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Intelliwatch: Next-Gen Baby Monitoring System

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***Abstract*— The task of finding child care has gotten much harder, particularly for working mothers. It's getting harder and harder for parents to keep an eye on their child's health all the time. Many families now find it difficult to monitor their children during their daily activities. It is challenging for working parents to provide the care and supervision that babies require around-the-clock because it is not always economical for them to do so. The goal behind this paper is to create a intelligent baby monitoring system that can provide real-time activity alerts to registered parents and notify them of their kid's status. This study focuses in particular on the critical factors that are crucial to preserving the baby's comfort. Additionally, a camera is attached so that the infant can be updated and streamed live. Through the use of a smartphone application, parents may watch a live feed of their infant, identify when they are crying, and keep an eye on the environment's temperature and humidity. The Raspberry Pi is interfaced with both a moisture and temperature sensor. Using the inter-integrated circuit (I2C) bus, the cry detection interface for Raspberry Pi facilitates the conversion of analog to digital signal processing in order to detect the sound of the baby. The Raspberry Pi is interfaced with a wet detecting sensor. ThinkSpeak software is interfaced with Raspberry Pi. The channel stats (sensor result chart) in ThinkSpeak allow for the monitoring of all interface sensor outcomes by creating a channel. By providing the parents with an authenticating IP address, parents will receive updates on the baby's live streaming.**

Index Terms— **Raspberry Pi, Measuring temperature and humidity, Cry detection, Wet detection, live video streaming.**

I. INTRODUCTION

These days, childcare issues are a barrier to employment, particularly for moms who work. Parents need child care, but due to other obligations, they are not always able to provide full-time care for their children and must spend time supervising them. These days, caring for a child while both parents work is a challenging endeavor. Keeping an eye on their kids throughout daily activities has proven difficult for many families. The daycare facilities offered in many countries are not to the satisfaction of many parents. Because they can't always take their babies with them at all times, working parents find it challenging to provide the care and supervision that babies require around-the-clock. The majority of academics use vision sensors in Internet of Things environments that are solely intended for adult users for a variety of purposes, like identifying anomalous activities. Control charts are a process optimization tool that our vision-based infant monitoring system uses to assess baby behavior. Control chart for real-time frames produced by a Raspberry Pi (RPi) with a connected vision sensor, updated at a specified interval. Baby motion is represented by points on a control chart; inappropriate behavior is indicated if the points exceed the upper control limit (UCL) or fall below the lower control limits (LCL).

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A basic baby monitoring system is made up of many modules that keep an eye on the actions and behavior of the babies and alert the people who are caring for them to any unusual or suspicious behavior by text message, email, or even a screen display. Human families have always had an innate need to shield their young from harm. But in this day and age, the majority of working parents find it challenging to always care for their young child. By utilizing the current technological era, parents have embraced new approaches to raising their children.In order to watch the kids in real time, this device employs a Raspberry Pi with a webcam. The Raspberry Pi is equipped with a web camera to record and store images. In addition to offering security and safety against child abuse, this monitoring device assists parents in keeping an eye on their child from a distance. The primary benefits of this initiative are the internet video access and real-time monitoring. When taking care of their infant, parents, babysitters, and anybody else with a baby face have a problem that a smart baby monitoring system is meant to alleviate. The primary goal of this work is to suggest an intelligent baby monitoring system that enables parents to watch and interact with their infants.

II. Literature Survey

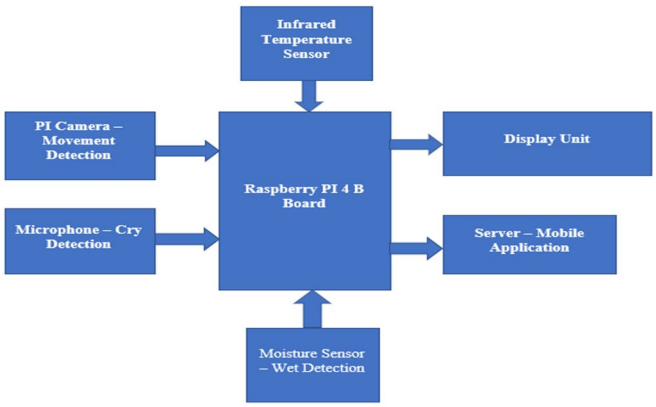
This section gives an overview of researches carried out related to the project work on "Smart Baby Monitoring System".

Ibrahim, D. M., Hammoudeh, M. A. A., Ambreen, S., & Mohammadi, S.[1] proposes systems available for desktops or smart phones/tablets that helps parents to monitor their babies. In the next subsections, we explain a number of these systems in terms of the functionalities and limitations. (I) Knight's Wireless Baby Monitor was designed with some features presented by individual wireless baby monitors in a single, integrated stand-alone monitor located on top of the baby's bed with full sensors. There will be a sensor for temperature, a sensor for motion, an audio sensor to resist accidental choking and suffocation in bed. Video, audio and the temperature of the infant will be accessible through the smartphone. The system contains three components: monitor part, alarm part and smartphone device. The main part is the monitoring in which various sensors, microprocessors, communications chip and batteries will be installed. The alarm part is a separated unit that can be placed at the end of a table, dresser, or other flat surface near an electrical socket. When the communication chip receives an alert from the monitoring part, the alarm part will flash a warning light and sound an audio alarm. The system provides a safe sleeping environment for children under the age of one year or less to reduce the infant mortality. II Integrity Baby Monitoring System The design of a GSM-based smart baby monitor system aims to provide better care for children. This system observes important parameters such as body temperature, humidity status, pulse rate, movement of an infant, and the use of GSM network, this information is transferred to their parents. Parameter details can be sent to the parents with alarm so any action can be taken. The system design consists of sensors for observing important factors, LCD display, GSM interface and sound alarm all controlled by one microcontroller. III Baby Monitoring System (Middle East Technical University) This system has some properties such as observing the baby's heart rate, measuring the baby's temperature and notifying the parents if a fever occurs and provides sleep cycle detection for detecting sleeping illnesses or showing current sleeping stage. By using the statistical data from the application, it will be possible to predict the baby's sleep habits and ideal sleep conditions. IV Automated Child Monitoring System In this system, a Raspberry Pi device connected to static camera and the movement of the camera is made dynamic using motors and other infrared sensors. The camera will be placed in the center of the room in order to cover all directions. The captured video can be streamed online and the parents can sign in to a website to access any information or updates. In addition, a GSM module is connected with Arduino which sends alert notifications whenever the camera is rotated.

Nazri et al. [2] proposes the smart baby cradle which incorporates few useful functions. First, the use of noise sensor for the detection of the child's crying activity. This will start the swinging of cradle to soothe the child. Next, the DHT sensor detects the surrounding temperature and humidity. When the detected temperature is higher than the set temperature i.e room temperature, the fan will automatically switch on. The goal of this project is to create a system that makes monitoring easy and produces good output. The suggested system prototype is built and tested to demonstrate its effectiveness in terms of cost and simplicity, as well as to assure safe operation, allowing infant-care process to take place anywhere and at any time. An automatic cradle designed with good characteristics will provide comfort to the baby and give good assistance to the parents or caretakers. With the information above, there are numerous components and factors to be considered when designing this smart baby cradle. This system is utilized whenever manual safety monitoring is challenging. Innovation has been made in such a way that it has reduced the complexity of human job. Along these lines, the new-born/infant care support framework has been created as an ideal option for parents or caretaker who are unable to devote enough time to

their children.
Jabbar et al.[3] discusses the baby cradle is used in various hospitals and maternity homes for infants to sleep in and for soothing them. Conventional cradles are used in villages or non-urban areas because of their low cost and simplicity. Parents might not have the time to soothe their baby to sleep or rock their baby back to sleep in the middle of the night. Studies about the effect of rocking a baby have been carried out and found that babies sleep better while being rocked or swung lightly because the rhythmic movement mimics the gentle rocking they felt while in their mothers' womb. Most available automated cradles are designed to rock non-stop. However, the rocking movement can make the baby nauseous and uncomfortable. Thus, allowing the automated cradle to rock the baby to sleep in the middle of the night is also a problem. Few studies have investigated the possibilities of automated baby cradle using different perspectives. A baby monitoring system has been proposed in which an enhanced noise cancelling system that monitors the baby and reduces sound pollution has been suggested. The main function of the system is to reduce the noise that might disturb the baby by playing relaxing songs. This system can also adjust the room's light intensity with the aid of a light sensor. However, our system has more advanced features, such as supporting real-time monitoring over the IoT network and vision monitoring using web camera.
Irawan, B et al. [4] infers based on studies in the health sector, the condition of a baby's sleep is a form of adaptation of a baby to its environment and is one of the basic needs for optimal growth and development for a baby. Based on research, most babies have regular sleep patterns, but 30% of children have sleep problems. Children's sleep patterns are affected by several factors, namely internal factors in children and physical environmental factors, with parental support playing an essential role in the formation of good sleep patterns for children. The monitoring system is used to see events or see the reaction of an event over a long period. According to current conditions, the excellent monitoring system has a fast data reading interval. Data recording at present is called a Real-time monitoring system. A real-time system is a management system that records data according to current conditions either through video or other media.
A.R. Telepatil et al.[5] presents the design and implementation of a Baby Monitoring System based on the GSM network, including the use of sensors, microcontrollers, and GSM interfaces. It also discusses the development of an intelligent baby monitoring framework using raspberry pi B+ as a control unit, as well as the design of a smart electronic cradle to assist the baby and bridge the gap between parents and the infant. The system is capable of sending a live video stream of the baby using a camera to a webpage accessible through both mobile phones and laptops. The main findings of the paper include the effective monitoring of vital parameters and transfer of information to parents, providing a convenient solution for busy parents, and presenting the electronic baby cradle as a valuable tool for parents with time constraints.

III. Proposed Model For Smart Baby Monitoring System



The parts and protocol of the Raspberry Pi-powered smart baby monitoring system are represented in the suggested block diagram in Figure 1. It receives input from outside sources and converts it into a consistent output. The most crucial feature of the suggested system is the cry detection feature, which allows you to listen to the sound of a baby crying. Other features include monitoring the temperature and humidity in the room, detecting live video streaming, and determining whether the baby is awake or asleep. Another crucial feature is the ability to use a moisture sensor to determine the baby's level of wetness, whether or not they are wet.

The required hardware are discussed below:
Raspberry Pi: The most recent Raspberry Pi model, the 4 B module, has enhanced features that make desktop performance on par with an entry-level x86 PC system. A powerful 64-bit quad-core processor, dual displays with up to 4k resolution via two micro-HDMI ports, hardware video decoding with up to 4kp60, up to GB of RAM, dual-band 2.4/5.0 GHz wireless LAN, Bluetooth 5.0, Gigabit Ethernet, USB 3.0, and PoE capability (with an additional PoE HAT add-on) are some of this product's standout features.
PI Lens: The Pi camera is a tiny circuit board that connects via a flexible ribbon cable to the Raspberry Pi's camera serial bus interface (CSI) port. The camera features a fixed focus lens with a resolution of 5 mega pixels, and the software allows for full resolution. The video resolution of the camera is 640*480p 60/90, 720p 60, and 1080p 30. The little board and cord make up the camera module. Attach ribbon to Raspberry Pi board's CSI connector.
Audio Sensor : The LM393 sound sensor module is seen in Figure 4. It is a signal output sensor with a single channel. The baby's sound is detected by this module. The operational voltage ranges from 3 volts to 4-5 milliamperes. This sensor can detect noise in the decibel range of 3KHz to 64Hz at virtually any frequency where the human ear is sensitive. A wailing baby often makes noise between 100 and 120 dB.
DHT-11 Sensor: A reasonably priced digital temperature and humidity sensor is the Figure DHT 11. It uses a humidity sensor and a capacitive humidity sensor to measure the surrounding air. The temperature measurement range of the sensor is 20 to 22 degrees Celsius, and its humidity range is 20% to 90%. To detect temperature, an accuracy module is utilized. After that, it outputs a digital signal on the data pin (no analog input pins are required). Plus, it's easy to use.
Sensor for moisture: The water level on the bed's cradle is detected by the system through the use of a sensor. In essence, the sensor is a gadget that is triggered when the infant goes on the bed. As a result, it supports water-saving technologies and automated irrigation systems. This sensor is also referred to as the rain sensor. The sensor operates at a voltage of five volts. An LM39 voltage comparator is used in it. A potentiometer on the sensor allows for sensitivity adjustment. The board is 3.2 cm by 1.4 cm. Reliable and reasonably priced. Babies should have between 40% and 60% of relative humidity in their rooms because their nasal passages are so small that an increase in moisture will alert the parents.
Thinkspeak Software:

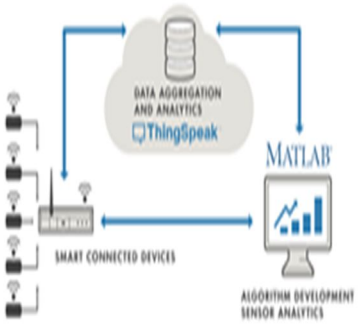


Fig.3: -Creating a channel in Thinkspeak Software

Fig.2: -Thinkspeak cloud

ThingSpeak is a platform that offers a range of services designed specifically for developing Internet of Things applications. It provides real-time data collecting, chart visualization of the data, and the ability to build apps and plugins for social network, web service, and other API collaboration.
With the help of the cloud-based analytics platform ThingSpeak, it is possible to compile, display, and examine real-time data streams. Data uploaded to ThingSpeak by the devices is instantly visualized by ThingSpeak. ThingSpeak allows to run MATLAB code, through which incoming data can be processed and conduct online analysis. ThingSpeak is frequently used for IoT devices that need analytics for proof-of-concept and prototyping. One must register and establish a channel in order to use ThingSpeak. Once a channel has been established, data can be sent, ThingSpeak process it, and then it is reverted back.

IV. Results And Discussion

This section discusses the implementation and analysis of smart baby monitoring system. It is based on the system analysis, which examined the output from a sound sensor that detected noise or sound coming from the infant and

a DHT11 sensor that measures the baby's surroundings and temperature

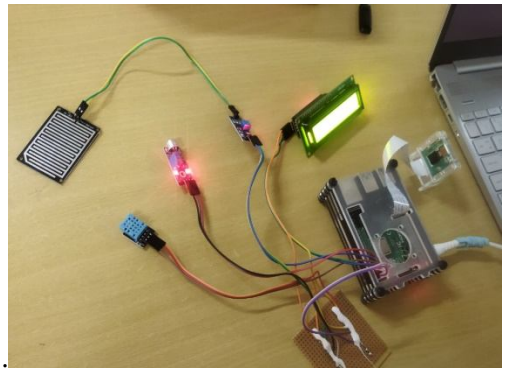


Fig..4: Hardware connection

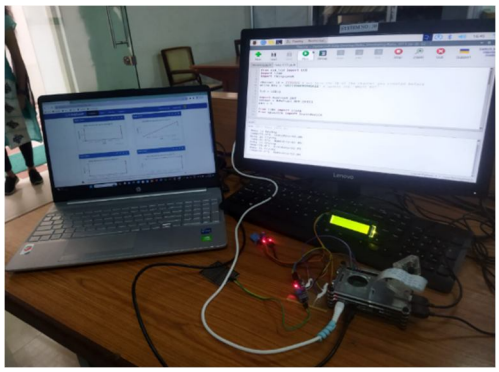


Fig.5:- Interfacing of Baby monitoring system

Fig 4 shows the circuit connection for the smart baby monitoring system in which led display, DHT11 sensor, Sound sensor, Wet sensor and Pi camera are interfaced with Raspberry Pi. Fig 5 shows the overall system connection of Hardware and Software connection interface with each other. The hardware sensors are interfaced through Pi and it is connected to a monitor for display. The entire system analysis of baby's condition is viewed as a chart and processed in Laptop.

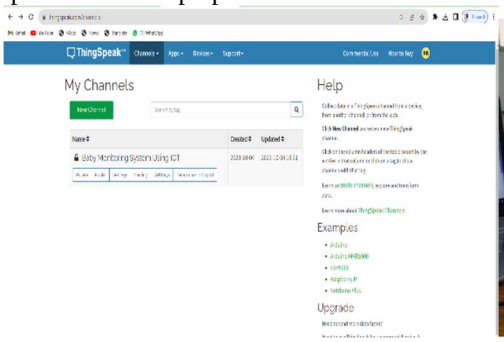


Fig.6:- Channel Creation

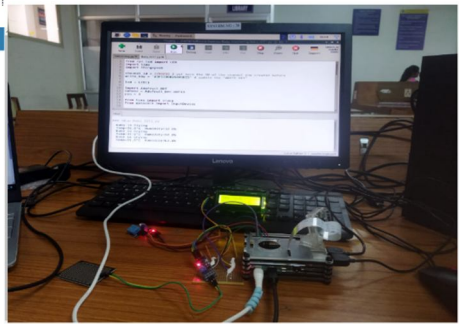


Fig.7:- Code Execution

Fig 6 shows the project channel for Thinkspeak software which is used to analysis the result. It is done by creating a Login id and Password in Thinkspeak thus by creating a new channel for the project. Fig 7 shows the input code execution in which the window shows the temperature, cry detection and wet detection sensor input window.

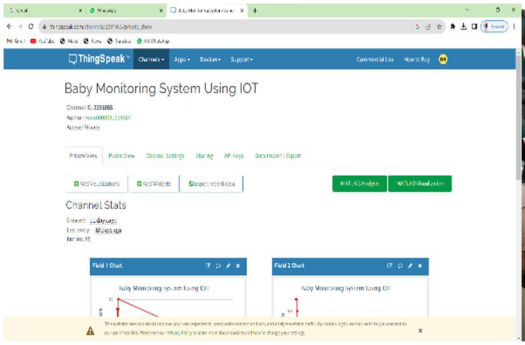


Fig.8:- Project window analysis

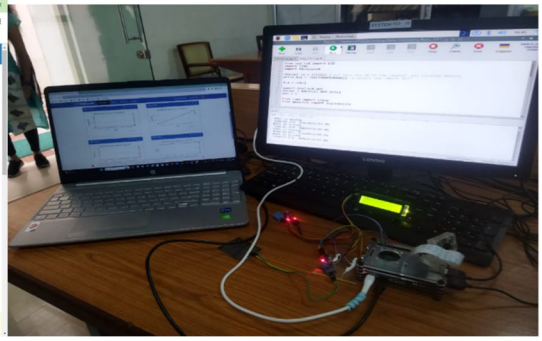
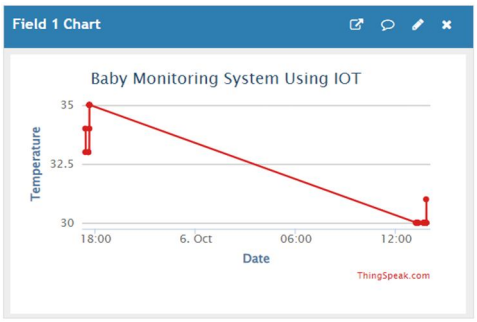


Fig.9:- Output window for temperature, cry detection and wet detection

Fig.8 shows the Project window analysis for Smart Baby Monitoring system. Fig.9 shows the Output window for temperature, cry detection and wet detection. It also shows the output and input system and the Hardware is connected with the input monitor.

Fig10 shows the Output window chart for the Temperature sensor which shows the entire temperature analysis chart for the system. Fig.11 shows the Output window chart for Humidity which shows the entire Humidity analysis chart for the system.



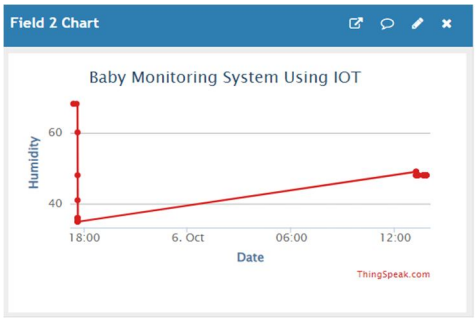


Fig.10:- Output window chart for Temperature sensor Fig.11:- Output window chart for Humidity

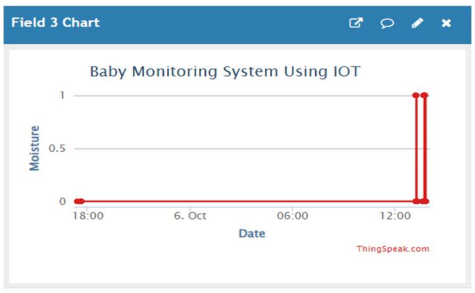


Fig.12:- Output window chart for moisture Fig.13:- Output window chart for sound detection

Fig.12 shows the Output window chart for monitoring the moisture which shows the Moisture analysis. Fig. 13 shows the Output window chart for the sound sensor which shows the cry detection analysis chart for the baby monitoring system.

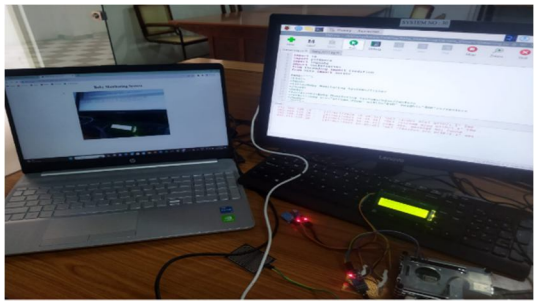


Fig.14:- Output window for Live Streaming

Fig. 14 shows the Output window of the live streaming of the baby. Live streaming helps the parents to monitor the baby in the real time.

V. Conclusion And Future Work

The primary goal of this work is to propose a smart baby monitoring system that enables parents to monitor and watch their infants. The project lessens parental stress and labor during working hours. The system's inexpensive initial cost and ability to have minimal operating costs are its benefits. For the technology to be both financially viable and appealing, there is a great deal of space for improvement and operational efficiency.

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