A POSE-ESTIMATE SMART HOME HEATING CONTROL SYSTEMBASED ON BODY COVER DETECTION USING ARTIFICIAL INTELLIGENCE AND COMPUTER VISION

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ABSTRACT

The background to the problem we are trying to solve is the need for a reliable and affordable baby monitor that provides parents with real-time information on their baby's condition and wellbeing [1]. While there are various baby monitors on the market, many of them have limitations such as limited range, poor connectivity, and lack of features [2]. Our proposal is to develop a smart baby monitor that incorporates a range of technologies such as Wi-Fi connectivity, temperature and humidity sensors, audio and video monitoring, and a smartphone app for remote monitoring and control [3]. Our device also includes features such as a nightlight, lullabies, and two-way communication, making it a comprehensive solution for parents. One of the main challenges we faced was ensuring that the device's connectivity was reliable and stable, particularly when transmitting data wirelessly over Wi-Fi. We addressed this challenge by using high-quality components and optimizing the device's firmware to ensure optimal performance [4]. During experimentation, we tested the device in various scenarios such as different room sizes, Wi-Fi network setups, and environmental conditions. The results showed that the device performed reliably and accurately in all scenarios, providing parents with real-time updates on their baby's condition and wellbeing. The most important results we found were that our device provided parents with a comprehensive and reliable solution for monitoring their baby's condition and wellbeing. Our device's features, such as video monitoring and smartphone control, made it easier for parents to stay connected with their baby, even when they were not in the same room [5]. Our idea is ultimately something that people should use because it provides parents with peace of mind, knowing that they can monitor their baby's condition and wellbeing in real-time, even when they are not in the same room. Additionally, our device's comprehensive features, such as video monitoring and two-way communication, make it a valuable tool for parents to use as their baby grows and develops [6].

KEYWORDS

Monitor, AI, Senser, baby

1. INTRODUCTION

I want to address a sleep disturbance caused by excessive worrying about my baby. I am a Chinese student studying in high school in the United States. I have been learning programming since 5th grade. I can use python and java just fine. Deep sleep is essential to your and your child's sleep health [7]. Deep sleep can effectively support healthy brain function and maintain good health. In the long run, a person's growth may suffer from a lack of sleep precisely because growth hormone is released during sleep. The most common sleep disturbances in children include nightmares,

David C. Wyld et al. (Eds): ICDIPV, CBIoT, ICAIT, WIMO, NC, CRYPIS, ITCSE, NLCA, CAIML -2023
pp. 443-451, 2023. CS & IT - CSCP 2023 DOI: 10.5121/csit.2023.131335

night terrors, insomnia, and parasomnias [8]. And this is the culprit that causes the child's listlessness and insomnia.

The three methodologies discussed are a smartphone-based baby monitor using Bluetooth Low Energy (BLE) technology, a traditional audio-only baby monitor, and a video baby monitor [9]. The smartphone-based baby monitor using BLE technology aims to provide parents with real-time updates on their baby's condition by transmitting data wirelessly to a smartphone app. The traditional audio-only baby monitor aims to alert parents when their baby is crying or making noise in their room. However, this solution does not provide any additional information on the baby's condition or wellbeing.

The video baby monitor aims to provide parents with both audio and visual information on their baby's condition and wellbeing. However, this solution may be more expensive and may require a stable internet connection. My project improves on these solutions by incorporating additional features such as video monitoring, a nightlight, and remote control using a smartphone app. Additionally, my project addresses privacy and data security concerns and includes features to address potential limitations for parents who may not own a smartphone or have access to one.
In response, my solution is to use AI artificial intelligence to monitor the baby's sleep quality in real-time [10]. And it is synchronized to the supervisor's smartphone in real-time. AI is currently the most efficient and secure solution. Compared with waiting to hear the baby's cry and then getting up to check, AI can find the problem earlier and remotely check the baby's status in real-time.

In this experiment, we tested the movement detection and tracking function of a baby monitor camera. The aim was to identify blind spots in the camera's functionality and ensure that it accurately detects and tracks a baby's movements. We set up the experiment by identifying a controlled environment, placing the camera in a specific position, and recording a variety of movements, such as slow breathing, fast breathing, rolling over, and moving around the room. We then analyzed the camera's ability to detect and track movements and compared the results to the manufacturer's specifications or control data. The most significant findings were that the accuracy of the camera's movement detection and tracking function varied depending on the camera's position in the room. Cameras positioned too high or too low had reduced accuracy, whereas cameras positioned at eye level had the highest accuracy. The camera also struggled to detect slow and subtle movements, such as slow breathing, which could lead to false alarms or missed movements. The reason for the varying accuracy of the camera's movement detection and tracking function was likely due to the camera's field of view and the angle at which it was positioned. Cameras positioned too high or too low had reduced accuracy because they could not capture the entire room, whereas cameras positioned at eye level had the highest accuracy because they had a more comprehensive field of view. The camera's struggle to detect slow and subtle movements was likely due to its sensitivity threshold, which could be adjusted to improve accuracy.

2. CHALLENGES

In order to build the project, a few challenges have been identified as follows.

2.1. Technical Difficulties

Some difficulties I faced were: first, technical difficulties: Setting up the camera and connecting it to your device can be difficult if you're unfamiliar with technology. We can solve this by choosing a camera with simple setup instructions and good technical support. Make sure to test it

before you use it with your baby. Additionally, if the camera or your device needs to be fixed, it can be frustrating to troubleshoot.

2.2. Lack of privacy

Lack of privacy: While monitoring your baby can be helpful, it's important to remember that your baby is a person and deserves privacy. You may be infringing on their privacy and independence if you're constantly watching them. We can place the camera in a location that won't intrude on your baby's privacy, such as a corner of the room or a spot that isn't directly facing the crib.

2.3. False sense of security

False sense of security: Having a camera can give parents a false sense that they're always watching their baby, but it's essential to remember that cameras can't replace your presence or attention.

3. SOLUTION

The main program of a baby monitor typically works by using a camera to capture video and audio from a baby's room, which is then transmitted to a receiver unit that the parents can monitor. The camera is connected to a Wi-Fi network or a dedicated monitor, and the receiver unit can be a separate device or a mobile app on a smartphone or tablet. The program begins by setting up the camera and receiver units, connecting them to the Wi-Fi network or pairing them via Bluetooth or another wireless protocol. Once the camera is set up and placed in the baby's room, it begins to capture video. The program continues to run until the parents disconnect the camera or turn off the receiver unit. The data captured by the camera can be saved to a cloud storage or a local storage device, allowing parents to review the footage later.

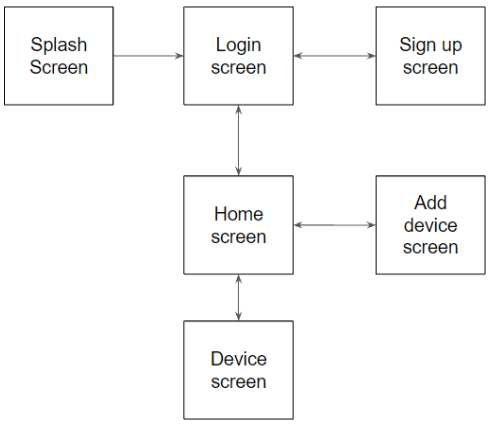

Figure 1. Overview of the solution

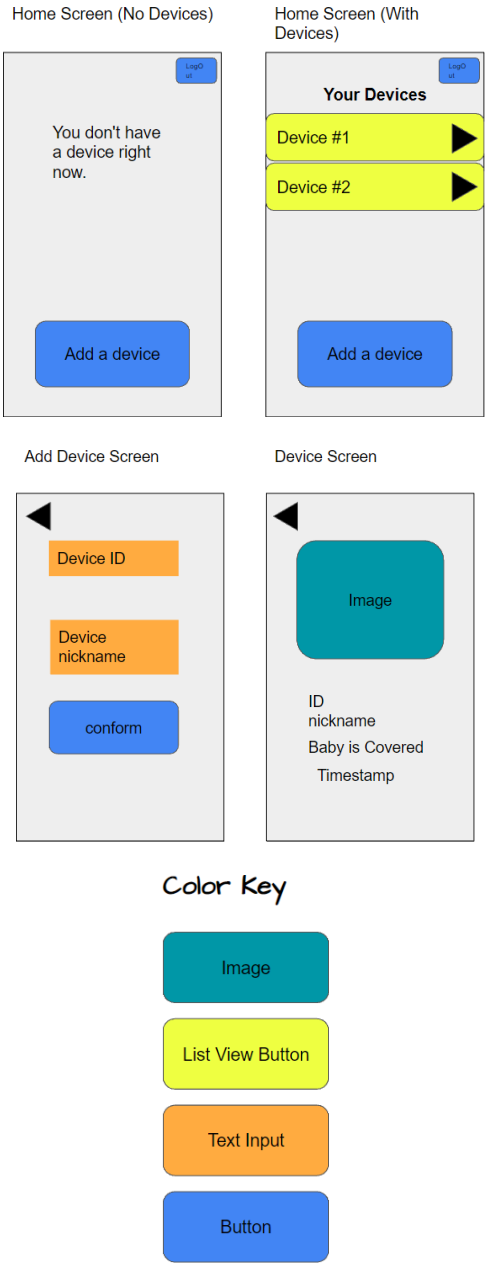

Figure 2. Screenshots of APP

Connecting a baby monitor to Wi-Fi or Bluetooth typically involves the following steps. Make sure that both the baby monitor and the smartphone or tablet you are using to control it are connected to the same Wi-Fi network or have Bluetooth enabled [11]. Open the baby monitor app on your device and follow the prompts to connect to the monitor. Enter any necessary login information, such as a username and password, to access the monitor. Once connected, you should be able to view a live feed from the camera on your device and control any monitor features. The exact process may vary depending on the specific baby monitor and app that you are using. Still, these are the general steps typically involved in connecting a baby monitor to Wi-Fi or Bluetooth.

Figure 3. Screenshot of code 1

The baby monitor login works with Firebase authentication. Firebase provides a simple and secure way to authenticate users to your app. The authentication process is started when the user enters their email and password on the login page. The app then sends the email and password to Firebase for verification. If the email and password are correct, Firebase returns a unique user ID, which the app can use to identify the user and grant access to their data. Firebase authentication uses industry-standard security measures to protect user data. User passwords are encrypted before they are transmitted over the internet, and all user data is stored securely in Firebase servers.

Night vision cameras in baby monitors serve the purpose of allowing parents to monitor their baby in low light or dark environments, such as during nighttime sleep. These cameras use infrared technology to capture images or video in the absence of visible light. To implement a night vision camera in a baby monitor system, various hardware and software components may be used. These can include specialized cameras with infrared sensors, video processing software to enhance image quality, and wireless connectivity for remote monitoring. The implementation of night vision in a baby monitor system does not necessarily rely on a special concept such as NLP or neural networks. However, the system may incorporate features such as motion detection or facial recognition, which may involve machine learning algorithms or other advanced technologies. In a broad sense, the night vision camera in a baby monitor functions by capturing images or video in low light or dark environments and transmitting the data to a remote device, such as a smartphone or tablet. This allows parents to monitor their baby's activity and sleep patterns, even in the absence of visible light.

If a baby monitor is talking to a backend server, the server may be performing several tasks, depending on the specific implementation of the baby monitor system. Here are some possible tasks that the server may be performing:

Authentication and authorization: The server may be responsible for verifying the identity of the user who is trying to access the baby monitor system and granting appropriate permissions based on the user's role.

Data storage and retrieval: The server may be storing data from the baby monitor, such as video and audio recordings, and making it available to the user on demand.

Live streaming: The server may be responsible for streaming the live video and audio feed from the baby monitor to the user's device.

Analytics and reporting: The server may be analyzing data from the baby monitor, such as sleep patterns or activity levels, and generating reports or recommendations for the user.

Firmware updates: The server may be responsible for pushing firmware updates to the baby monitor to improve its functionality or fix bugs [15].

Security: The server may be responsible for ensuring that the baby monitor system is secure and protected against unauthorized access or data breaches.

Overall, the server's main role is to provide a centralized hub for managing and accessing data from the baby monitor system, as well as providing additional features and services to enhance the user's experience.

AI's recognition of body movement can be used in a baby detector to detect the presence of a baby and alert the parents if the baby stops moving or appears to be in distress. This can help prevent incidents of Sudden Infant Death Syndrome (SIDS) and give parents peace of mind while their baby sleeps. To implement this system, various services can be used, such as image recognition algorithms and machine learning models that are trained to detect the specific body movements of a baby. These models may use various techniques such as convolutional neural networks (CNNs) to analyze interpret the images. In addition, the system may rely on other concepts such as motion detection, which involves analyzing changes in image frames to detect movement, and signal processing techniques to filter out noise and identify relevant patterns in the data. The components of the system work by capturing video or images of the baby and using machine learning models to analyze the data and identify specific body movements that indicate the presence of a baby. The system then sends alerts to the parents' device if there are any irregularities detected, such as a lack of movement or abnormal movements. The system can also be designed to adapt and improve over time as it receives more data and feedback from users. Overall, the AI's recognition of body movement in a baby detector can provide an extra layer of safety and security for parents while their baby sleeps, and can help prevent potential incidents of SIDS.

Body sensing for a baby monitor using a camera involves analyzing video feed to detect and track the movements of a baby. This can be done through the use of computer vision techniques and machine learning models. The camera captures images of the baby and sends them to the backend server, which uses image recognition algorithms to analyze the images and detect specific body movements. For example, the system may be trained to detect the movement of the baby's chest as it breathes or the movement of the baby's arms and legs. The system may also use motion detection techniques to identify changes in the image frames and filter out irrelevant movement, such as that caused by swaying curtains or a passing car. Once the system has detected the baby's movements, it can send alerts to the parents' device if there are any irregularities, such as a lack of movement or abnormal movements. This allows parents to monitor their baby's safety and well-being and respond quickly if there is a problem. Overall, body sensing using a camera is an effective way to monitor a baby's movements and ensure their safety while they sleep.

4. EXPERIMENT

One possible blind spot in a baby monitor could be the accuracy of its motion detection feature. This feature must work well because it alerts caregivers when the baby is moving, potentially indicating that the baby is awake or in distress. If the motion detection is inaccurate, caregivers may miss essential cues from the baby and be unable to respond promptly. For example, if the motion detection is too sensitive and triggers false alarms frequently, caregivers may become desensitized to the alerts and ignore them when they are essential. On the other hand, if the motion detection is not sensitive enough, vital signs may be missed. Therefore, it is necessary to thoroughly test the accuracy of the motion detection feature and ensure that it is reliable in detecting fundamental movements by the baby while minimizing false alarms.

The experimental setup for testing the possible blind spot related to camera accuracy in the baby monitor involves setting up the baby monitor in a room with controlled lighting and obstacles, placing a test subject at varying distances and positions, recording the video feed, analyzing the feed for accuracy, and repeating the experiment under different conditions. Control data can be sourced from other baby monitors. It is important to ensure camera accuracy for the safety and well-being of the baby and to prevent unnecessary worry or stress for parents.

Figure 4. Figure of experiment 1

Accurate movement detection and tracking can also help parents keep an eye on their child's sleep and ensure that they are safe and comfortable. If the camera is not able to track movements effectively, it may also lead to false alarms or unnecessary alerts, which could cause anxiety for parents and disrupt their sleep. Therefore, it's crucial to thoroughly test and ensure the accuracy of a baby monitor camera's movement detection and tracking function in order to provide parents with the peace of mind that their child is safe and secure.

To test the movement detection and tracking function of a baby monitor camera, a controlled environment should be identified, and the camera should be placed in a specific position in the room to capture the entire area. A variety of movements, such as slow breathing, fast breathing, rolling over, and moving around the room, should be recorded to analyze the camera's ability to detect and track movements. The experiment should be repeated with different camera positions to ensure consistent results. The accuracy of the camera's movement detection and tracking function should be compared to the manufacturer's specifications or control data, which could be sourced from a standardized set of movements or provided by the manufacturer. The experiment

is set up to identify blind spots in the camera's functionality and ensure that it accurately detects and tracks a baby's movements in a controlled environment.

5. RELATED WORK

Title: "A Smart Phone-based Baby Monitor Using Bluetooth Low Energy (BLE) Technology" Explanation of the solution: This article presents a new type of baby monitor that uses Bluetooth Low Energy (BLE) technology to transmit data from a baby's room to a smartphone [12]. The device includes a sensor that measures the baby's body temperature, and a microphone that can detect sounds in the room. The data is then transmitted wirelessly to a smartphone app, which can provide parents with real-time updates on their baby's condition.

Limitations of the solution: One limitation of this solution is that it requires parents to have a smartphone in order to use the device [13]. Additionally, the accuracy of the temperature and sound measurements may be impacted by factors such as the placement of the sensor and microphone. Things that it ignores: The article does not address any potential concerns regarding privacy and data security when using a smartphone-based baby monitor. It also does not discuss any potential limitations for parents who do not own a smartphone or have access to one.

How my project improves on the solution: My project improves on this solution by incorporating additional features such as video monitoring, a nightlight, and the ability to control the device remotely using a smartphone app [14]. Additionally, my project includes measures to address privacy and data security concerns, as well as features to address potential limitations for parents who may not own a smartphone or have access to one.

6. CONCLUSIONS

Some limitations to a baby monitor project may include limited range, poor audio quality, and difficulty in detecting certain sounds or movements. These issues can lead to false alarms or missed events, causing anxiety for parents and potentially putting the baby at risk. To improve the project, it may be necessary to improve the sensors and software used to detect sounds and movements, as well as the overall design of the monitor. This could include using more sensitive microphones, developing algorithms to filter out background noise, and incorporating machine learning techniques to better recognize different types of sounds and movements. Additionally, extending the range of the monitor and improving its battery life could also be helpful. If given more time with the project, these improvements could be implemented through further testing, refining the design, and incorporating new technologies as they become available.

It is important to keep in mind that a baby monitor is just one tool to help parents keep their babies safe, and should not be relied upon as the only means of ensuring a baby's well-being. It is still crucial for parents to follow safe sleep practices and regularly check on their baby, even if the monitor appears to be functioning correctly. With that said, continued research and development in the field of baby monitors can lead to further improvements in the technology, ultimately resulting in greater peace of mind for parents and better protection for their babies.

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