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IoT Enabled Respiratory Sensing Device for Asthma Curing Game for Children

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Abstract: Effective self-regulation is crucial for achieving optimal asthma management. However, individuals with asthma sometimes completely stop participating in sports and fail to follow the guidance provided by their doctor during a visit. To optimize asthma management, it is important to promote consistent physical activity and foster asthma education among both asthma patients and their parents. The objective of the project is to develop an engaging and authentic game situated in a hospital environment to assist asthmatic patients in effectively managing their illness. The airflow sensor is linked to the NODE MCU, which processes the sensor data. The NODE MCU then records the processed data in the IoT database. The primary objective of this game is to generate interest among asthma patients by tracking and visualizing their growing breathing levels. This would facilitate physicians in readily monitoring the health of asthma patients.

Keywords: Raspberry Pi, IoT, Respiration sensor, Temperature Sensor, Heartbeat Sensor, Game Level

I. INTRODUCTION

Asthma is an illness that may be fatal. Less-developed countries have the highest number of fatalities attributed to asthma. Children who have asthma are more likely to suffer from non-communicable illnesses than other children. The condition's rising prevalence among children is causing an annual decrease in average lifetime. Compared to men, a greater number of women have been effectively treated for this illness. Children are often the ones who are diagnosed with asthma for the first time, even though asthma is a chronic disorder that may afflict anyone at any age. Asthma cannot be inherited. It is estimated that one in every four children will get asthma, even though one or both of their parents suffer from the ailment. Several symptoms that are indicative of asthma include coughing, trouble speaking, a perspiring face, wheezing, a pale appearance, shortness of breath, blue lips or fingernails, chest tightness or pressure, and difficulty breathing. There is a certain precipitating element that might bring on an asthma attack. As a result of the tightening of the muscles that surround the bronchial airways, which makes breathing more difficult, this is a serious worsening of the signs that came before it. During an asthma attack, the lining of the airways often generates more mucus, in addition to edema and the thickness of the airways. Bronchospasm, inflammation, and the creation of mucus are the several components that comprise an asthma episode. This sickness allows for just a small quantity of air to be breathed in or expelled at any one time. Individuals who suffer from asthma often have allergies to a variety of allergens, including household bacteria and germs, allergies to pets, molds, and pollutants from trees, grasses, and weeds. In addition to dust, perfume, smoke, paint, cold, the aroma of baking, and air pollution, there are additional triggers that do not cause allergic reactions. Several factors might bring on an asthma attack, including physical activity, stress, medicine, and infections of the airways, such as the common cold or the flu. The good news is that there is an asthma treatment that may make it such that you have very little difficulty. The goal of asthma therapy is to attain the highest possible level of lung function, to be free from annoying symptoms at all times of the day and night, to be able to take part in activities that are comparable to those of other people, and to avoid missing any school or work appointments. It is recommended that asthma be managed with the use of medicine, which should ideally have little to no adverse effects and remove the need for trips to the hospital or critical care units.

II. LITERATURE REVIEW

Delmas and colleagues (2018) found that developing a serious game using the participatory design (PD) technique to aid in the teaching approach for asthmatic children may have beneficial impacts. Because it has an impact on educational effectiveness, pedagogical efficiency, and therapeutic benefit, the Kid Breath assessment in a real-world situation (use at home) is part of the contribution (Study 1). Study 2 aimed to assess the additional value of incorporating an IT'S into KidBreath to advance the field of automated learning customization in health education. The criteria used in this study were similar to those utilized in studies [1] and [2].

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In the realm of wearable technology and the IoT, John Dian and colleagues (2020) evaluated the most important research projects. There is a multitude of real-world applications for the wearable Internet of Things that represent a multitude of fresh opportunities. They performed an analysis of the major research conducted on this subject and discovered more than one hundred papers. They categorized the study into four basic categories, depending on its applicability. In addition, we grouped the techniques for each cluster. Once an integrated Internet of Things system becomes available, wearable electronics will hold great promise. The IoT and wearable technologies have not yet reached their full potential. Furthermore, the cellular Internet of Things has the potential to revolutionize the market for wearable IoT, which has not yet attracted a substantial amount of attention from scientific research [3].

An evaluation of numerous aspects of IoT-based healthcare technology was carried out by M. Riazul Islam and colleagues (2015). They also provided several healthcare system designs that facilitate the transmission and reception of health data within the IoT infrastructure. Significant research and development initiatives have focused on technology and services in the medical field, driven by the Internet of Things. There are also in-depth research projects mentioned in the article that discuss how the IoT may be able to promote exercise, monitoring of chronic illnesses, personal health, and care for both young and elderly people.

The purpose of this paper is to provide a comprehensive overview of how recent and ongoing developments in sensors, devices, internet applications, and other technologies have inspired cost-effective healthcare devices and integrated healthcare facilities to endlessly expand the potential of the Internet of Things-based healthcare resources for additional improvements. Additionally, the paper offers more insight into market developments as well as creative solutions. The authors propose a framework to decrease important privacy concerns and improve knowledge of IoT healthcare security [5]. The study analysed a large number of security processes and barriers, revealed many research difficulties in this area, and revealed several research challenges that exist in this field.

Gaurav Pate et al. (2012) demonstrated a mobile game that motivates youngsters to monitor their maximum exhalation flow regularly using a custom-built spirometer. The game's main recent additions are the inclusion of interactive entertainment elements and the healthcare regimen itself, which gives kids and teenagers an extra incentive to follow the regimen. This has enormous ramifications for asthma sufferers and medical professionals alike. A good preventative care regimen that can lead to an improved life experience and fewer expensive hospital stays is monitoring PEF. Future health-related games for a range of chronic or lifelong ailments may benefit from the design ideas used in this game, in our opinion. [6].

Using mHealth devices, Kevin et al. (2021) investigated a wide range of features for the management of asthma. The algorithms have shown promising outcomes, but their evaluation has at most remained limited to assessment. Furthermore, a restricted demographic and short datasets were primarily employed to construct the algorithms. As a result, it is uncertain how well these algorithms would execute in the general community in a practical setting. [4]

Ijaz Ahmad et al. (2022) thought carefully about how to present the key technological principles and capabilities of remote healthcare systems. First, as part of remote monitoring and remote assistance, the key convincing arguments for the utilization of remote health care are presented. Second, every significant technological component that is essential to meeting the demands of remote monitoring and remote assistance is determined. Third, cutting-edge studies are used to analyze all of the listed technologies and technological frameworks. These are current technologies, developing technical ideas, and research initiatives. Fourth, significant research is required in each technology within the broader category of remote healthcare systems recognized to motivate future research. In conclusion, this article clarifies new and existing technology for remote medical care. [1]

Chris Hass et al. (2017) described the design, delivery, and analysis of a home-based treatment for financially underprivileged youth to enhance asthma health outcomes. The surveillance and management tasks were provided in an integrated astronaut-themed game to sponsor user acceptability also adherence to the therapy process. The authors developed Aspira (asthma home monitoring system) to comprise a particle detector, tablet, digital spirometer and coupled to a data management server.

The primary target group for this study was children from low socioeconomic backgrounds because of their disproportionately high incidence of asthma and limited asthma knowledge. Aspira was the very first treatment of its kind to offer the target population an affordable, simple-to-use in-home surveillance system. Aspira was created to improve use, involvement, and effectiveness within the target group, and it is based on the social cognitive theory. To determine the viability and early performance of the created increased Aspira model, exploratory research was done among 4 groups in the Seattle metropolitan area with asthmatic children. [7]

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III. METHODOLOGY

As shown in Figure 1, the approach involves the use of health monitoring equipment to diagnose and treat asthma. A patient's heart rate, temperature, and breathing are all monitored and recorded by sensors that are used to monitor and track the patient's health. Before delivering the results via a mobile application, it monitors asthma, temperature, and heart rate with the assistance of the Internet of Things. The NODE MCU is linked to the sensors, and after that, the operator is responsible for making decisions. The results are presented or the values that were measured are linked to the web server after the gathering of the results has been completed. The use of this strategy does not allow for the monitoring of the patient's breathing patterns; rather, it just assists in the awareness of the patient's current position. The status of the patient is then identified, and it is decided whether the patient is in a critical condition or if they are in a healthy condition. This method does not provide a means of practicing inhalation; rather, it just assists in gaining a better understanding of the patient's condition.

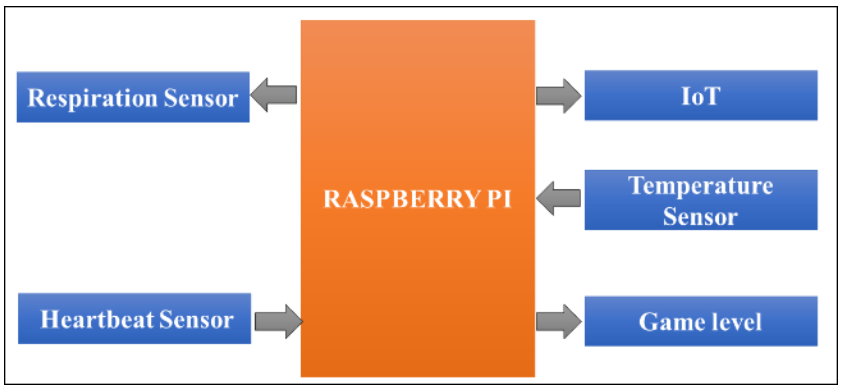

Figure 1. System Architecture

3.1 Respiration Sensor

Figure 2. Respiration Sensor

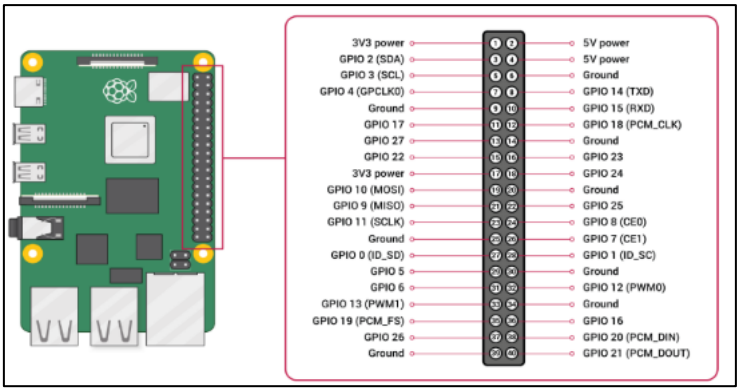

Figure 3. Raspberry Pin Configuration

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The Respiration Sensor is a sensitive girth sensor that is linked to a belt that adheres to itself using a latex rubber band that is both easy to fit and very long-lasting. It does this by displaying the waveform and amplitude of breathing whenever it detects an expansion or contraction of the chest or abdominal region. It is possible to wear it on top of clothing. Placement of the respiration sensor is accomplished by the use of a long hook and loop strap that is worn across the chest or belly. For the majority of applications, a single sensor has to be positioned around the abdomen. Alternatively, a second respiration sensor might be used to wrap the chest. The use of two sensors is beneficial to exercises that focus on abdominal breathing. The pin arrangement of the respiration sensor is shown in Figure 3.3, and Figure 3.2 shows an illustration of the respiration sensor.

3.2 Temperature Sensor

Maxim Integrated offers the 1-wire customizable DS18B20 temperature sensor, which can be seen in Figure 3.4. This sensor may be purchased from the company. To determine the temperature in challenging environments, such as those involving a variety of chemicals, mines, or dirt. Because of the sturdy case of the sensor, which can optionally be made waterproof, mounting the sensor is a straightforward process. To keep track of a wide range of temperatures, from -55 degrees to +125 degrees, with a reasonable precision of 5 degrees Celsius. The alternate method for collecting several temperature measurements rather than eating up a significant number of the digital pins on the microcontroller. This is because each sensor is located in a particular position and only needs a single MCU connection to convey data. To communicate with one another, the sensor makes use of the 1-Wire communication protocol.

Figure 4. DS18B20 Temperature sensor

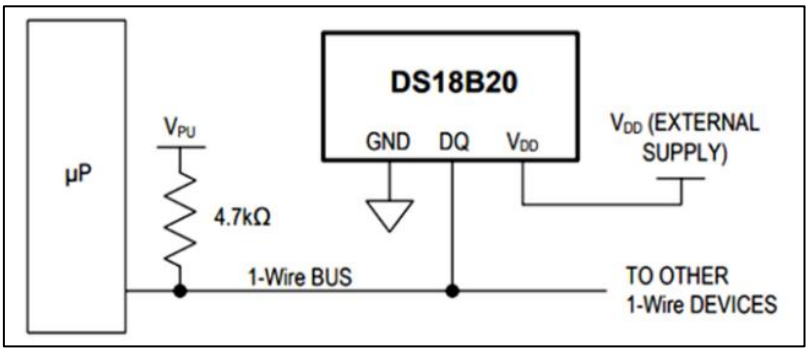

Figure 5. Microcontroller with a pull-up resistor

Figure 5 shows the pull-up resistor. When the bus is not in use, a pull-up resistor is utilized to keep the line in a high state. A 2-byte register inside the sensor will be used to store the temperature reading that it recorded. By sending a sequence of data, this data can be retrieved using the 1-wire approach. Two distinct kinds of commands a ROM request and a function command must be delivered to read the values.

3.3 Heartbeat Sensor

The Heartbeat Sensor operates in a very simple manner, as seen in Figure 6. An ambient light sensor and an LED are positioned on one of the sensor's opposing wings, while many circuits are situated on the other side. This circuitry is responsible for performing the noise cancelling and amplification operations. The LED on the front side of the sensor covers a vein in the human body. You may use either your fingers or the tips of your ears for this task, but it is important to place them exactly over a vein. The LED is now beaming light directly into the vein.

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The circulation of blood is dependent on the pounding of the heart, so it is crucial to monitor both blood circulation and heartbeats. The heartbeats are detected over some time by examining the subtle fluctuations in the received light. The ambient light sensor will register an increase in light intensity when it detects blood circulation since blood has a higher reflectivity for light.

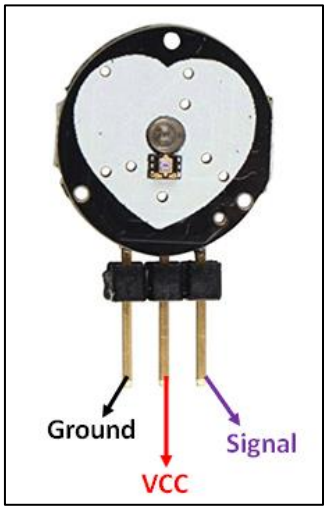

Figure 6. Heartbeat Sensor

Although the Heartbeat sensor is simple to use, it is crucial to position it properly. It's also a good idea to cover the sensor with superglue, plastic tape, or another non-conductive substance because all of the sensor's circuitry is directly exposed. Furthermore, it's never suggested to use wet hands when using these sensors. To apply this pressure, clips or Velcro tapes are typically used. The sensor's surface should be positioned on top of the vein, and a light pressure application is required. Simply connect the sensor to the Vcc and ground pins to utilize it. The sensor can be supplied by either a +5V or 3.3V system. Once the microcontroller is turned on, attach the Signal pin to the ADC pin to monitor changes in output voltage.

3.4 IoT

The IoT is a network that consists of networked computing devices, physical things, digital and mechanical gear, people, and animals that do not need to interact with one another or with computers to exchange data via a network. The IoT aims to transform sensor data into actionable information for business decision-making, enabling machine-to-machine communication, supporting academic research, and enhancing resource utilization efficiency.

IV. CONCLUSION

This work focused on conducting background research for this project. The following conclusions will be drawn about this graduation project, with a focus on the crucial factors that must be considered throughout the game development process. The gadget tracks many physiological parameters, such as asthma, body temperature, and heart rate, and presents the data on an IoT platform accessible via a smartphone application.

The NODE MCU links the sensors. Education plays a significant role in enhancing asthma management, as inferred from this graduation project. Education should address topics such as strategies for avoiding triggers, managing asthma attacks (including exercise), fostering acceptance, making informed nutrition choices, quitting smoking, and understanding medication use. Providing clients and/or families with information on these features of the illness will benefit the client by enabling them to use this knowledge in their everyday lives.

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