AN INTELLIGENT ROBOT FOR MONITORING AND PROTECTING TODDLERS

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Project Proposal Report

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DECLARATION

I declare that this is my own work, and this proposal does not incorporate without acknowledgment any material previously submitted for a degree or diploma in any other university or institute of higher learning and to the best of my knowledge and belief it does not contain any material previously published or written by another person except where the acknowledgment is made in the text.

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Signature of the Supervisor: _____   Date: _____

ABSTRACT

Robotics (R), Machine Learning (ML), and Artificial Intelligence (AI) are three of the most extensively used phrases in the current period with the tremendous development of Information Technology (IT) being radically transformed by these technologies (IT). The fundamental purpose of this idea is to give parents with a beneficial monitoring and protection tool for their children. This proposal describes the methodology and approach that will be followed to design and implement the robot, as well as a schedule of important milestones and deliverables. There is a need for innovative solutions that can provide effective monitoring and protection for toddlers, particularly in situations where direct supervision is not always possible. Robotics, Open CV-related technologies, Machine Learning, and Artificial Intelligence will be incorporated into implement this proposed solution. We intend to have features such as: monitoring toddler for parents virtually while detecting un-authorized presence or possible threats.[1] Play music according to child's behavior and ability to parents to virtually interacting with toddlers.[2] The robot will also be able to self-navigate and follow the toddler while avoiding obstacles.[3] Develop a reliable alerting system to alert parents when needed.[4] Mentioned above are the primary objectives that will concern in this project. Proposed solution in this paper is innovative and unique and has the potential to provide significant benefits to parents and caregivers while significantly improve the safety and well-being of their toddlers.

Key Words – R, AI, ML, and IoT.

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1 Chapter 1: Introduction

1.1 Introduction

As modern parents busy schedule, domestic duties, and parenting responsibilities, it can be difficult to maintain a constant check on their toddlers. With the advancement of technology, it is conceivable to develop an intelligent robot that can assist parents in watching their children and detecting potential threats. In this proposal, we present a concept for an intelligent robot capable of watching children remotely, detecting unauthorized presence, and alerting parents as required.

The proposed project entails the construction of a robot capable of monitoring toddlers in a variety of ways, including the identification of the toddler's behavior, detection of any threats that is possible for toddler. The robot will also be able to play soothing music based on the toddler's actions, such as napping or screaming. In addition, the robot will be outfitted with unique sensors and cameras to detect unauthorized presence like an animal and potential risks to the infant. The robot will be equipped with self-navigation, allowing it to navigate around the toddler while avoid obstacles as it follows the toddler around the bed.

In this paper we will discuss about the process of establishing a virtual monitoring system for the toddler's surroundings to provide parental oversight and to detect any unauthorized presence which means identifying potential threats to the child's safety, such as those stemming from animals. In addition, expelling such animals using a sound that can only hear for animals. This robot's advanced features will provide parents with a vital service, allowing them to keep an eye on their young children while attending to other duties. The proposed project will comprise the design and development of the necessary hardware and software to develop the robot, along with the evaluation of its effectiveness in a range of circumstances.

➤ **What does feature of monitoring the toddler's surroundings offer for user?**

❖ Monitoring the environment.

Establishing this feature will provide 24x7 virtual monitoring of the toddler's surroundings through a robot that is equipped with a camera and unique sensors. The camera will capture live video stream of the toddler's surroundings, allowing parents to remotely monitor their child's environment.

❖ Identifying potential threats.

The camera and sensors of robot will identify any unauthorized presence, such as animal or intruders, in the toddler's environment. In addition, the robot will be programmed to detect potential threats to the child's safety, and inform parents to act accordingly.

❖ Expulsion of animals.

The proposed project comprises the design and development of a sound-based animal repellent system for the robot. This technology will generate a sound that is inaudible to humans but unpleasant to animals, so discouraging animals from invading the toddler's habitat. If an animal enters the area, the robot will identify it and trigger the sound-based deterrence system, expelling the animal and ensuring the child's protection. The proposed robot's utilization of sound-based animal repellents is a non-invasive and ethical way for expelling animals and is a significant component.

> **Benefits of feature of monitoring the toddler's surroundings.**

- **Enhanced safety and security.**

   Provides an additional layer of protection and surveillance for young children, especially in situations where caregiver may be preoccupied or unable to constantly observe the youngster. With its monitoring capabilities, the robot may warn carers for any potential risks or dangers. The robot also able to identify and expel animals that come over to toddlers itself.

- **Offers parents greater freedom and flexibility in terms of caregiving responsibilities**.

   The robot's usage of IoT technology enables parents and carers to watch a child's actions and environment remotely, offering peace of mind and flexibility in terms of supervision.

- **Allow multi-tasking for parents.**

   With the capability of supervising and amusing the child, parents may have more time and energy to perform other activities or pursue other interests, allowing them more freedom and autonomy.

1.2   Research Gap

Lack of research on the use of sensors and machine learning algorithms for recognizing potential risks such as animal encroachment and fire hazards in a toddler's environment is a potential research gap in the proposed project. Existing sensors can detect fire and animal activity, but their effectiveness in the context of toddler monitoring has not been extensively studied. Another potential research gap in this project is the lack of study on the efficiency of sound-based animal deterrent systems for implementation in a specialized robot for toddler monitoring. While there is some study on the use of sound-based deterrents for animals, there is minimal research on the use of such systems to expel animals from the environment of a toddler. In addition, there may be a paucity of research on the possible influence of such systems while considering the well-being of the child, such as whether the sound-based deterrents could cause the kid discomfort or distress. Tackling these research gaps could enable to ensure that the suggested device is effective at expelling animals while guaranteeing the safety and comfort of the toddler.

1.3   Research problem

The proposed project's research problem is the unavailability of an efficient and accurate system that provides virtual surveillance of toddlers' surroundings to detect possible threats to the kid and animal expulsion using humane and non-invasive approaches. Existing monitoring methods, including baby monitors and security cameras, are incapable of detecting and expelling animals from the toddler's environment. Existing animal deterrent measures, such as physical barriers and chemical sprays, may be invasive or dangerous to animals as well as toddler. This information and technological gap pose a substantial threat to the safety and wellness of toddlers who are susceptible to animal and fire-related dangers. The suggested project is to address this research issue by creating a robot with the capability of detect any unauthorized presence, identify potential threats to the child's safety, such as those stemming from animal or fire-related hazards and evict animals in a compassionate and non-invasive manner to confirm the safety of the toddler.

1.4   Research Objectives

This research project's primary objective is to design and develop a robot capable of offering virtual monitoring of a toddler's surroundings, detect any unpermitted presence, and identify potential threats to the child's safety, such as those resulting from animals. In addition, the robot will expel such creatures using a sound inaudible to humans.

1.5   Research Questions

- What is the most effective method for remotely monitoring the toddler to parents that is far from him?
- How to train robot to identify animals accurately?
- What are the sensors need to use to detect un-authorized presence?
- How to generate human inaudible sound to expel animals after identifying?

2   Chapter 2: Background and Literature Review

In recent 10 years, virtual monitoring systems have extensively grown in popularity, giving parents more freedom and peace of mind while providing added security for their children. Traditional monitoring systems, such as baby monitors and security cameras, are effective at giving parents with a live stream of their child's environment, but they are incapable of detecting and removing animals from the toddler's territory. However, these existing devices could be unable of detecting possible dangers such as fire hazards. To address these constraints, several researchers have investigated the use of sensors and machine learning algorithms in the field of detecting potential hazards and expelling the animals.

1) Animal Repellents from Agricultural Fields

In this chapter of "Advances in Intelligent Systems and Computing" book series, P. Sreevardhan, B. Vidheya Raju & Durgesh Nandan (2020) proposed a system to repel animals from agricultural fields in order to decrease the problems or damages caused by animals to the farm.[1] They suggested high-frequency and high-amount sound waves to drive animals away. To repel animals, they did improvements to existing approaches by utilizing ultrasonic frequencies. Ultrasonic animal repellent emits varied sound frequencies based on the animal species repellent at the time.
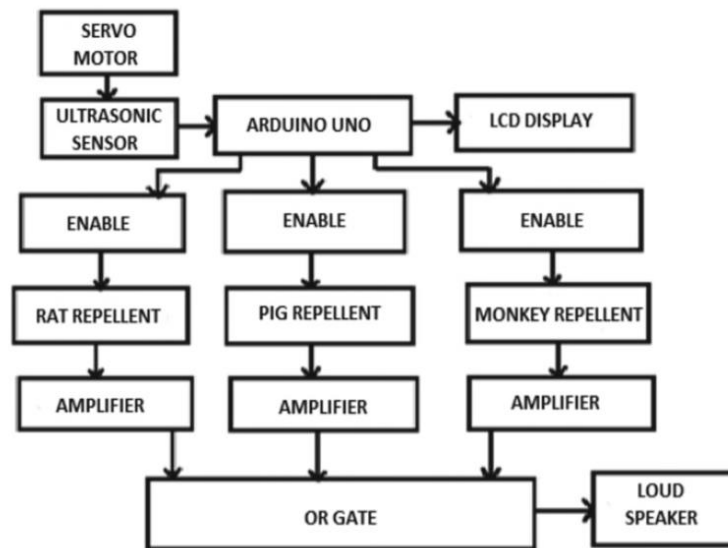
Figure 2.1 Block diagram of Arduino-based animal's repellent

When the target (animal) is spotted, Arduino activates each repellant circuit for a predetermined amount of time using time-division multiplexing. To repel animals, each repellent circuit generates a distinct frequency. They created this method to repel three creatures (rats, monkeys, pigs). When the ultrasonic device detects an animal, it sends the information to Arduino. Using a

basic enable circuit on the time-division mechanism, Arduino enables the deterrent circuits that produce 50 kHz for rats, 32 kHz for monkeys, and 16 kHz for pigs. [1]These repelling circuits' frequencies are sent to a buzzer for sound waves. To deter the animals, these sound waves are emitted up to 100 cm into the air.

2) **Internet of Things-Based Baby Monitoring System for Smart Cradle**

Here presented a new algorithm for a system which is critical in providing improved baby care when parents are away. The Node Micro-Controller Unit (NodeMCU) Controller Board is used in the developed system to collect data from the sensors and upload it via Wi-Fi to the AdaFruit MQTT server.[2] Sensors are used in the proposed system to monitor the baby's essential factors such as ambient temperature, moisture, and crying. To monitor a baby's essential factors, such as crying condition, humidity, and ambient temperature, a smart cradle with a baby monitoring system through IoT has been devised and manufactured. [2] Because it included a built-in Wi-Fi module, NodeMCU was utilized as the main controller board in the project's circuit design, allowing the deployment of the IoT idea in the developed system. Because of its simplicity and open-source nature, the NodeMCU was used to meet the demand for IoT.

Figure 2.2 Flow chart of their proposed monitoring system
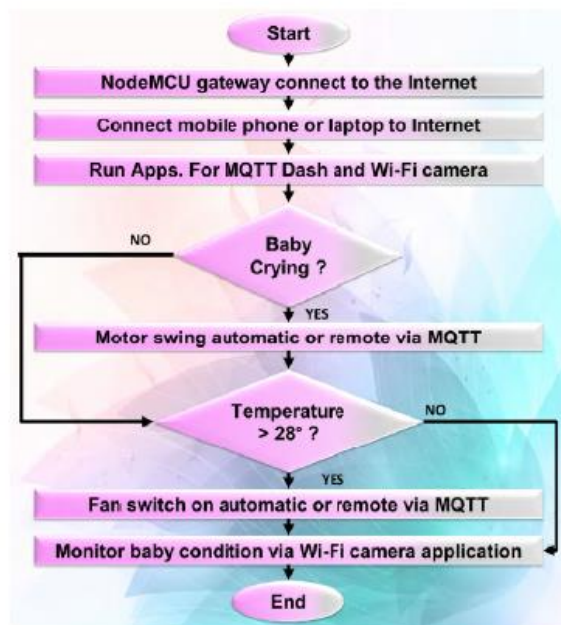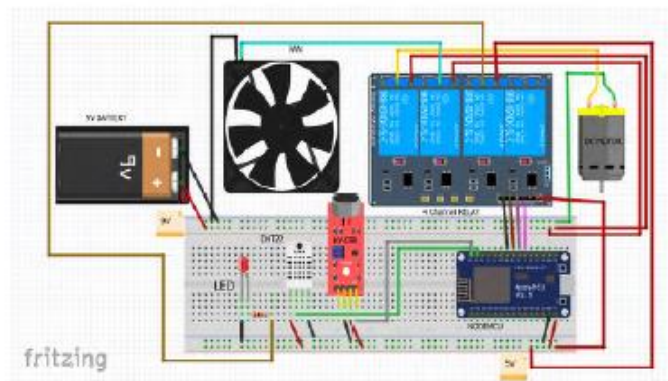

Figure 2.3 Component diagram of the system

Overall, according to this literature emphasizes the necessity for a comprehensive system that allows virtual monitoring of toddler habitats while also expelling animals in a non-invasive and humane manner. By filling this vacuum in literature, parents will have more effective tools to keep their children safe and secure.

3 Chapter 3: Methodology

3.1 Research

This research project will begin with a comprehensive analysis of the existing technologies available for the virtual monitoring of toddlers and the detection of animal-related threats. The research will also study the sound frequencies that can be used to deter animals without being audible to the toddler. It will guarantee the sound that generate by the robot will not scare the child. The research will be undertaken through a comprehensive evaluation of published research papers, book chapters, and technical reports.

3.2 Proposed Methodology

The robot's environment monitoring and animal expulsion will be discussed in this proposed project. A camera capable of streaming video to a computer or mobile device is required as a primary component. The camera will continuously record the surroundings of the toddler. We planned to use HD cameras with night vision and IP connectivity for optimal results. These are digital cameras that can transmit data over an IP network and connect via Wi-Fi or Ethernet to a virtual monitoring system. The most important aspect of the project is the identification of unpermitted presence. The camera function of the robot must be expanded in order to identify such an object. A real-time optimized Computer Vision library will be used to improve the functionality of a camera's ability to identify potentially dangerous animals for a toddler. A speaker capable of ultrasonic sound production must be added to the robot. After accurately identifying the animal as described previously, the robot emits a high-frequency sound that is inaudible to humans but serves to repel the animal.

3.3   Equipment and Purposes

Table 1 Table of used equipment and its purposes

Equipment	Purposes
Camera	A camera is main part of this project since we need to monitor the surrounding of toddler. For that we need a good quality video capturing camera to record the surroundings. (Having features like 360` capturing, night vision and IP camera would be better).
Microcontroller	A microcontroller, such as Raspberry Pi, is required to control the motions of the robot and to interpret data that gather will from the camera and sensors.
Power Supply	The robot required power to operate for that supply proper power amount via power supply is mandatory.
Speaker	Ultrasonic sound needs to be generated from the speaker with matching frequency for repel the animals that might threatened to the toddler.
Other Sensors	To detect un-authorized presence, duration to the animal from the toddler etc.

3.4 Implementation of The Proposed Method

3.4.1 Hardware Implementation

The hardware implementation of environment monitoring and expelling animals' part of the robot will be discussed in this section. As a main component, a camera that capable of stream video to a computer or a mobile device is required. The camera will capture the surroundings of toddler 24x7. We planned to use HD, night vision and IP enabled camera to best results. These are digital cameras that can send data over an IP network and link to a virtual monitoring system through Wi-Fi or Ethernet. The best part of the project is to develop the identifying un-authorized presence part. The function of the robot's camera need to be further developed for identify such thing. A real-time optimized Computer Vision library will be used to enhanced the functionality of camera to recognize animals that is possible danger for the toddler. Finally, a speaker which is able to produce sounds in the ultrasonic range need to be included to the robot. After identifying the animal accurately as mentioned earlier, the robot itself generates a high frequency sound that in-audible for humans but used to repel away the animal.

3.4.2 Software Implementation

Development of software that allows to analyze the video stream and control the robot will be developed incorporating all the four members our group. Parents who are the aimed users of this product will be able to monitor their child remotely from any location with the help of this Graphical User Interface (GUI).

When developing internal process of the robot, first need to gather data from camera and sensors like smoke detectors, heat detectors, sonar etc. then those collected information must be processed. We will use some set of software's to fulfil those areas. For instance, real-time optimized Computer Vision library like OpenCV will be used to clearly identify un-authorized presence like interference of an animal. Also, the reinforcement learning algorithm is commonly used for tasks like detecting objectives via camera, where the robot needs to learn how to accurately identify animals over other things in the room. The method is based on trial and error, with the robot receiving rewards or penalties based on its behavior as feedback.

3.5   Prototype Development

The next phase of the project is to assemble the robot's hardware and software into a functional prototype. The prototype will undergo rigorous testing to guarantee that it can provide virtual monitoring of a toddler's surroundings, gathering information about environment conditions, detecting any unauthorized presence which is like an animal with the use of intelligent camera, and highlight potential threats to the child's safety, such as animal attacks. In addition, the robot will be tested to ensure that it can expel animals using an inaudible sound to humans.

4 Chapter 4: Proposed Testing and Evaluation

The final step is evaluating and testing the robot's performance. The evaluation will be done through extensive testing in a controlled environment. The potential of the robot to offer virtual surveillance 24x7 constantly, detect accurate temperature, humidity and Oxygen level, detect potential dangers accurately, and expel animals without harm will be evaluated. The evaluation will also consider the robot's usability and user-friendliness.

Expected Outcomes:

The proposed research project is expected to have the following outcomes:

- Design and development of a robot capable of providing constant virtual monitoring of a toddler's surroundings, accurately detecting any unauthorized presence, and identifying potential threats immediately to the child's safety, such as animal-related hazards.
- Development of software that can analyze the video stream and control the robot.
- Construction of a functional prototype of the robot.
- Evaluate the performance of the robot and minimize the faults.

Timeline:

The proposed research project is anticipated to be completed in twelve months. The timeframe of project is as follows:

Month 1-2: Research about the topic and tasks

Over the first two months, a comprehensive literature evaluation of published research papers, conference proceedings, and technical reports on the field of virtual monitoring, the detection of animal though the camera will be examined. This research will guide the robot's design and development.

Month 3-4: Hardware Design

Between months 3 and 4, the robot's hardware will be designed. This will incorporate the speaker, camera, and sensors. Information gathered in the first two months of period will guide the design.

Month 5-6: Software Development

During months 5 and 6, software will be created incorporated with other members that can analyze the video stream and control the functionalities of the robot. Programming languages will be

utilized for software development while real-time optimized Computer Vision library like OpenCV will be used to recognize objects through camera.

Month 7-9: Prototype Development

During months 7-9, a prototype of the robot's hardware and software will be assembled. Extensive testing will be conducted to confirm that the prototype can provide virtual monitoring of a toddler's surroundings, detect any unwanted presence, and flag any safety hazards.

Month 10-11: Testing and Evaluation

Throughout the tenth and eleventh month of phase, the performance of the robot will be tested by exhaustive testing in a controlled environment. The capability of the robot to offer virtual surveillance, detect potential dangers, and repel animals will be evaluated. The evaluation will also consider the robot's usability and user-friendliness.

Month 12: Final Report and Conclusion

In the final month, the project's final report will be produced. The report will highlight the study undertaken, the robot's design and development, and its performance evaluation. In addition, the paper will provide more suggestions for further research in this area.

Table 2 Gantt Chart

Research about the topic and tasks	■	■										
Hardware Design			■	■								
Software Development					■	■						
Prototype Development							■	■				
Testing and Evaluation									■	■	■	
Final Report and Conclusion												■
Month	1	2	3	4	5	6	7	8	9	10	11	12

Conclusion

The proposed research project aims to build and develop a robot capable of providing virtual monitoring of a toddler's surroundings, detecting any unauthorized presence, and identifying potential threats to the child's safety, such as those resulting from animals. In addition, the robot will expel such creatures using a sound inaudible to humans. The project will be conducted through extensive research, hardware design, software development, prototype development, and testing. The project is anticipated to last 12 months. The proposed research has the potential to contribute to the existing body of knowledge about the virtual monitoring of toddler's environment and the detection of animal-related threats, as well as offer toddlers an additional layer of security while parents and caregivers to deal with their work in peace of mind.

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