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AUTOMATION OF RESUSCITATOR BY SENSING THE LOW HEART BEAT

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Abstract : Resuscitator is an apparatus used to restore respiration, generally used to force the oxygen/air in to the lungs of a patient who is not breathing properly. When a person is not breathing properly due to the lung problem, the heart beats of that person will be lowered and may cause serious illness and this is called Bradycardia in medical science. If any person is suffering from Bradycardia, his/her heart beats may fall to less than 50 times a minute and it can be a serious problem by which the heart can't pump enough oxygen-rich blood to the body. If this happens, the patient may fall in coma or short of breath. In such condition, it is essential to pump the oxygen forcibly in to the lungs through this operates called Resuscitator. In this project work, the heart rate or pulse rate is monitored continuously through a pulse rate sensor, if the pulse rate falls less than 40, immediately the Resuscitator mechanism will be activated automatically and air will be pumped in to the lungs to rescue the life of patient. This automatic self-inflating resuscitator enables assisted ventilation of patients requiring total or intermittent ventilatory support. Manual resuscitation is a form of artificial respiration that uses a breathing bag (manual resuscitator) to assist patients with breathing. It is usually used when the lungs are not functioning properly. If support is not available in critical condition, than the patient may die due to the poor blood circulation occurred due to the low pulse rate and there by this automatic resuscitator system is designed. The heart rate monitor designed here is intended to measure the blood flow cycles through our finger tips, for this purpose IR sensors are used to detect the blood flow through finger tips. These sensors wired with LM358 can generate pulses according to the blood flow. LM 358 is high gain duel op-amp and its output is fed to the embedded system constructed with 89c51 microcontroller chip. Now this controller chip is programmed to measure and display the heart rate through LCD. Since the healthy heart beats will be more than 60, here the system is programmed to energize the air pumping mechanism automatically when pulse rate falls less than 40. LCD is used to display the pulse rate per minute. DC motor is used to activate the air pumping mechanism.

Keywords: Construction of air pumping mechanism designed with Silicon resuscitator with accessories, DC motor, Reciprocating mechanism, crank, Main processing unit built with 89C51/52 Microcontroller chip, Pulse rate sensor built with IR sensors and IC358, LCD, power supply unit, Buzzer, alarm reset key, etc.

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1. INTRODUCTION

Bradycardia is a type of heart disease and those are suffering of this disease, their heart rate will be very low. Bradycardia can be a serious problem if the heart rate is very slow and the heart can't pump enough oxygen-rich blood to the body. If this happens, the sufferer may feel dizzy, very tired or weak, and short of breath. Initial treatment of any patient with Bradycardia should focus on support of airway and breathing. If Bradycardia is severe, additional air must be pumped in to the lungs of patient to increase the heart rate. Presently, medical authority is using manual operated resuscitator by which the patient may not get proper treatment in time because diagnosing the problem may consume more time. To avoid this situation, here this automated motorized resuscitator is designed which can detect the low heart rate and energizes the air pumping mechanism automatically. A resuscitator is a device using positive pressure to inflate the lungs of an unconscious person who is not breathing or whose heart rhythm is very low, in order to keep them oxygenated and alive. A bag valve mask (BVM), sometimes known by the proprietary name Ambu bag or generically as a manual resuscitator or "self-inflating bag", is a hand-held device commonly used to provide positive pressure ventilation to patients who are not breathing or not breathing adequately. The device is a required part of resuscitation kits for trained professionals in out-of-hospital settings (such as ambulance crews) and is also frequently used in hospitals as part of standard equipment found on a crash cart, in emergency rooms or other critical care. An oxygen resuscitator is a medical device that uses positive pressure to help both conscious and unconscious patients receive the oxygen they need. While many emergency departments, intensive care units, and other areas use mechanical resuscitators for patients and to pump the air forcibly, for this purpose continuous human efforts are required and a person must be present near the patient bed to operate this device for long time which is quite painful activity. To avoid this painful activity here an automatic resuscitator mechanism is designed that monitors the heart rate continuously and energizes the mechanism automatically when the system detects that the pulse rate is less than 40. In this regard, this project work is designed to pump in fresh air in to the lungs through air pumping mechanism designed with synthetic air balloon. With the help of a pipe attached to the air pumping mechanism, fresh air can be pumped in the lungs. The fresh air pumping mechanism is designed with reciprocating type of crank mechanism that will be attached to the dc motor shaft. The motor is used to blowing up a balloon by forcing its body through mechanism by which the balloon sucks and releases the fresh air from open air and pumps the same in to the lungs. This specially designed rubber or synthetic balloon can create enough air pressure to pump the air forcibly through pipe. There are many reasons to slow down the heart rate, one main cause is week heart and other cause is low BP. These are common risk factors for heart disease, hence monitoring Heart rate during above reasons is important and accordingly taking suitable medical care is also important. The heart rate monitor (HRM) designed here is very useful instrument, it is a kind of bio-medical instrument and is a personal monitoring device that allows one to measure and display the heart rate in real time. The heart rate monitor designed here is intended to measure the blood flow cycles through our finger tips, for this purpose IR sensors are used to detect the blood flow through finger tips. These sensors wired with LM358 can generate pulses according to the blood flow. LM 358 is high gain duel op-amp and its output is fed to the embedded system constructed with 89c51 microcontroller chip. Now this controller chip is programmed to measure and display the heart rate through an LCD interfaced with controller chip. Since the healthy heart beats will be within the range of 60 to 90 beats per second, here an alarm is used to alert the low pulse rate which will be energized automatically when the heart rate decreases to less than 40. LCD is used to display the pulse rate per minute. The processor or micro-controller chip is programmed such that it acquires data for every 15 seconds and multiplied internally by which final value will be displayed. Once the alarm is energized it remains in energized condition until someone activates the reset button.

1.1 Background

Automating a resuscitator by sensing a low heart rate involves the integration of technology to detect and respond to critical physiological parameters, particularly a low heart rate, without direct human intervention. This application is commonly associated with medical devices and emergency response systems, such as automated external defibrillators (AEDs) and automated chest compression devices.

1.2 Objectives

The automation of a resuscitator by sensing a low heart rate aims to achieve several important objectives, all focused on improving the outcomes of individuals experiencing cardiac emergencies. Here are key objectives:

1. **Rapid Response Time:**
   - **Objective:** Minimize the time between the onset of a low heart rate and the initiation of life-saving interventions.
   - **Rationale:** Automated systems can detect abnormal heart rhythms faster than human response, leading to quicker initiation of critical medical interventions.
2. **Consistent and Effective Chest Compressions:**
   - **Objective:** Ensure consistent and high-quality chest compressions during cardiopulmonary resuscitation (CPR).
   - **Rationale:** Automation reduces the variability in chest compression depth and rate, enhancing the overall effectiveness of CPR and increasing the likelihood of restoring blood circulation.
3. **Early Defibrillation:**

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- **Objective:** Administer timely defibrillation in cases of shockable rhythms, such as ventricular fibrillation.

- **Rationale:** Early defibrillation is crucial for restoring a normal heart rhythm and improving the chances of survival. Automated systems can quickly identify and respond to shockable rhythms.

1.3 Scope of the study

The scope of the study on the automation of a resuscitator by sensing a low heart rate encompasses a wide range of interdisciplinary areas. Here are key aspects that could be included in the scope of such a study:

1. Medical Science and Physiology:
   - Understanding the physiological aspects of cardiac emergencies, including the causes and consequences of a low heart rate.
   - Exploring the relationship between different cardiac rhythms and the appropriate interventions.
2. Biomedical Engineering:
   - Developing and analyzing sensors for accurately detecting low heart rates.
   - Designing and optimizing automated algorithms for interpreting physiological data and making decisions in real-time.
3. Technology Integration:
   - Investigating the integration of sensors, actuators, and automation technologies into resuscitator devices.
   - Exploring the compatibility of automated resuscitators with existing medical equipment and emergency response systems.

4. Human-Machine Interaction:
   - Assessing the usability and effectiveness of user interfaces for bystanders and healthcare professionals.
   - Studying the psychological and behavioral aspects of individuals using automated resuscitators during emergencies.
5. Emergency Medicine and Pre-hospital Care:
   - Evaluating the impact of automated resuscitators on pre-hospital care and emergency medical services.
   - Studying the feasibility and effectiveness of deploying automated resuscitators in various environments, including homes, public spaces, and healthcare facilities

2. METHODOLOGY AND LITERATURE SURVEY

Block diagram :

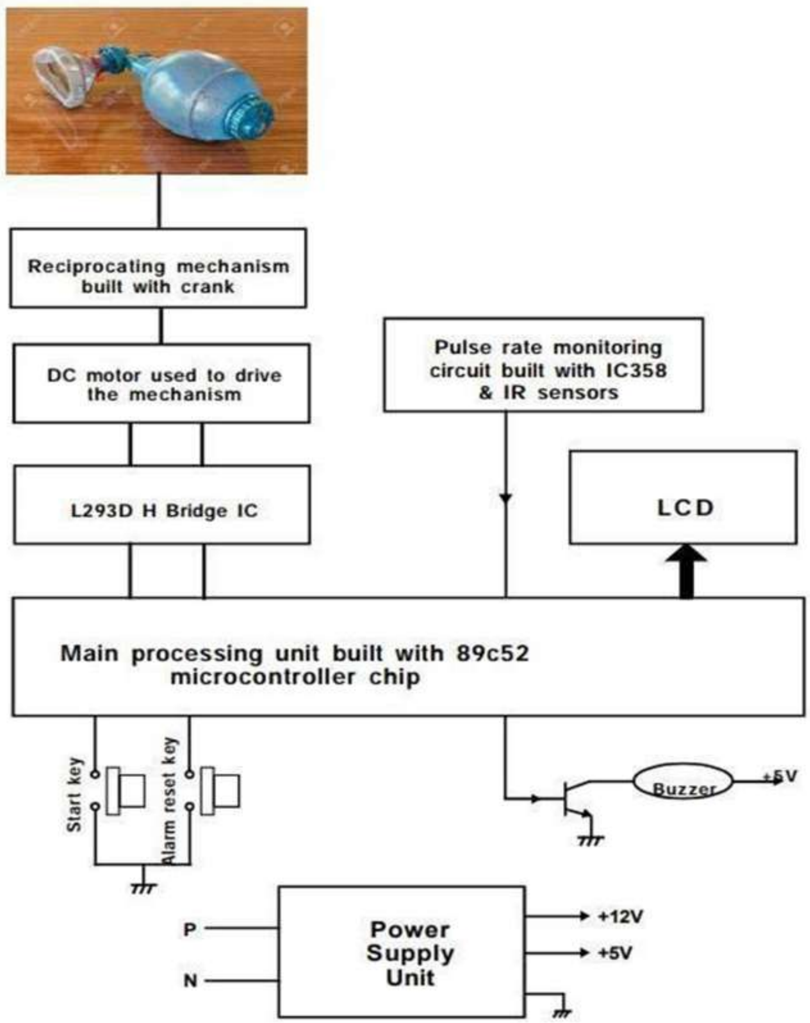

Figure 2.1: Automation of Resuscitator by sensing the Low Heart beat - Block Diagram

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Circuit diagram :

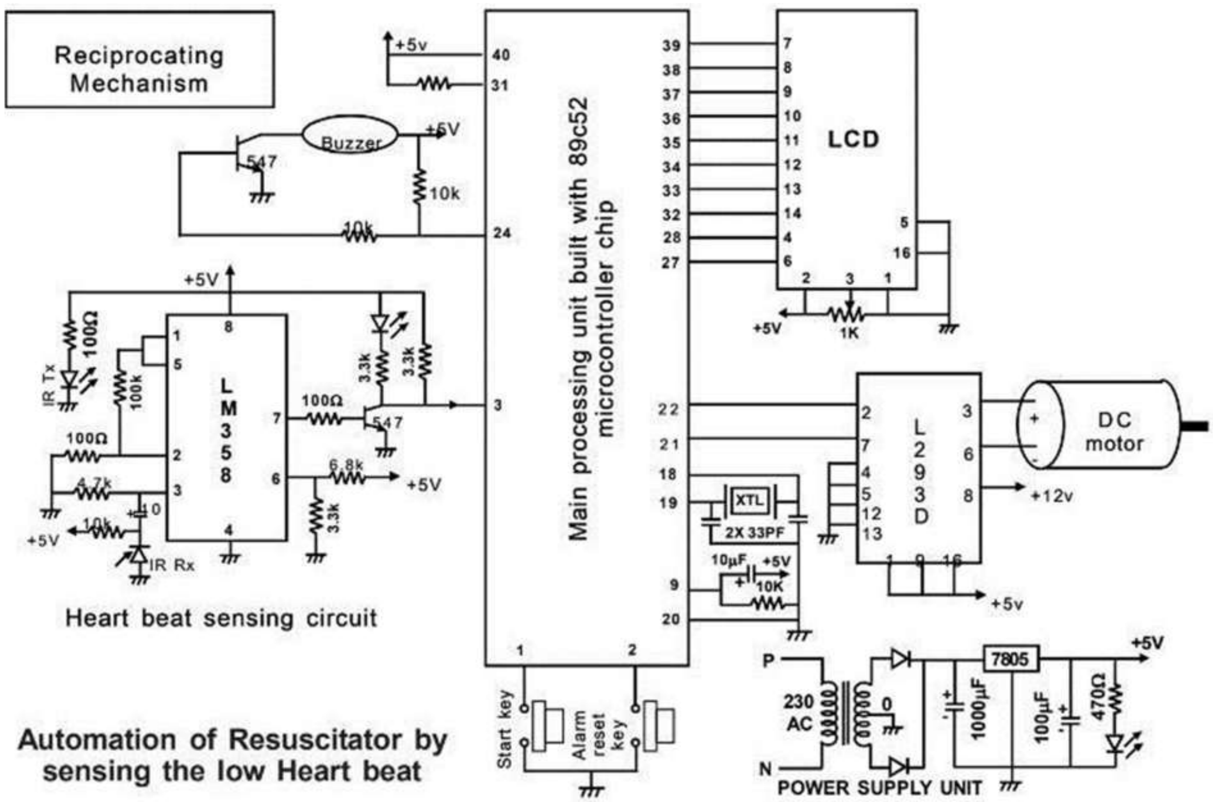

Figure 2.2 : The main circuit diagram of Automation of Resuscitator by Sensing the low heart beat

3. PERFORMANCE ANALYSIS OF RESUSCITATOR

As described in the above chapter, a resuscitator is a device using positive pressure to inflate the lungs of patient who is having breathing problem due to the week or sick heart or sick lungs. The system developed here is used in order to keep the patient oxygenated and alive during emergencies until the patient is treated well. This is a temporary life support machine.

Bag valve mask and standard components

A bag valve mask (BVM), sometimes known by the proprietary name Ambu bag or generically as a manual resuscitator or "self-inflating bag", is a hand-held device commonly used to provide positive pressure ventilation to patients who are not breathing or not breathing adequately. The device is a required part of resuscitation kits for trained professionals in out-of-hospital settings (such as ambulance crews) and is also frequently used in hospitals as part of standard equipment found on a crash cart (a trolley carrying medicine and equipment for use in emergency resuscitations), in emergency rooms or other critical care settings. Underscoring the frequency and prominence of BVM use in the United States, the American Heart Association (AHA) Guidelines for Cardiopulmonary Resuscitation and Emergency Cardiac Care recommend that "all healthcare providers should be familiar with the use of the bag-mask device.

Manual resuscitators are also used within the hospital for temporary ventilation of patients dependent on mechanical ventilators when the mechanical ventilator needs to be examined for possible malfunction or when ventilator-dependent patients are transported within the hospital. Two principal types of manual resuscitators exist; one version is self-filling with air, although additional oxygen (O2) can be added but is not necessary for the device to function. The other principal type of manual resuscitator (flow-inflation) is heavily used in non-emergency applications in the operating room to ventilate patients during anaesthesia induction and recovery.

Use of manual resuscitators to ventilate a patient is frequently called "**bagging**" the patient and is regularly necessary in medical emergencies when the patient's breathing is insufficient or has ceased completely. Use of the manual resuscitator force-feeds air or oxygen into the lungs in order to inflate them under pressure, thus constituting a means to manually provide positive-pressure ventilation. It is used by professional rescuers in preference to mouth to mouth ventilation, either directly or through an adjunct such as a pocket mask.

4. MECHANICAL VENTILATION

Mechanical ventilation, assisted ventilation or intermittent mandatory ventilation (IMV), is the medical term for using a machine called a ventilator to fully or partially provide artificial ventilation. Mechanical ventilation helps move air into and out of the lungs, with the main goal of helping the delivery of oxygen and removal of carbon dioxide. Mechanical ventilation is used for many reasons, including protecting the airway due to mechanical or neurologic cause, to ensure adequate oxygenation, or to remove excess carbon dioxide from the lungs. Various healthcare providers are involved with the use of mechanical ventilation and people who require ventilators are typically monitored in an intensive care unit.

Mechanical ventilation is termed invasive if it involves an instrument to create an airway that is placed inside the trachea. This is done through an endotracheal tube or nasotracheal tube. For non invasive ventilation in people who are conscious, face or nasal masks are used.

The two main types of mechanical ventilation include positive pressure ventilation where air is pushed into the lungs through the airways, and negative pressure ventilation where air is pulled into the lungs. There are many specific modes of mechanical ventilation, and their nomenclature has been revised over the decades as the technology has continually developed.

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5. PERFORMANCE ANALYSIS OF HEART BEAT SENSOR

Heartbeat sensor provides a simple way to study the function of the heart which can be measured based on the principle of psycho-physiological signal used as a stimulus for the virtual- reality system. The amount of the blood in the finger changes with respect to time. The Sensor is designed based on IR moulded technique, means the mechanical arrangement of finger clip consists photo diode at one side and IR signal generator at other side, both will be placed parallel to each other such that when the clip is attached to the finger tip, the IR energy passed through the tissue of finger, here depend up on the blood flow through finger tip, the photo diode receives proportionate IR energy. Means whenever the heart pumps the blood, due to the significant blood flow, the IR energy will be reflected back and otherwise it will be passed through the finger. So Once the Finger is inserted in to the clip, for every beat, the circuit generates a pulse in the form of logic high signal known as pulse and these pulses are fed to the Arduino processor to measure and display the heart rate or pulse rate.

In order to calculate the heart rate based on the blood flow to the fingertip, a heart-rate sensor is assembled with the help of op-amp for monitoring the heartbeat pulses. Thumb Sensor is a plug-and-play type of heart-rate sensor designed for Arduino and other compatible type of microcontroller chips. It can be used by students, athletes, etc; it is a kind of bio medical instrument which can be used in hospitals. Thumb heart Sensor adds amplification and noise cancellation circuitry to the hardware. It's noticeably faster and easier to get reliable pulse readings. Heart beat Sensor operates between 3 to 5V DC.

The heart rate sensor measures heart rate in Beats per Minute using an optical LED light source and an LED light sensor. The light shines through the skin, and the sensor measures the amount of light that reflects back. The light reflections will vary as blood pulses under skin past the light. The variations in the light reflections are interpreted as heartbeats.

The accuracy of the information and data provided by this device and its related software, including heart rate readings, may be affected by factors such as environmental conditions, skin condition, specific activity performed while using/wearing the device, settings of the device, user configuration, user- provided information, placement of the sensor on the body, and other end-user interactions. Please refer to the user manual for more information on proper wear and use.

6. APPLICATIONS OF BIOMEDICAL INSTRUMENTATION

Biomedical instrumentation

Is a main branch in biomedical engineering. Mainly focuses on how electronics equipment can measure physiological patient data and improve medical care. Basically for diagnostic biomedical instrument like ecg, the background is electrical and electronics. Control and instrumentation engineers (C&I engineers) are responsible for designing, developing, installing, managing and maintaining equipment which is used to monitor and control engineering systems, machinery and processes.

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Biomedical engineering (BME) is the application of engineering principles and design concepts to medicine and biology for healthcare purposes. This field seeks to close the gap between engineering and medicine, combining the design and problem solving skills of engineering with medical biological sciences to advance health care treatment, including diagnosis, monitoring, and therapy. Biomedical engineering has only recently emerged as its own study, as compared to many other engineering fields. Such an evolution is common as a new field transitions from being an interdisciplinary specialization among already-established fields, to being considered a field in itself. Much of the work in biomedical engineering consists of research and development, spanning a broad array of subfields.

Prominent biomedical engineering applications include the development of biocompatible prostheses, various diagnostic and therapeutic medical devices ranging from clinical equipment to micro-implants, common imaging equipment such as MRIs and EKGs, regenerative tissue growth, pharmaceutical drugs and therapeutic biologicals.

Bioinformatics is an interdisciplinary field that develops methods and software tools for understanding biological data. As an interdisciplinary field of science, bioinformatics combines computer science, statistics, mathematics, and engineering to analyze and interpret biological data.

7. WORKING OF 89C51 CONTROLLER CHIP

The situation we find ourselves today in the field of microcontrollers had its beginnings in the development of technology of integrated circuits. This development has enabled us to store hundreds of thousands of transistors into one chip. That was a precondition for the manufacture of microprocessors. The first computers were made by adding external peripherals such as memory, input/output lines, timers and others to it. Further increasing of package density resulted in creating an integrated circuit, which contained both processor and peripherals. That is how the first chip containing a microcomputer later known as a microcontroller has developed.

This is how it all got started...

In the year 1969, a team of Japanese engineers from BUSICOM came to the USA with a request that a few integrated circuits for calculators were to be designed according to their projects. The request was sent to INTEL and Marcian Hoff was in charge of the project there. Having experience working with a computer, the PDP8, he came up with an idea to suggest fundamentally different solutions instead of the suggested design. This solution presumed that the operation of integrated circuit was to be determined by the program stored in the circuit itself. It meant that configuration would be simpler, but it would require far more memory than the project proposed by Japanese engineers. After a while, even though the Japanese engineers were trying to find an easier solution, Marcian's idea won and the first microprocessor was born. A major help with turning an idea into a ready-to-use product was Federico Faggin. Nine months after hiring him, Intel succeeded in developing such a product from its original concept. In 1971 Intel obtained the right to sell this integrated circuit. Before that Intel bought the license from BUSICOM, which had no idea what a treasure, it had. During that year, a microprocessor called the 4004 appeared on the market. That was the first 4-bit microprocessor with the speed of 6000 operations per second. Not long after that, an American company CTC requested from Intel and Texas Instruments to manufacture an 8-bit microprocessor to be applied in terminals. Even though CTC gave up this project, Intel and Texas Instruments kept working on the microprocessor and in April 1972 the first 8-bit microprocessor called the 8008 appeared on the market. It was able to address 16Kb of memory, had 45 instructions and the speed of 300 000 operations per second. That microprocessor was the predecessor of all today's microprocessors. Intel kept on developing it and in April 1974 it launched an 8-bit processor called the 8080. It was able to address 64Kb of memory, had 75 instructions and initial price was $360.

8. HARDWARE DETAILS

To prove any project work practically for the demonstration purpose, construction of described model is essential. For this purpose suitable hardware in the form of electronic, electrical and mechanical components are essential to perform the given task. When these components are integrated together or working together, better results can be obtained from the project work. Since it is a practical oriented project work, the content presented in the abstract must be proven practically. In this regard required active hardware like IC's and other special components must be gathered and their details must be described in this chapter to fulfil the concept of perfect project report.

Electronic hardware is Hardware, in the context of technology, refers to the physical elements that make up electronic system or electro-mechanical system, and everything else involved that is physically touchable. When an embedded system is considered, that contains a processing unit (Often microcontroller chips are preferred to build a processing unit) Sensors, control circuits that includes the motors, relays, switching devices (like power Mosfets, transistors, etc). Hardware works hand-in-hand with firmware and software to make a system function. Software is a collection of code installed into the microcontroller chip. Often LCD displays are used to monitor the system performance or results. In this project work also LCD is used to display the pulse rate produced by the heart beat sensor.

The following are the active components used in this project work.

1 – 89C52 main processor

2 – Voltage regulator

3 – L293D H Bridge IC

4 – DC motor

5 – LM358

6 – Buzzer

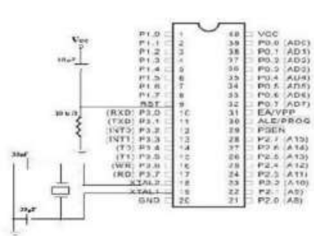

FIGURE 11.1 89C52 PIN DIAGRAM

9. RESULT AND CONCLUSIONS

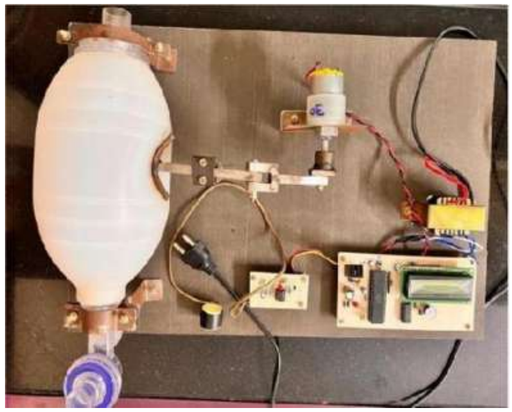

Figure 12.1 system setup

A resuscitator is a piece of medical equipment that is used to force oxygen or air into the lungs of a patient who is not breathing properly. When a person's lung condition prevents them from breathing normally, their heart rate drops, which could lead to serious illness. Bradycardia results in the heart beating less frequently than 50 times per minute, which can be extremely harmful since the heart cannot pump enough oxygen-rich blood to the body. The use of a resuscitator is essential in such a circumstance. The heart rate monitor developed here is designed to measure the blood flow cycles through our fingertips; IR sensors are used to detect blood flow through fingertips. These LM358-connected sensors can generate pulses dependent on blood flow. An embedded system called the LM 358 was created using the 89c51 microcontroller microprocessor. It is a dual op-amp with a high gain. This controller chip is currently measuring the pulse rate and displaying the results on the LCD. Due to the fact that a healthy heart beats more than 60 times per minute, the technology is programmed to automatically start the air pumping mechanism when the pulse rate falls below 40. The pulse rate in beats per minute is displayed on an LCD. The air-pumping apparatus is driven by a DC motor.

9. CONCLUSION

The project work **"Automation of Resuscitator by sensing the low heart beat"** is completed successfully and results are found to be satisfactory. During our trail runs we found that, making heart beat monitoring system is very difficult because we won't get any sensors available readily. In this regard we have made our own using IR sensors and IC358. In this combination the blood flow through finger tip must be monitored through IR sensors. After making so many trails, we came to know that we need very sensitive sensors to monitor the blood flow. The output of sensors is amplified and triggered to generate a logic pulse for every wave of blood flow through finger tip. Now the controller is programmed to read and display the pulses produced by the heart beat sensing circuit.

Regarding Resuscitator, we purchased one manual operated device and it is automated using the subject of Mechatronics in which the mechanism will be activated automatically by sensing low the heart beat. The key feature of this device is a compressible reservoir, typically made of silicone that automatically expands upon release. The self-inflating manual resuscitator may be used for hand ventilation in the absence of an oxygen or air source. But in our project work it is designed as automatic using motor and its associated mechanism.

10. FUTURE SCOPE

The automation of a resuscitator by sensing low heartbeats is an intriguing and potentially impactful application of technology in the healthcare industry. While I don't have real-time information on the latest developments, as of my last update in January 2022, I can provide insights into the general trends and potential future scope of such automation.

1. Improved Response Time: Automation in resuscitation devices can significantly enhance response times during critical situations. Rapid detection of low heartbeats and immediate initiation of resuscitation measures can be crucial in saving lives.
2. Smart Monitoring Systems: Future resuscitators may integrate with smart monitoring systems that continuously assess the patient's vital signs. These systems could utilize advanced sensors and artificial intelligence to detect subtle changes in heart rate, providing early warnings and interventions.
3. Integration with Wearable Devices: As wearable health technology continues to advance, there is potential for integration between resuscitators and wearable devices. Continuous monitoring through wearables could trigger automatic responses in resuscitation devices when abnormal heart patterns are detected.
4. Machine Learning Algorithms: The incorporation of machine learning algorithms can enhance the accuracy of heartbeat detection and improve the overall performance of automated resuscitators. These algorithms can adapt and learn from diverse datasets, making them more effective in different patient scenarios.
5. Telehealth and Remote Monitoring: The automation of resuscitators could be part of a broader telehealth system, allowing healthcare professionals to monitor patients remotely. In the event of a detected low heartbeat, automated resuscitation measures could be initiated while medical personnel are alerted for further intervention.
6. IoT and Connectivity: Internet of Things (IoT) technology can be leveraged to connect resuscitators to healthcare networks. This connectivity can facilitate real-time data transmission, enabling healthcare providers to access patient information and device status remotely.

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7. Ethical and Regulatory Considerations: As with any automated medical system, ethical considerations, patient consent, and regulatory compliance are crucial factors. The development and deployment of automated resuscitators would need to adhere to stringent safety and ethical standards.
8. Training and Education: The introduction of automated resuscitators would require adequate training for healthcare professionals to understand the technology and its limitations. Training programs would need to be developed to ensure proper usage and maintenance.

It's important to note that the successful implementation of automated resuscitation technologies requires collaboration between healthcare professionals, engineers, regulatory bodies, and other stakeholders. As technology continues to advance, the future scope of automation in healthcare, including resuscitation, holds great promise for improving patient outcomes and overall healthcare efficiency.

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