]. By the end of December 2020 the Egyptian Minister of Health Hala Zayed officially announced the start of the second coronavirus wave in Egypt. In April 2020, Egypt had from 3,000 to 4,000 ventilators in its quarantine hospitals and 11,000 ICU beds nationwide, according to Cabinet Spokesman Nader Saad, who also stated that ventilator use nationwide has increased to 42 percent in hospitals due to the dramatic rise in coronavirus cases where so that the percentage of ventilator use increased sharply due to the presence of cases with chronic diseases or older people [10].Due to the shortage of ventilators in Egypt, the United States Government, through the United States Agency for International Development (USAID),has provided the Government of Egypt with a donation of 250 ventilators for intensive care units [11]. The lack of ventilators worldwide has paid the attention of the Egyptian government to cope with this shortage in where the Egyptian president ordered manufacturing the ventilators and providing the Egyptian factories with the supplies they need to prevent importations [12].

The ventilator (also called a respirator) is a device based on pneumatic and electronics system in order to monitor, assist, or control human lung ventilation, in addition to both of intermittent or continuous respiration. In order to avoid human interaction, the ventilator can be used to control the oxygen level inside the human body, lack of oxygen in human body can cause hypoxia which might happen as a result of blood loss during a surgery or might happen due to insufficient oxygen in the body of the patient[5].Ventilators helps in maintaining a suitable exchange of gases, even during low breathing rates and myocardial infarction. Another functions of the ventilator include, the aid of lung expansion, the adequate combination of anesthetic sedation for muscle relaxing, and stabilizing the thoracic wall [13].

To operate the ventilator, three basic components are required: A source of input energy, means of regulating the breaths by converting the input energy into an output one through the regulation of pressure and flow, and means of monitoring the performance and displaying results and instantaneous situation of the patient.[14] .The ventilator is made of a compressed air reservoir, air and oxygen supplies, a set of valves and tubes, and a disposable or reusable patient circuit. The air reservoir is compressed several times a minute to deliver room-air or an air/oxygen mixture. The lungs release the overpressure which is also called passive exhalation, the exhaled air is released through a one-way. The oxygen percent of the inspired gas can be set from 21 percent as ambient air, up to 100 percent (pure oxygen) [13].

There are two types of ventilator devices. The first type pushes air mechanically into the patient lungs whether the patient needs to inhale or exhale. This type depends on using the conventional bag valve mask (BVM) which is deflated manually by hands. Instead of using hands, such types of ventilators are equipped with a robotic arm that squeezes the bag with a certain frequency, but these types of ventilators are limited for patients during anesthesia or near death, because if used with a conscious patient the inadequate air pressure may lead to death through barotrauma[15].The second type of ventilator that we are intending to design and manufacture is the pneumatic type which is more commonly used in intensive care units to treat COVID-19 patients. This type of ventilator contains sensors and switches that allows it to be adjusted with the preset pressure and volume settings in order to deliver the desired breath to the patient according to the patient requirements. The settings are adjusted by the clinic according to patient need and has a control unit and a screen to monitor the current settings[16]

Questions and Objectives

Since the beginning of the COVID-19 pandemic which affected more than 1.5 million people across the world, there have been a shortage of ventilators among all hospitals all over the world including Egypt.

After Medtronics released the design specifications of one of its ventilators, there have been some initiatives and calls in Egypt to manufacture local and cheap ventilators which can be quickly manufactured and on large scale. Our objective is not to produce a simple manual ventilator such bag-valve-mask (BVM), although of its simplicity and low cost but it doesn’t fulfill the basic requirements of the ICU units. The lack of volume and pressure adjustment as well as pressure feedback may damage the lung on the long run by causing some injuries, such as Barotrauma (caused by increased air pressure), and Volutrauma (swelling of the alveoli caused by increased tidal volume).

Instead, our objective is to design and manufacture a portable ventilator that can be easily manufactured and used inside the Intensive care units of the Egyptian hospitals units to support COVID-19 patients and other patients suffering from respiratory diseases. The ventilator design proposed here will not be used as an alternative to the highest technology devices that are used for the most critical cases of treatment, but will be suitable and useful in the hospital environment for milder symptoms or long term care and recovery. It is intended to be used in small hospitals or rural areas that cannot afford the high prices of commercial ventilators, or backup to cover shortage of ventilators in large hospitals during the pandemic.

Our wide objective to undergo technology transfer of ventilator design and manufacturing to the Egyptian medical environment. The know-how of the ventilator control system and software interface mainly count for the high prices of 4^{th} generation ventilators. By designing our own software and control system we will introduce a very cheap ventilator when compared to imported ones. We will use 3D printing to technology available to us to produce all polymer connectors found in the system. The rest of pneumatic and electronic components will be outsourced cheaply and will be compatible with hospitals oxygen supplies, connections and operating modes. The ventilator design proposed here will support the most important ventilation modes "Volume controlled and Pressure controlled modes" commonly used in commercial ventilators. In addition, it will be automated in order to adjust ventilation parameters needed by patients suffering from Acute respiratory distress syndrome (ARDS), or COVID-19, such as, Peak Inspiratory Pressure (PIP), tidal volume, Respiratory rate, and Fraction of Inspired Oxygen (FIO2) concentration.

The ventilator will also be capable of a basic non-invasive operation mode where a fixed pressure is delivered to the patient through a face mask not through an invasive artificial airway (endotracheal tube). In all modes of operation, Positive End Expiratory Pressure (PEEP) will be available, which is not a ventilator mode but is designed to support steady low positive pressure to the lungs which is important to avoid alveoli collapse of the patient.

The ventilator we intend to design can receive compressed oxygen either from hospital standard outlets or a compressed cylinder. In case of oxygen shortage, the ventilator can use low pressure oxygen from concentrators or filtered ambient air. This will be achieved by using a high power medical air blower, flow and pressure sensors that are all controlled by the control system and adjusted through a touch screen. The required proportions of FIO2 determined by the ICU doctor can be obtained through electronic controlled proportional valves instead of old mechanical and manual regulators.

The work in this ventilator will be divided into three specializations: electronics, mechanical, and software. The ventilator we propose, will be at the prototype stage, it will need to be approved medically in the future and will need to be verified by medical experts. After the conceptual design phase the final design will be subjected to validation and tests of the software and control system in order to generate feedback and make further corrections and improvements. Later on, after the prototype passes the quality and standard tests, we are looking for addressing firms and companies that are capable of starting its mass production. The most well know entities that can handle mass production of electronic components in Egypt: The Military Factories, the Arab Organisation for Industrialisation, and the Al-Arabi Factory.

Project Description

Our general approach for the ventilator design is only to follow the general design specifications released by Medtronic medical company ventilator model known as "Puritan Bennett (PB) 560 portable ventilator". The company made it available to anyone the full design specifications, production manuals, design documents and software code for the ventilator hardware

For these reasons, it is worth stating that we going to design and implement our own software, control unit and specific graphical user interface (GUI), after just following the main procedures and design specification of PB 560.Hence we will not copy the Medtronic ventilator design or obtain a licence. Instead we will create our adapted design with similar performance characteristics.

The PB 560 ventilator has a number of advantages, one being that it's relatively small, compact and lightweight in such a way that make it possible to move around and eligible for use in a range of different healthcare environments and settings. The design was originally introduced in 2010, so it gained a good reputation for more than ten years as a qualified equipment, in addition to be safe for medical use and treating patients. Another advantage of following the design specifications of PB 560 ventilator is that we can evaluate options for rapid manufacturing of ventilators. As stated by Medtronic, the design of PB 560 is much simpler to follow than PB 980 and PB 840, which makes it suitable for anyone new to the field with limited or no prior experience. This will facilitate the technology transfer of ventilator manufacturing to the Egyptian industry.

So our objective is to make a prototype that will allow the manufacturing of a reduced price ventilator that could be an alternative to imported high price ventilators that have price ranges from 150,000 to 300,000 EGP. We will produce a ventilator prototype with the most important ventilation modes "Volume controlled and Pressure controlled modes" commonly used in commercial ventilators, it will be automated and allow us to adjust ventilation parameters to patients' individual needs. PIP pressure, tidal volume, RR rate, and FIO2 concentration for each patient is vital to patients suffering from ARDS that may result from COVID-19. In addition to cure serious issues of lung damage resulting from compliance or collapse.

The ventilator we intend to design can receive compressed oxygen either from hospital standard outlets or a compressed cylinder. In case of oxygen shortage, the ventilator can use low pressure oxygen from concentrators or filtered ambient air. This will be achieved by using a high power medical air blower, flow and pressure sensors that are all controlled by the control system and adjusted through a touch screen. The required proportions of FIO2 determined by the ICU doctor can be obtained through electronic controlled proportional valves instead of old mechanical and manual regulators. The schematic diagram in

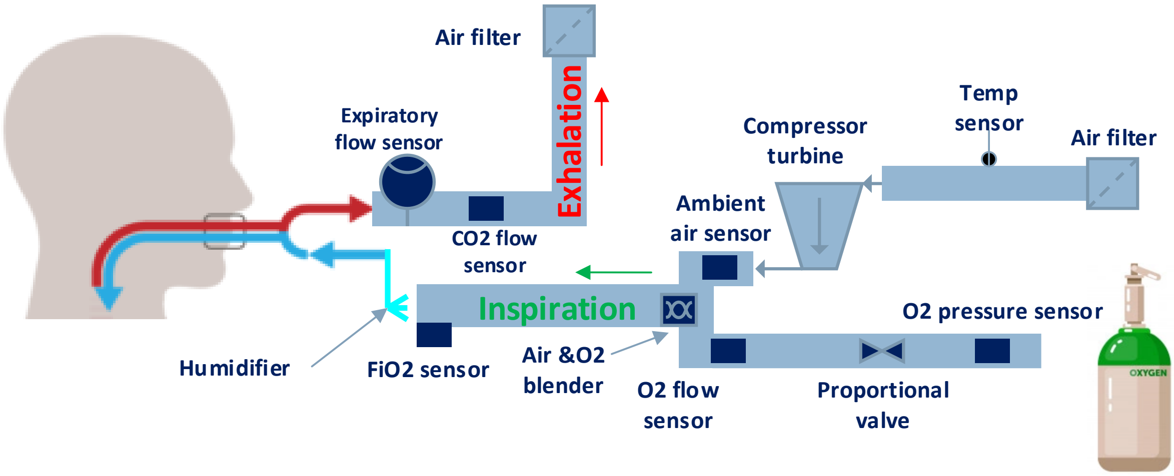


Figure 1shows the main components and flow mechanism of the proposed design.

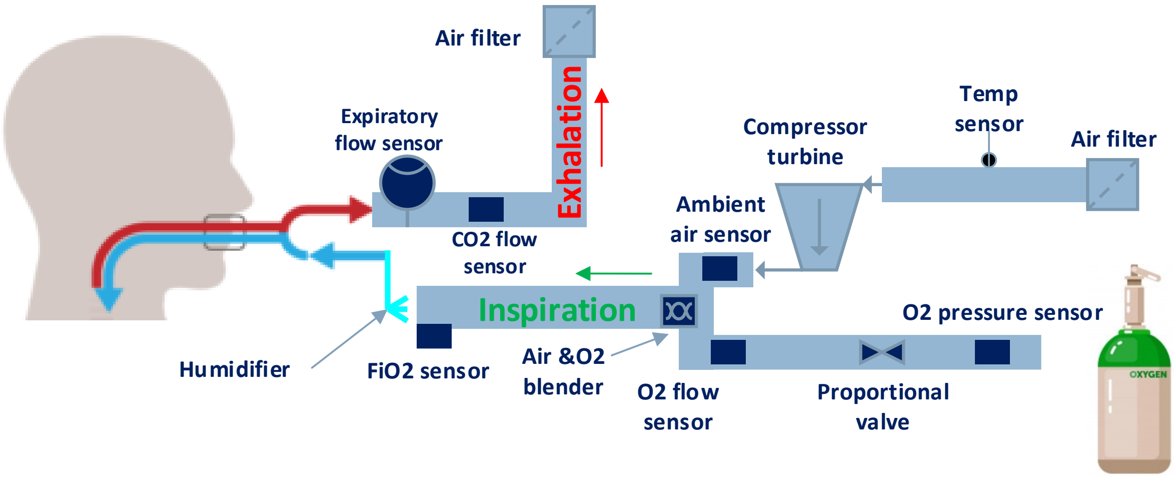


Figure 1. Schematic diagram of the ventilator components

The ventilator will operate with the most common modes of operations that are available in commercial ventilators, the modes of operations and their abbreviations are as follows.

PRVC (Pressure Regulated Volume Control)-**CPAP (**Continuous Positive Airway Pressure)-**SIMV-PC** (Synchronized Intermittent Mandatory Ventilation)- non-invasive operation (**NIV)** mode where a fixed positive pressure is delivered to the patient through a mask without the need of an endotracheal tube-**PEEP** (Positive End-Expiratory

Pressure) is not a ventilator mode in itself but is designed to support steady low positive pressure to the lungs.

Our design will consist of modules; different modules will be interconnected together via the control unit. There will be a separate module for controlling power supply, gas pressure, gas flow, temperature, valves, sensors, blower, and display board as shown in the block diagram in Figure 2,which shows how different modules of the control circuit are interconnected to each other. The modular design presented here has many benefits, first it will ensure the ease of technology transfer through reverse engineering and the possibility of mass production of this prototype in the future, also it will add flexibility of modifying the design for different ventilation modes, in addition to ease of maintenance and replacement of spare parts.

An embedded system board that control all ventilator parts Unidirectional valves to prevent back-flow of exhaled gases, avoiding mixing of CO2 with inspired gas. Also there will be pressure sensors for the continuous measurement of airway pressure in the patient breathing circuit. Flow sensors are essential to measure the volume of inhaled and exhaled gas. A set of audible and visible alarms for any failures regarding O2/CO2 gas flow, volume and pressure out of range parameters, and power failure.

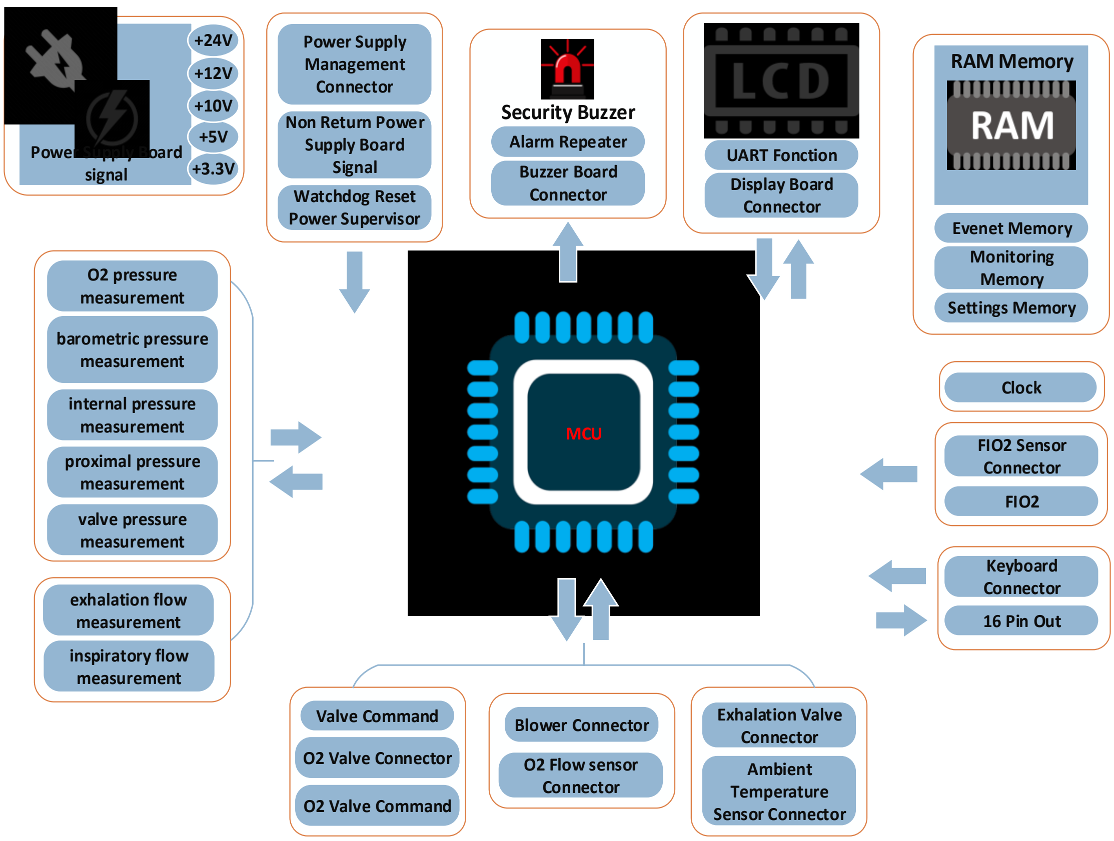


Figure 2. Block diagram of the micro controller unit with different modules

Figure 3 Ventilator with a stand porotype

There will a GUI touch screen with mode menus and plot charts representing the actual ventilator pressure, flow and volume readings. A proportional valve will be available to control the percentage of oxygen delivered to the patient with an alarm if it drops below the set limit.

There will be disposable air filters in series with the tubing on the inspiratory and expiratory limbs of the breathing circuit to prevent contamination of the ventilator as in Figure 1, in addition to a humidifier for heat and moisture exchange which simulates the normal warming and humidifying function of the upper airway and to prevent dehydration of the respiratory tract. The outer case of the ventilator will be 3D printed as a prototype, the ventilator will have a metal base where an oxygen supply can be attached to it, and a Y-piece to merge the inspiratory and expiratory limb connected to the patient as illustrated in Figure 3.

Research Design and Methods

As mentioned previously we are intending to follow the main design specifications and procedures published by Medtronic for its ventilator model "Puritan Bennett (PB) 560 portable ventilator". We will breakdown all components of the design in order to determine the frame of work we will follow. Beside the data published in media about the number of ventilators in public hospitals during the COVID-19 pandemic, we will collect quantitative data about the shortage in number of ventilators in private hospitals of Alexandria.

The quantitative data will also include a survey about the different models of ventilators available with the percentage of each of the most popular models available in Egypt, e.g. PB 840, PB 760, PB 740, Drager Evita, General Electric, and NEUMOVENT.

Qualitative data will be conducted through interviews with number of Intensivists (staff of ICU) in different private and public hospitals in order to configure out different aspects about ventilators available.

First we will obtain date about the general satisfaction of staff with each model of the ventilators mentioned above, regarding ease of operation, advantages and drawbacks during operations, system stability, the user interface benefits of each, and the most frequent errors and instability for all models. Second we will undergo interviews with biomedical engineers and technicians working with the maintenance and installation of different models to acquire a more technical review about the most common faults and drawbacks for each model. The data collected will help us to configure the most common technical faults and reliability, the frequently required spare parts and their availability.

In order to configure the design specifications of our prototype we will collect quantitative data from different ventilator models as well as the PB 560 regarding the following design specifications:

1. Physical Characteristics.

2. Environmental requirements such as: temperature, atmospheric pressure, etc.

3. Pneumatic specifications such as: turbine maximum flow and pressure, etc.

4. Electrical specifications.

6. Internal ventilator airway compliance.

7. Performance specifications including: working pressure, maximum pressure limit, etc.

8. Patient circuit inspiratory resistance including adults and pediatric specifications.

9. Inlet air filter specifications including, filter type, efficiency and flow resistance.

10. Inspiratory bacteria filter specifications such as, maximum allowable flow resistance.

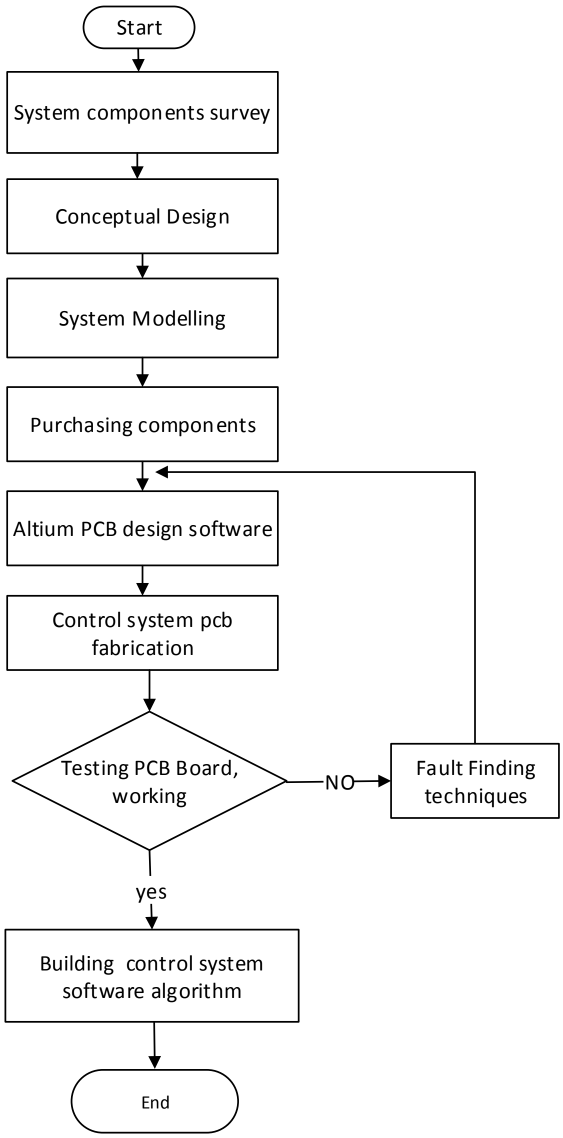


Figure 4 steps of building a control system software algorithm.

The next step in the research method is to figure out the theory of operation of the two main systems, pneumatic system and electronic system in order to determine the components of such systems and build a bill of material (BOM) for the ventilator. The two system general components and features are as follows:

- Pneumatic system components such as: air filters, inlet valves, oxygen valves, turbine assembly, inlet silencer, outlet silencer, inspiration and exhalation valves, flow sensors, pressure sensors, barometric pressure sensors and patient circuit.
- Electronic components such as: the power supply, internal battery charging and discharging, power source priority and switching, USB interface, microcontroller

functions, GUI interface, turbine control, battery connections, temperature sensors and ventilation requirements, alarms and troubleshooting.

- Ventilation features such as: the tidal volume target, leak compensation, circuit detection and management, relative or absolute pressure, invasive and non-invasive ventilation, and FiO2 oxygen settings.

The conceptual design will then built be after configuring all system components and operational requirements, the conceptual design will then be built, followed by building a model for the system and purchase components.

Modelling and simulation for PCB design will be executed using Proteus software after design of PCB circuits using Altium E-CAD software, the PCB board will be fabricated then tested for fault findings as shown in Figure 4.

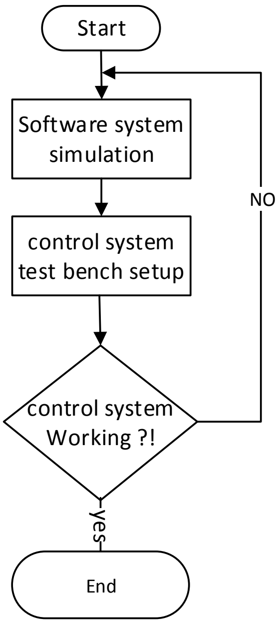


Figure 5 control system setup

After building control system software algorithm, further tests and experiments to check the validity of the control system, as shown in Figure 5.

If the control system is working, we will then move to the next stages as shown in Figure 6.

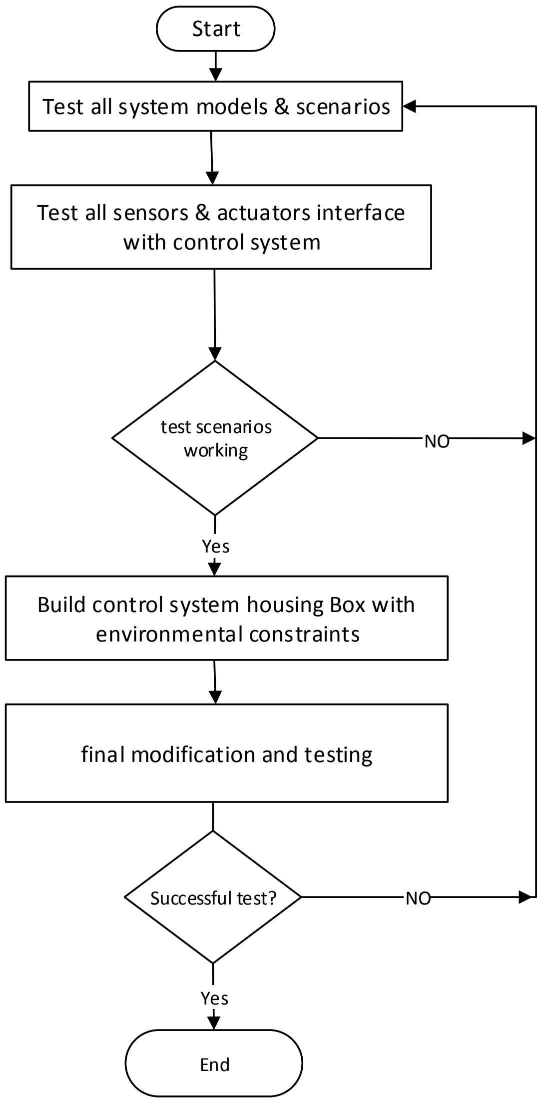


Figure 6 Building the final control system

Anticipated Results and Evaluation Criteria

As mentioned in the above section, different qualitative and quantitative date will be collected, analysed and evaluated starting from the beginning of the project till the end of testing the porotype and publishing the journal paper as follows:

Pie charts will be used to analyse the results of surveys made in the beginning to figure out the most common ventilator models available in hospitals, by showing percentage of each.

Frequency diagrams using Microsoft excel will be created to summarize the result of surveys with technicians concerning the most common faults and errors generated by different models of ventilators.

Numerical evaluation matrices will be used to compare and select system electrical and pneumatic components. First we will create different evaluation criteria in order to compare, then select best alternative.

Quality function deployment tools such as House of Quality matrix will be built in order to achieve to relate hospital requirements to technical specifications, rank technical specifications according to how strong they are related to hospital requirements as shown in Figure 7.

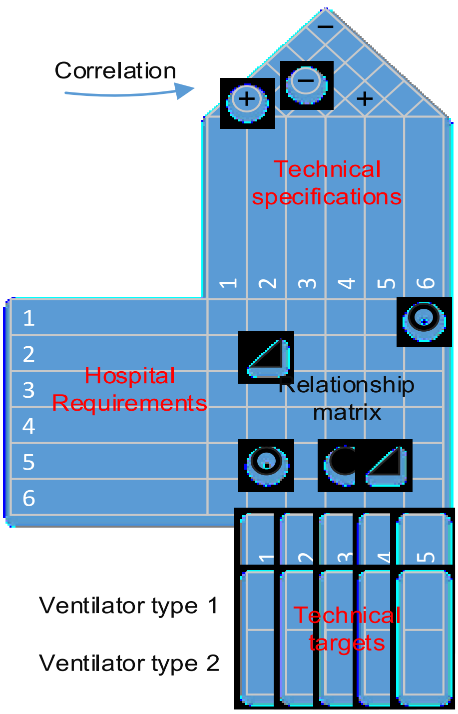


Figure 7. Example of proposed house of quality for the ventilator porotype.

Due to the need to configure the ventilator with different parameters and because we should follow the maximum and minimum settings we will design a GUI touch screen that will display different parameters such as, the airway pressure, airway flow, and tidal volume delivered to the patients. The GUI will be linked to the embedded system which controls and monitor other parts of the ventilator according to the specific software developed by our team.

The embedded system software will include a complete set of alarms for outside range parameters or parameters reaching a dangerous limit and also alarms for self-diagnosis and flow leakage. Final tests will be performed via hospital personnel in order to conform the validity make further modification after which the prototype can be medically authorised as a final product and adopted by a manufacturing authority for later production.

Expected Project Outcomes and Impact to AASTMT

I- Technical output and Impact:

The project expected outputs as described in the following points:

- A working prototype of a ventilator.
- Modular control system with complete documentation.
- Modular ventilator software with algorithm documentation and flowchart.
- Publishing a paper with results to show the impact of the self-made software algorithm and its capabilities.

II- Financial feasibility & Socio-economic Impact:

Egyptian society will greatly benefit from this project specially during and after the current pandemic which indicated a huge shortage in the number of ventilators available in the hospitals of the ministry of Health (2382 Ventilators in 363 Hospitals According to the Ministry of Health) or in the hospitals of the Ministry of Higher education and Scientific Research (2705 Ventilators – According to the Ministry of Higher Education).

The pandemic had shown the great need of the industry of ventilators as some of server cases in COVID-19 patents need the usage of ventilator. Even USA and Europe market had also shown leakage of ventilators.

The need is clear to be fulfilled by in investment opportunities in the field of supplying the health sector with ventilators to form a shield against the break down that might happen in hospitals demand due to the increasing numbers of critical or severe cases of COVID-19.

Preliminary feasibility study

As mentioned earlier we have made a preliminary survey about the most common ventilator models available in Egyptian hospitals and their prices. The prices that we obtained were for only three common models and the average price was above 300,000 to 350,000. As shown in Table 1

Table 1. Prices of three ventilator models

Model	Price(EGP)
PB 840	350,000
Drager Evita	350,000
General Electric	300,000

The full list of ventilator components and their prices are not yet complete and will be collected through the first month survey. We have made a primary feasibility study as shown in Table 2 which is based on estimation of components prices, based on our experience with the design and manufacturing field, in addition to manufacturing and assembly costs with an estimated price of 25% profit margin. Putting into consideration that this cost will be much more less in case of mass production. The estimated selling price will be equal to 238,547 EGP compared to 300,000 of the average ventilator price.

Table 2 Preliminary Feasibility Study of proposed ventilator

Item	**EGP**
Component Costs	180,000
Pneumatic components	120,000
Electronic components	60,000
Manufacturing Costs	1,750
Injection Molding of Case	150
PCB printing-CNC (10 Hrs.*50 EGP/Hr)	500
Assembly (20 Hrs * 30 EGP/Hr)	600
Testing (10 Hrs*50 EGP/Hr)	500
Total Components and Manufacturing Costs	181,750
Overhead costs (5%)	9,088
Total Costs	190,838
Selling Price (Profit Margin 25 %)	**238,547**

III – Publication:

As mentioned before in the technical output and impact, one of our expected outcomes is one peer-reviewed original research paper accepted for publication (received a DOI) in a Q1-Q2 journal or its equivalent.

Based on the design specification of the ventilator system and the originality of the control system and software algorithm, the system test results should be summarised in a scientific publication to show the main system features in the modular design in most of its parts.

This also will keep the rights of the Arab Academy for Science, Technology and Maritime Transport (AASTMT) in any further opportunities for enhancing the system or in any chances of investment in the production scale.

Resources

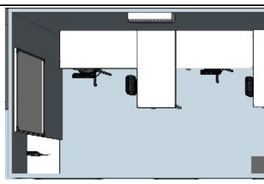
Personnel

Name of Team Member	Position / Title	Exp(Y)
Dr. Ahmed Shoier	Manager of TVI Institute	27
Eng. Yassin Shaalan	Projects' Coordinator	16
Eng. Khamis Talha	Software Consultant	36
Eng. Ghada Younes	Design Engineer	16
Eng. Riham Zeineldin	Software Engineer	9
Dr.Ismail Morsi	Head of Emergency and First Aid Training Unit	31
Mr. Mohamed Safwat	Electronics Technician	4
Mr. Ahmed Salama	Biomedical Technician	1
Mr. Ahmed AbdelSalam	Mechanical Technician	4

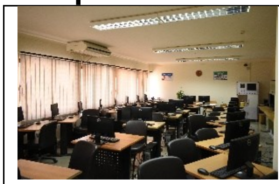
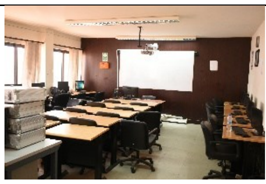
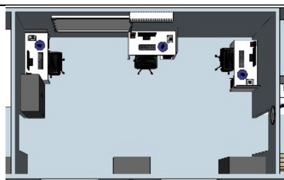
Office Facilities (4th Floor – Industry Service Complex)

Dr. Ahmed Shoier (409)- Eng. Yassin Shaalan (408)-Eng.Ghada Younes (413)

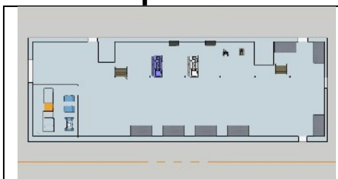
Laboratory Space

				
Mechatronics Lab 308	Reverse Eng Lab 03	Turning CNC Lab 07	Innovation Lab 102	Router CNC Lab 05

Computer Laboratory Facilities

			
Embedded Systems 27 PC	Computer Lab 16 PC	CNC Turning 22 PC	Projects 3 PC

Workshop Facilities

		
Projects Workshop	Traditional Turning	Welding Workshop

Major Equipment:

				
CMM Machine	CNC Router	CNC Plasma	3D Printer	Plastic Injection

Team Information

The project total team members whom will be participate in the project implementation are: **9** members. **8** of the team members belongs to the Arab Academy for Science, Technology and Maritime Transport. In addition to Eng. Khamis Talha, a software consultant with than 30 years of experience in the computer engineering field.

Principal Investigator	Co-PI &Co-ordinator
Dr. Ahmed Shoier/ 01223400759 ahmed.shoier@aast.edu	Eng. Yassin Shaalan/01006009989 yassin.shaalan@aast.edu

Team members background

Team member	**Sub teams**	**Background**
Dr. Ahmed Shoier	Project LPI	PHD. Mechanical Engineering
Eng. Yassin Shaalan	CO-PI/ Report Writing	MSc. Industrial and Management Engineering
Eng. Khamis Talha	Software and Programming	BSc. Computer Engineering
Eng. Riham Zeineldin		B.Sc. Electronics and Communications Engineering
Eng. Ghada Younes	Design	B.Sc. Architectural Engineering
Dr.Ismail Morsi	Medical Consultant	Consultant Emergency physician.
Mr. Mohamed Safwat	Electronics Technician	PCB design and electronic work.
Mr. Ahmed Salama	Biomedical Technician	
Mr. Ahmed AbdelSalam	Mechanical Technician	Mechanical Assembly, Machining.

Research Team Information Table

Name of Res. Team Member in English	Name of Res. Team Member in Arabic	University / Institute In English	Position / Title	A	B	C	D	E	F
Dr. Ahmed Shoier	د. أحمد شعير	AASTMT(PI)	Manager of Technical and Vocational Institute	10	3	7000	0	0	01223400759
Eng. Yassin Shaalan	م. يس شعلان	AASTMT (CO-PI)	Projects' Coordinator	30	12	1300	0	0	01006009989
Eng. Khamis Talha	م. خميس طلحة	Industry	Researcher from industry	30	10	1500	0	0	01222765749
Eng. Ghada Younes	م. غادة يونس	AASTMT	Design Engineer	30	6	1300	0	0	01016361880
Eng. Riham Zeineldin	م. ريهام زين الدين	AASTMT	Software Engineer	30	9	1100	0	0	01007077741
Dr.Ismail Morsi	د. إسماعيل مرسي	AASTMT	Head of Emergency and First Aid Training Unit	10	3	2600	0	0	01006009462
Mr. Mohamed Safwat	أ. محمد صفوت	AASTMT	Electronics Technician	30	6	800	0	0	01016361880
Mr. Ahmed Salama	أ. أحمد سلامة	AASTMT	Biomedical Technician	30	9	500	0	0	01285571615
Mr.Ahmed AbdelSalam	أ. أحمد عبد السلام	AASTMT	Mechanical Technician	30	6	600	0	0	01123862181

A = % of time spent on project
B = No. of months
C = Incentive per month (LE)
D = Number of other projects and their IDs
E = Total % of time spent on other projects
F = Contact No.

Ahmed Mohamed Sadek Shoier

Alexandria, Egypt – +201223400759 / +201000773704– amshoier@gmail.com /ahmed.shoier@aast.edu
Manager of Technical and Vocational Institute -Industry Service Complex – Arab Academy for Science, Technology and Maritime Transport.

Education

- Jan 2013 Ph.D. Degree in Mechanical Engineering, Alexandria University.
  Thesis Title: Applying Swarm Intelligence for Tuning the PID Controller of Electrohydraulic Systems.

- 1998 M.Sc. Mechanical Engineering, Alexandria University.
  Thesis Title: Effect of different parameters on belt skimmer characteristics.

- June 1990 B.Sc. Mechanical Engineering, Alexandria University.
  Graduation Project: Experimental work on straight walled diffusers.

International Projects:

- Participate in Skills Development Partnerships with Anniesland College, Scotland funded by British Council- skill for Employability Program.

- Participate in Vocational and Education development project with Grimsby college funded by British Council.

- Participation in Integrating Blended Entrepreneurial and Manufacturing Technology Competency into Socioeconomic Development in Egypt (BEMT).

- Participation in Blended Vocational – Engineering - Industry Shared Learning Environment for Stream of Socially & Technically Competent Technicians and Engineers VET-ENG

- Participation in Innovation for Leather in Jordan and Egypt (INNOLEA)".
- Participation in “Smart Control Systems for Energy Management: New Master Degree.

Teaching Academia Courses:

- Fluid Mechanics.
- Hydraulic Circuits.
- Pneumatic Circuits.
- Application for Hydraulic and Pneumatic Systems.
- Internal Combustion Engine.
- Refrigeration and Air Condition.
- Engineering Mathematics.
- Engineering drawing.

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Yassin M. Shaalan
Alexandria, Egypt – 01006009989 – yassin.shaalan@aast.edu/yshalaan@gmail.com
Projects Coordinator at Research and Development Department - Industry Service Complex – Arab Academy for Science, Technology and Maritime Transport.

Experience

- **AUG' 16 – UP TO DATE**- R&D projects Coordinator: Manages the execution, prepare feasibility studies, monitor material requirements, schedule and coordinate all R&D projects with in the ISC workshops and Labs.
- **FEB '13 – UP TO DATE-** Lecturer of Pearson HND level 5 Engineering program. Teaches technical courses organized by Arab Academy.
- **SEP '07 – UP TO DATE**- Reverse Engineering Lab Supervisor: Operate and use metrology Equipment
- **DEC '08 – NOV' 10**-Industrial workshops Supervisor: Manages Industrial workshops including variety of manufacturing processes e.g. Welding, Turning, Grinding and sand casting- Supports the maintenance of Academy facilities through workshop capabilities.

Education

- Arab Academy for Science, Technology & Maritime Transport, College of Engineering and Technology, Alexandria, Egypt. Master of Science (MSc) in industrial and management engineering (Operations Management), GPA: 3.5/4, Thesis Title: " Simulation Analysis of Segmented CONWIP: Application to Reentrant Flow Lines" FEB '13- AUG '18
- AAST, College of Engineering and Technology, Alexandria, Egypt. B.Sc. program in "Industrial Engineering & Management Systems". FEB '02 – JUN' 05

Publications

Published and presented a paper at the international conference on Industrial and management Engineering and operations Management, IEOM 2018 Bandung, Indonesia, March 6-8, 2018. (Awarded best track paper)

Other Activities

- Undergoes research and reverse engineering techniques using advanced metrology equipment.
- Feasibility studies.
- Technical report writing.
- Work breakdown structure
- Project management and planning
- Follow Up
- Quality control

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Khamis Talha Amin Gad Alla -01222765749– khamis-talha@hotmail.com- Research Engineer at "Egyptsat".

Education

- B.Sc. in Computer with grade (Good) in June 1983 Faculty of Engineering Alexandria University.
- Finished master degree pre courses from Faculty of Engineering Alexandria University.

Projects and Work Experience

- Video compression and UDP broadcast software develop using h265 and FFmpig -car counting software -ANPR software developed using Open library-software controls satellite receiver card plots SNR signal and search channels and switch to preview screen-research for developing a GPS compass-GUI software for car "radar device" android application for Egypt Nile boat navigation and collision detection and voice communication simulating standard AIS-Complete GUI and control software Medical Ventilator-Electric Car Dashboard-system for code using AI technology Recognizing Containers-"Visitor management" software for "Civil ID Card" recognizing- Help Desk and Call Booking system

Ismail Mohamed Mohamed Morsi -01006009462 – ismail.morsi@aast.edu/
Head of Emergency and First Aid Training Unit, Consultant Emergency physician, AASTMT

Education

- B.Sc. M.B, CH.B. Degree, Faculty of Medicine, Alexandria University 1990.
- Master Degree in Emergency Medicine, Faculty of Medicine, Alexandria University1990.
- Diploma in Total Quality Management in Healthcare. AUC- Egypt –2003.

Experience

- Consultant in Emergency Medicine-Member of American College of Emergency Physicians-Member of American Heart Association-ACLS Instructor certified from American Heart Association-Certified from American College of Surgeons-Specialist, Emergency Department Tawam Hospital, Al Ain, UAE- Medical Officer, Emergency Department,TawamHospital,AlAin,UAE- Emergency Physician,Emergency Department Alexandria Main University Hospital, Egypt-Staff Physician-Accident and Emergency Iskan Emergency Department King Fahad National Guard Hospital. Riyadh, KSA

Training Courses

- Advanced Trauma Life Support (ATLS) June, 1992.Recertified March 2007
- Advanced Cardiac Life Support (ACLS) November,1992. Recertified: October,1994, September,1996 and February,2007
- Paediatric Advanced Life Support (PALS) April 2007. Recertified May, 2009.
- Fast Assessment Sonography for Trauma (FAST) December 2006.-Conscious sedation course, March 2007-Advanced Trauma Life Support instructor course (ATLS- instructor) December 2008, Renewed 2012 and 2016-Advanced Cardiac Life Support (ACLS – instructor) November, 2007

Riham Abdallah Mosaad Zeineldin *+201007077741 – rihamzieneldin@adj.aast.edu.*
Software Engineer at R&D Department - Industry Service Complex – AASTMT.

Education

- B.Sc., Electronics and Communications Engineering, Faculty of Engineering, Alexandria University 2012.
- Diploma in Computer Science from Arab academy for Science, Technology and Maritime Transport 2017.

Work Experience, Research and Skills

- Software design and validation for simulated curiosity rover Project-Baby Incubator Project-Satellite Internet Receiver-Real-time Data Streaming Robot -Smart House design, and Software developer in the ECO House Project Funded by ASRT and supervised by AASTMT-CFD Simulation responsible of the sweeper car project in AASTMT-Face Recognition Software development Project held by AASTMT-ISC.
- Software Engineering experience-AVR microcontrollers in various applications using C languages. Arduino in various Applications-Excellent knowledge: utilizing sensors, ARM Processors-C/ C++/ C#/ Mat lab. -Embedded systems- Mobile Application
- Published 3 papers **(ICIES 2012&2014) at IEEE** International **Conference** on Innovative Engineering t "Accurate Indoor Localization Based on RSSI with Adaptive Environmental Parameters in Wireless Sensor Networks".-"Indoor Localization Based on RSSI in 3D Wireless Sensor Networks RIMO based model".-**AEAS 41st Conference** "Networked, Anti-failure and Cost-efficient Neonatal Incubator Model".

Ghada Mohamed Younes 01005652081– ghadayounes@gmail.com
Design Engineer - ISC – AASTMT

Education

- M. Sc student in Industrial Engineering- Faculty of Engineering Alexandria University, year 2015 –Information Technology Incorporation (ITInc.) 9 months Postgraduate program – Major in Multimedia (Head of class 2007).
- BSc in Architectural Engineering - Faculty of Engineering Alexandria University, year 2004-2005.

  Work Experience, Research and Skills
- Graduation Projects: Artist Residential Complex at El-Fayoum- Aiming to preserve a palm tree island in Qaroun lake. **ITI Graduation Project:** Interactive CD for the blind, Braille Printed Shapes book (1st of a kind in Egypt and Middle East)-A Short-animated 3D movie, and a Website.

Work Experience (2007 - up to current date**):**

- **Head of Design unit:** Organization and following up the design of advertising and printed material, and production workshop designs-**Head of the "Planning and Design" committee** at the Arab skills competition.**Lecturer at** TVI, AASTMT (Maths for Engineers, Engineering Math, Engineering drawing & AutoCAD, Analytical Methods for Engineers, Computer Aided Design and Manufacture and CNC courses.

Computer Skills: AutoCAD-Adobe Photoshop-Adobe Illustrator-Adobe Premiere-Adobe Audition-Corel Draw-Microsoft Office.

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Mohamed Safwat (01016361880 – mohamed_safwat@adj.aast.edu)
Electrical and electronics technician at R&D Department - Industry Service Complex – Arab Academy for Science, Technology and Maritime Transport.

Education, Experience and Skills

- Electrical Installation 3 years Diploma Ministry of Education and Vocational Education 2013
- PCB design & manufacture, Control system prototyping and embedded systems programming. Regional Informatics Center (From Jan 2017 – To July 2017).
- PCB, Programming, Altium designer, CNC, Prototyping, Microcontrollers.
- **2020** COVID-19 disinfection gates, **2019** Erasmus+ Vet-Eng HVAC (1,2,3 and 7)

Ahmad Mohamed Salama Mohamed (201285571615– Theamsasd@gmail.com)
Electrical and electronics technician at R&D Department - Industry Service Complex – Arab Academy for Science, Technology and Maritime Transport.

Education, Experience and Skills

- HND in Mechatronics from Arab academy for Science, Technology and Maritime Transport- B.Sc. in Anthropology - Faculty of Art - Alexandria university
- El kouther for medical service: Maintenance technician.
- Top technology for medical service- Work as: Maintenance technician.
- John tech for medical service: Maintenance technician.
- ROV Competition participation for two years- Robotics
- R&D in Arab academy for Science, Technology and Maritime Transport.
- Pure mobility- Atmospheric water generator- Eco house-Four wheeled industrial robot (funded by ministry of scientific research)-Satellite modem (funded by RDI program, EU) Baby incubator- Disinfection robot- CNC Router Machine.

Ahmed AbdelSalam Mohamed AbdelSalam 01123862181 – hamada.hinz1@gmail.com.
Lathe Technician at Research and Development Department - Industry Service Complex – Arab Academy for Science, Technology and Maritime Transport.

Education, Experience and Skills.

- Industrial& Vocational and Industrial Diploma- 2nd Fishery Officer -3rd Commercial Officer from AASTMT
- Fire Fighting Training Course-Safety Training Course
- Traditional turning Machining (8 Years at AASTMT and Omega Co)
- Projects Prototyping at Workshop Projects : Plastic Recycling Machine-ROV-Air Operated Vehicle-Brain Operated Wheelchair-Solar Energy Operated Wheelchair - Hydraulic Parking-Hydraulic Elevator-Cans Recycling Machine

Project Management

Once the grant is accepted by the AAST we will start all project activities which begins by the stage of collecting data and ends by making a prototype and publishing final results after 12 months as follows:

The project will be divided into five main stages with the duration shown:
Data collection and analysis (2months)-Building PCB and control circuits (2 months). Building software (3 months). Final assembly and testing (3 months). Results and publications (2 months).

The work breakdown structure (WBS) of all activities is shown in Figure 8

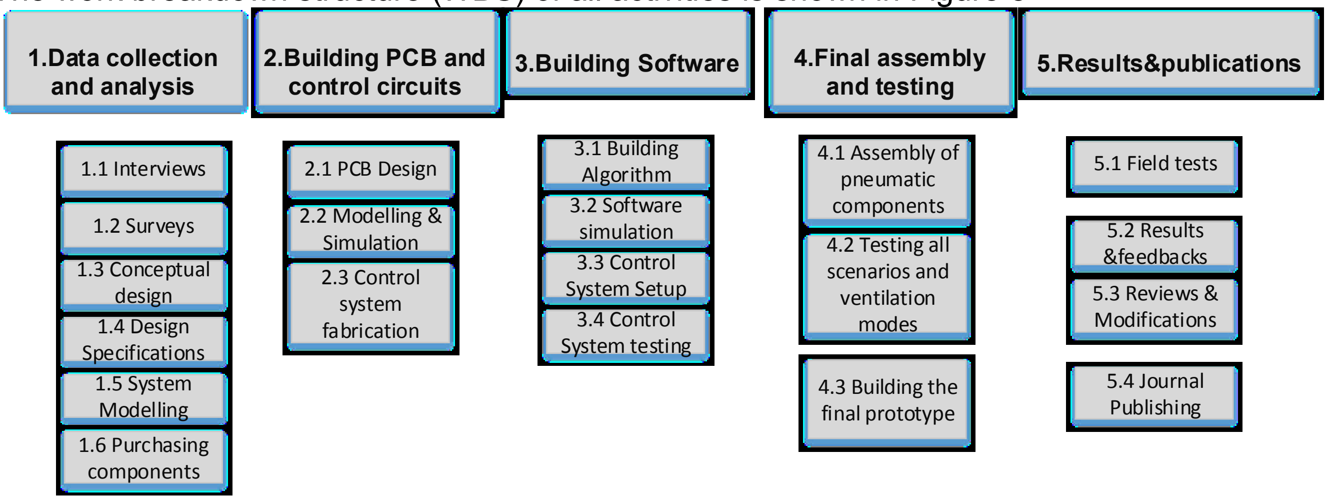

Figure 8. WBS of all project activities

Progress follow-up:
To keep up with the project progress we will do the following:

- The availability of online meeting when ever needed using Zoom.
- Creating progress report every 3 months during the project to keep track of the work after each stage, Progress meeting and follow up after the end of each major stage.

Team member responsibilities

Name	Responsibility
Dr.Ahmed Shoeir	LPI & researcher
Eng.Yassin Shaalan	CO-PI, researcher & PM, report writing, Data analysis.
Eng.Khamis Talha	Researcher from industry and software consultant
Eng. Riham Zeineldin	Software Design and Coding
Eng. Ghada Younes	Design and graphics
Dr.Ismail Morsi	Medical Consultant, Hospital coordination
Mr.Mohamed Safwat	Electronics Technician, PCB design, control.
Mr.Ahmed Salama	Biomedical Technician, hospitals surveys, Purchase
Mr.Ahmed AbdelSalam	Mechanical Technician, Machining, assembly.

Gantt chart

Table 3.Gantt chart of all project activities (critical activities in red)

Activity Name	M1	M2	M3	M4	M5	M6	M7	M8	M9	M10	M11	M12
1.Data collection and analysis												
1.1.Interviews with clinicians												
1.2.Ventilator types surveys												
1.3.Conceptual design												
1.4.Design specifications												
1.5.System modelling												
1.6.Purchasing components												
2.Building PCB and control circuits												
2.1.PCB design												
2.2.Modelling and simulation												
2.3.Control system fabrication												
2.4.First progress report												
3.Building software												
3.1.Building software algorithm												
3.2.Software simulation												
3.3.Control system setup												
3.4.Control system testing												
3.5. Second progress report												
4.Final assembly and testing												
4.1.Assembly of pneumatic components												
4.2.Testing ventilation modes												
4.3.Building the final prototype												
4.4. Third progress report												
5.Results and publications												
5.1.Undergo field tests												
5.2.Collect results and feedbacks												
5.3.Rreviews and modifications												
5.4.Publish results in journal paper												
5.5.Fourth progress report												

Allowable Project Costs

According to the research methodology that will be followed during the execution phases of the project, and according to the rules of the AASTMT's Innovation Research Grants (IRG) the cost was determined according to the following summary in Table 4.

Table 4. Project costs summary

No.	Item	Percentage (%)	Amount (EGP)
1	Staff Cost	20	100,000
2	Mobility Cost (Staff and Equipment Transportation)	5	25,000
3	Dissemination, Seminars, Workshops and Printing Cost	5	25,000
4	Data Collection, Training, ISO Standards Purchasing and Publications	5	25,000
5	Equipment, Acquisition of Materials, Spare Parts and Fabrication Cost	65	325,000
Total Cost (EGP)		**100**	**500,000**

Breakdown of Costs Other Grant(s)

Table 5 Eligible costs breakdown

Eligible costs	Break downs	AASTMT support (L.E.)
(A) Staff Cost	Dr. Ahmed Shoier PI	20,000
	Eng. Yassin Shalaan (Co-PI)	17,000
	Eng.Khamis Talha (Team Member)	15,000
	Eng.Ghada Younes (Team Member)	7,000
	Eng. Riham Zeineldin (Team Member)	8,000
	Dr. Ismail Morsy (Medical Consultant)	8,000
	Mr.Mohamed Safwat (Technician)	5,000
	Mr.Ahmed Salama (Technician)	5,000
	Mr.Ahmed AbdelSalam (Technician)	5,000
	Consultation fees	10,000
	Total	**100,000**
(B) Equipment	Chassis Mold and mounting	125,000
	Sensors	65,000
	Microprocessors	33,450
	GUI Interface	12,350
	Connection and filters	21,850
	Valves	17,150
	High Pressure Blowers	8,500

Eligible costs	Break downs		AASTMT support (L.E.)
	Motor Controllers		19,700
	Spare parts		22,000
	Total Equipment		**325,000**
(C) Expendable Supplies & Materials	Stationary		2,000
	Miscellaneous Laboratory, Field supplies, Materials		3,000
	Total expendable Supplies & Materials		**5,000**
(D) Travel	Internal Transportation		10,000
	Accommodation		15,000
	Total travel		**25,000**
(E) Other Direct Costs	Services	Manufacture of specimens & prototypes	3,000
		Acquiring access to specialized reference sources databases or computer software	3,000
		Computer services	2,000
	Report preparation		3,000
	Publications & patent Costs		25,000
	Workshops organization or Training		10,000
	Website for project dissemination (3 Years)		10,000
	Total other direct costs		**45,000**
(G) Total Costs			**500,000**

Plans for Disseminating Research Results / Sustainability of the action

After finishing the project of making a working prototype of a mobile ventilator. The ventilator will pass different tests to ensure its stability during work. to ensure the sustainability of this project. In order for the project data to be shared and utilized, the ventilator will pass through different stages and places as follows:

Product authorization (after 12 month)

After finishing the project and pass all tests successfully, and by the aid of AASTMT administration we will address the ministry of health and other authorized committees in the government in order to authorize the prototype and then apply a patent request.

Public Hospitals and clinics (during and after 12 months)

Undergo final tests by aid of clinicians in hospitals, collect their reviews and experience and share information about our ventilator capabilities.

Industry Sector (after 12 month)

Addressing firms and companies that are capable of starting its mass production. The most well know entities that can handle mass production of electronic components in Egypt: The Military Factories, the Arab Organisation for Industrialisation, and the Al-Arabi Factory.

AASTMT Clinics (during and after 12 months)
Testing the ventilator Inside the campus clinics in different branches and possibility of adding other units to be manufactured inside the Academy workshops to be used as backup in all AASTMT clinics.

AASTMT events (during and after 12 months)
Sharing the ventilator information and the importance of technology transfer in different exhibitions inside and outside the Academy. e.g. Health care competition organized by the ***ISC (Arab Skills Competition)***

AASTMT graduation projects (after 18 months)
Share the research information with undergraduate student of Technical and Vocational Institute, and coordinate with the education department to let student get involved with the technology through graduation projects and research.

Social Media (during and after 12 months)
Share the research information, design specification, project importance, data about shortage of ventilators in Egypt, feasibility studies and results on a Facebook page, and a webpage.

Key Publications and references.

[1] M. D. Landry, L. Geddes, A. Park Moseman, J. P. Lefler, S. R. Raman, and J. van Wijchen, "Early reflection on the global impact of COVID19, and implications for physiotherapy," *Physiotherapy*, vol. 107, pp. A1–A3, 2020, doi: https://doi.org/10.1016/j.physio.2020.03.003.
[2] S. Tian, W. Hu, L. Niu, H. Liu, H. Xu, and S. Y. Xiao, "Pulmonary Pathology of Early-Phase 2019 Novel Coronavirus (COVID-19) Pneumonia in Two Patients With Lung Cancer," *J. Thorac. Oncol.*, vol. 15, no. 5, pp. 700–704, 2020, doi: 10.1016/j.jtho.2020.02.010.
[3] "Coronavirus: What are ventilators and why are they important? - BBC News." https://www.bbc.com/news/health-52036948 (accessed Feb. 22, 2021).
[4] "Ventilators and COVID-19: What You Need to Know > News > Yale Medicine," 2020. https://www.yalemedicine.org/news/ventilators-covid-19 (accessed Feb. 10, 2021).
[5] A. Mohsen Al Husseini, "MIT E-VENT | Emergency ventilator design toolbox," *Proc. 2010 Des. Med. Devices Conf.*, pp. 1–9, 2010, [Online]. Available: https://e-vent.mit.edu/.
[6] A. A. Malik, T. Masood, and R. Kousar, "Reconfiguring and ramping-up ventilator production in the face of COVID-19: Can robots help?," *J. Manuf. Syst.*, Oct. 2020, doi: 10.1016/j.jmsy.2020.09.008.
[7] "There Aren't Enough Ventilators to Cope With the Coronavirus - The New York Times." https://www.nytimes.com/2020/03/18/business/coronavirus-ventilator-shortage.html (accessed Feb. 12, 2021).
[8] "Medtronic Shares Ventilation Design Specifications to Accelerate Efforts to Increase Global Ventilator Production | Medtronic." https://newsroom.medtronic.com/news-releases/news-release-details/medtronic-shares-ventilation-design-specifications-accelerate (accessed Feb. 25, 2021).
[9] "Egypt: WHO Coronavirus Disease (COVID-19) Dashboard | WHO Coronavirus Disease (COVID-19) Dashboard." https://covid19.who.int/region/emro/country/eg (accessed Feb. 10, 2021).
[10] "Ventilator use in Egypt rises to 42%, number of cases expected to double in a week: Cabinet - Politics - Egypt - Ahram Online." http://english.ahram.org.eg/NewsContent/1/64/397472/Egypt/Politics-/Ventilator-use-in-Egypt-rises-to-,-number-of-cases.aspx (accessed Feb. 22, 2021).
[11] "U.S. Donates Ventilators to Support Egypt's COVID-19 Response, Strengthen ICU Capacity | U.S. Embassy in Egypt." https://eg.usembassy.gov/u-s-donates-ventilators-to-support-egypts-covid-19-response-strengthen-icu-capacity/ (accessed Feb. 22, 2021).
[12] "Egypt to produce ventilators for COVID-19 patients - EgyptToday." https://www.egypttoday.com/Article/1/83144/Egypt-to-produce-ventilators-for-COVID-19-patients (accessed Feb. 11, 2021).
[13] Freescale Semiconductor, "Ventilator/Respirator Hardware and Software Design Specification," *Ventilator/Respirator Hardware and Software Design Specification , Rev. 0, 11/2011*, 2011. https://docplayer.net/10921139-Ventilator-respirator-hardware-and-software-design-specification.html.
[14] Martin J. Tobin, "Chapter 3. Basic Principles of Ventilator Design," in *Principles and Practice of Mechanical Ventilation*, 3rd ed., 2012.
[15] B. El Majid, A. El Hammoumi, S. Motahhir, A. Lebbadi, and A. El Ghzizal, "Preliminary design of an innovative, simple, and easy-to-build portable ventilator for COVID-19 patients," *Euro-Mediterranean J. Environ. Integr.*, vol. 5, no. 2, pp. 1–4, 2020, doi: 10.1007/s41207-020-00163-1.
[16] "Featured Stories | Medtronic." https://news.medtronic.com/increased-ventilator-manufacture (accessed Feb. 23, 2021).

Declaration

- I declare that this proposal will not be submitted in whole or part for funding; twice within the same cycle, or to other funding programs within AASTMT, or other funding agencies. The research team members have participated in many research projects funded from many funding agencies inside and outside Egypt. But, most of these funded projects was performed more than three years ago.

The following project is the only one executed within the last three years.

Project Title	[VET-ENG] Blended Vocational-Engineering-Industry Shared Learning Environment for Stream of Socially- and Technically-Competent Technicians and Engineers
Funding Agency	Erasmus+ Programme of European Union
Project Duration	3 Years
Start Date	2016
End Date	2019
Total Fund/Year	333,333 €/Year (Total Budget nearly 1,000,000 €)
Abstract	A new innovative learning methodology for vocational AND engineering students is introduced, which integrates teams from both disciplines to work together in project-based learning environment which engages teams in cooperative project work that requires both groups diverse competencies, this is expected to improve the academic and skill competencies of both teams and ensures social blending of the once segregated groups throughout the industry-inspired projects being mutually developed. The projects shall map the ILOs of the vocational and engineering academic courses, while adding a new layer of inter-personal skills. The project shall target, mechanical, electrical, manufacturing and mechatronics tracks for both vocational and engineering disciplines. The project aims at developing a new line of industry human capital (engineers and technicians), who are free of social segregation mindset, possess industry-tailored competences, capable to fit directly in the actual work environment after graduation, embrace true work ethics and respect their fellow colleagues and who have been engaged in up-to-date technologies throughout their school life within the factory. This is achieved through establishment of (engineering school-vocational school-factory) shared learning environment, where industry-inspired project-based learning is implemented in engineering and vocational curricula engaging vocational and engineering students in fully integrated teamwork realizing different aspects of a mutual project and/or product that is prescribed by industry

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Acknowledgment Form

Please copy this section, sign and scan it as a part of your proposal

By signing below, I acknowledge that I have read, understand and accept to comply with all the terms of the foregoing application, mentioned in AASTMT general conditions and guidelines for submitting a research proposal, including, but not limited to:

- The total number of the application pages should not exceed **30 pages** excluding a cover page, as well as all sections of the proposal (as mentioned in AASTMT General Conditions and Guidelines for Submitting Research Proposal).
- At any time, a contracted AASTMT project team member should only be participating in a maximum of one project.
- Allowable budget maximum limit should be strictly adhered to in the project proposal. In all cases, requested budget has to be justified in detail.
- AASTMT guidelines, IPR rules, code of ethics, etc. (www.aast.edu), should be read carefully and adhered to. These are integral parts of the contract.
- All proposals – in addition to PI and other data - must be uploaded to the AASTMT website by the designated deadline. Uploaded PI data should conform to the corresponding data in the application form.

Applications will not be considered eligible and will be discarded in the following cases:

- Proposals submitted by e-mail or sent as hard copies or uploaded to the AASTMT website after the deadline.
- Proposals not conforming to the designated format.
- Proposals whose uploaded PI data does not conform to PI data in the proposal file.
- Proposals in which the allowable budget maximum limit has been exceeded.
- Proposals in which maximum allowable contracted AASTMT project participation limit has been exceeded.
- Proposal letter does not include a scanned copy of the signed and stamped PI institution endorsement letter in case of team member work outside AASTMT.
- Proposal does not include a scanned copy of the signed acknowledgment form.

Date & Signature: 14-3-2021 ________________________

Design and Implementation of Mobile Ventilator

Institution Endorsement Letter

Institution Name: AI VISION SOFTWARE

Address: 72 Mostafa Kamel street - Flemng area - Alexandria

On behalf of **Ai vision software** – Alexandria City – Arab Republic of Egypt, we are pleased to agree of the participation of **Eng. Khamis Talha** in the project titled:

" Design and Implementation of Mobile Ventilator"

In the call initiated by **"Arab Academy for Science, Technology & Maritime Transport"**

Eng. Khamis will participate as an expert team member with Industry Service Complex at Arab Academy for Science, Technology & Maritime Transport which is the prime bidder of the proposed project.

Eng. Khamis will help and supervise the execution the following tasks:

- Survey work including scientific and market surveys.
- Concept design for system components.
- System design.
- Determine the system specifications.
- Technical evaluation of tendering offers.
- System Evaluation during and after implementation.
- Publication of scientific paper after finishing the system implementation.

Manager

رؤية لبرامج الكمبيوتر
AI VISION SOFTWARE
مهندس / خميس طلحة أمين

Institution Endorsement Letter: Design and Implementation of Mobile Ventilator

Prime bidder institutional name:

Industry Service Complex, Arab Academy for Science, Technology & Maritime Transport

Prime bidder institutional address:

Abu Qir Main Campus, Alexandria, Egypt.

AASTMT's Innovation Research Grants (IRG)

Collaborative Research Project (CRP) Topic Areas

Medical sciences