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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The above candidate has carried out research for the B.Sc. Dissertation under my supervision.

Signature of the Supervisor: ________________ Date: ____________________

ABSTRACT

Robotics (R), Machine Learning (ML), and Artificial Intelligence (AI) can be known as mostly used terms in this era since it has brought tremendous change in the industry of Information Technology (IT). The proposed system has been designed to address the growing concerns of parents and caregivers regarding the safety of their young children. With the rise of technology and automation, there is a need for innovative solutions that can provide effective monitoring and protection for toddlers, especially in situations where direct supervision may not always be possible, which is going to be enriched with Robotics, Open CV related technologies, Machine Learning, and Artificial Intelligence (AI). We plan to have functionalities such as; (1) a toddler-proof robot navigation system with obstacle avoidance and safe movement. (2) To establish virtual monitoring of the toddler's surroundings to provide parental oversight and detect unauthorized hazards.(3) Develop system also offers reliable alerts based on child behavior. (4) Develop interactions with robots that are more effective and familiar to toddlers and their activities. Mentioned above are the primary functions that will concern this system. The intelligent robot proposed in this paper has the potential to significantly improve the safety and well-being of toddlers while also providing peace of mind for parents and caregivers.

Key Words – R, AI, ML, and IT.

TABLE OF CONTENT

LIST OF FIGURES

1 INTRODUCTION

1.1 Background & Literature Survey

As modern parents have busy schedules, domestic duties, and parenting responsibilities, it can be challenging 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 the 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 and detection of any threats that are possible to a toddler. Also, this robot will be able to monitor a toddler's environment, like temperature, humidity, and oxygen level, etc. The robot can also 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 presences 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 avoiding obstacles as it follows the toddler around the bed.

The potential for robots to assist in everyday tasks and improve our lives is becoming increasingly apparent as technological advancements in robotics continue. One of the primary areas of concentration is the creation of a navigation system for robots that will enable them to navigate around toddlers, who can be difficult to predict and are often unpredictable. It is absolutely necessary to have a reliable robot navigation system that is capable of avoiding obstacles and moving in a secure manner in order to design a robot navigation system that is suitable for use by toddlers.

A system like this would make it possible for robots to move around on their own in environments where young children are present, thereby enhancing the level of security and productivity in childcare facilities, private homes, and public areas. This task presents a number of challenges, some of which include the requirement that the robot be capable of recognizing and avoiding obstacles, responding appropriately to unpredictable behavior, and ensuring safe movement in close proximity to people. However, due to the rapid development of robotics technology and techniques for machine learning, the creation of a robot navigation system that is resistant to being tampered with by young children is becoming more feasible.

Monitoring and protecting toddlers from harm is a critical concern for parents, caretakers, and society at large. Because they offer an additional layer of protection and assistance, intelligent robots have the potential to play a significant part in the process of monitoring and safeguarding toddlers. We will investigate the current state-of-the-art in intelligent robots for monitoring and protecting toddlers, with a particular emphasis on the robots' navigation systems, as part of this literature review (1).

In this paper, the authors proposed the use of an intelligent robot for supervising and assisting toddlers. The navigation system of the robot was designed with a Simultaneous Localization and Mapping (SLAM) algorithm at its core. It also featured a depth camera and ultrasonic sensors for locating obstacles and avoiding collisions with them. The primary purpose of the robot was to keep an eye on the young child and offer assistance in the event of an emergency. The proposed robot was put through its paces in a simulated setting, and the results demonstrated that it had the capacity to effectively monitor the toddler and aid in critical circumstances (1).

The purpose of this paper was to propose an intelligent robot for the protection of toddlers that is based on the detection and avoidance of obstacles. The navigation system of the robot made use of a stereo camera and a 2D laser scanner in order to identify potential hazards and plot a course that would keep the child safe. The voice recognition system on the robot was also able to identify the toddler's voice and react appropriately when it did so. The proposed robot was put through its paces in a simulated setting, and the results demonstrated that it was able to successfully navigate around obstructions and keep the child safe (2).

In this paper, the authors proposed the use of a semantic segmentation-based intelligent robot for the monitoring and assistance of toddlers. The navigation system of the robot made use of a depth camera and a semantic segmentation algorithm in order to track the toddler and keep track of their movements. The caretaker or the toddler could receive assistance from the robot if it determined that the toddler was in imminent danger. The proposed robot was put through its paces in a simulated setting, and the results demonstrated that it had the ability to keep a close eye on the child and offer assistance in the event of an emergency (3).

In this paper, the authors proposed using reinforcement learning to create an intelligent robot that could protect toddlers. A reinforcement learning algorithm was used by the robot's navigation system so that it could learn how to navigate and keep the toddler safe. The proposed robot was put through its paces in a mock setting, and the findings demonstrated that it was able to effectively learn how to protect the toddler and navigate around obstacles (4).

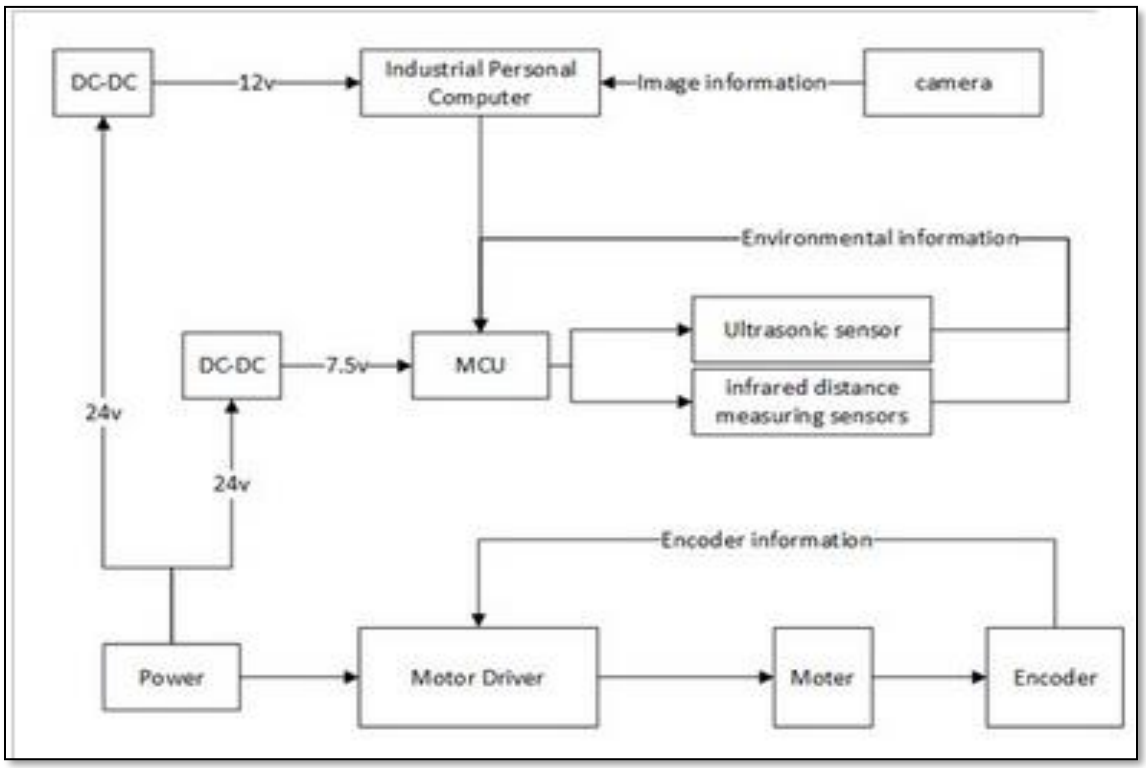


Figure 1.1 : Composition of mobile robot system

In this paper, a multi-sensor fusion intelligent robot designed for assisting and navigating with toddlers was proposed. The navigation system of the robot made use of a multi-sensor fusion algorithm, which brought together the results of measurements taken by a depth camera, a 2D laser scanner, and an inertial measurement unit (IMU). The toddler could receive help from the robot as it navigated around obstacles and offered its support. The proposed robot was put through its paces in a simulated setting, and the results demonstrated that it was capable of guiding and assisting the toddler in an effective manner (5).

In this paper The ultrasonic obstacle avoidance robot simply employs an ultrasonic sensor to avoid obstacles along the fixed route. Obstacle avoidance cannot be informed. Robots rarely avoid pits. This study combined an infrared range sensor and visual information to ultrasonic sensor obstacle avoidance so the robot could avoid potholes and traffic signs. This work offers a multi-sensor, multi-obstruction autonomous mobile robot with intelligent obstacle avoidance. Cascade Classifiers train positive and negative samples for road signs with identical Colour and shape. The intelligent robot's obstacle avoidance logic is developed for autonomous obstacle avoidance and path planning uses multi-sensor information fusion. The infrared sensor detects the ground depression on the wheel path, the ultrasonic sensor measures the distance to surrounding obstacles and road signs, and the camera detects road signs, which the computer processes and sends to the main controller. Microprocessors process environment data and send control commands to execution units. Analyzing the ultrasonic sensor, infrared distance measurement sensors, and model trained from the road sign sample, as well as testing in the complicated environment manually produced, verifies the design's practicality(6).

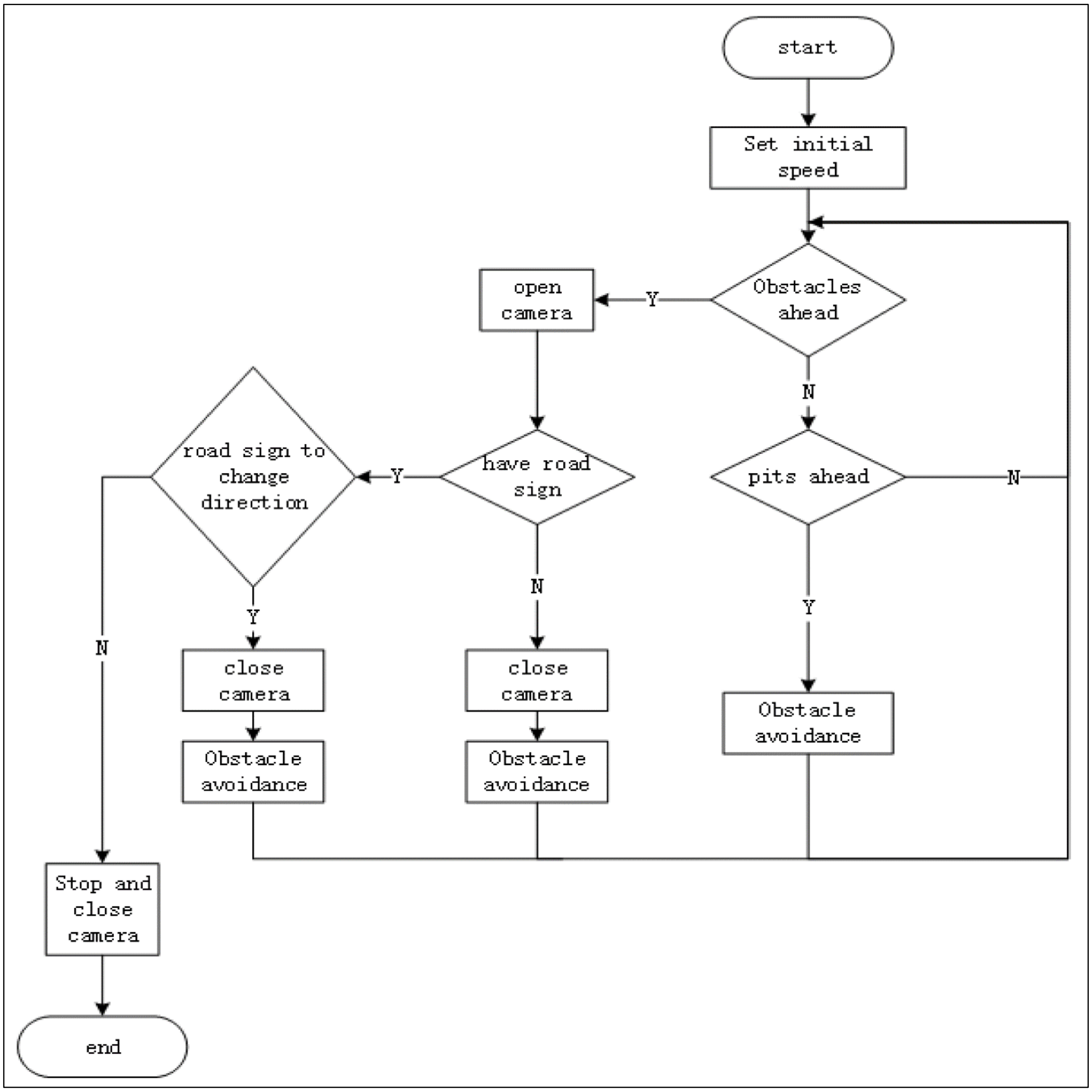


Figure 1.2 : Block diagram of obstacle avoidance program Composition of mobile robot system.

1.2 Research Gap

The usage of robots in many contexts has grown dramatically over time, and numerous researchers have studied the possibility of human interaction with robots. Concerns include children's safety around robots, who might accidentally engage with them or cause injury. Thus, creating robots that can intelligently clear the space as required and preserve friendly interactions with young children is crucial. Despite the growing interest in this topic, there still needs to be a sizable research gap in creating kid-friendly robots. There needs to be a common framework for creating kid-friendly robots. Most research in this field has gone into creating visually appealing robots for kids, but other considerations, such as safety and behavior, are also important. In this research, we will cover this research gap intelligently, clear the area, and maintain non-threatening human-robot interaction with toddlers. By addressing these research gaps, we can create a safe and positive environment for children to interact with robots and help promote child-friendly robotics development.

1.3 Research Problem

How to develop a robot navigation system that can successfully and securely navigate around a toddler, including obstacle avoidance navigation and safe mobility to produce a robot navigation system that is toddler-proof. This includes handling the difficulty of ensuring that the robot can intelligently clear the area, such as if a child engages with or destroys it, while retaining the capacity for non-threatening human-robot contact with a toddler.

This problem involves several sub-problems, including the development of sensor technologies that can detect the presence of toddlers and potential dangers in the robot's environment, the design of navigation algorithms that can navigate safely around toddlers and other obstacles, and the integration of human-robot interaction technologies that can facilitate non-threatening interactions with toddlers.

Addressing this research issue is essential for the development of safe and successful robotic systems that may engage with children in a number of settings, such as healthcare, education, and entertainment. By designing a robot navigation system that can effectively and safely navigate around toddlers while retaining the ability to engage in non-threatening human-robot contact, researchers can ensure that these robotic systems are useful, safe, and appealing to children and their parents.

2 OBJECTIVES

2.1 Main Objectives

The development of a toddler-protecting robot navigation system has as its main objective the development of a robotic system capable of navigating around a child effectively while simultaneously ensuring the toddler's safety and well-being.

2.2 Specific Objectives

- Effectively and safely navigate around a toddler.
- Incorporating the obstacle avoidance navigation
- Robot must be able to clear the area intelligently, for instance if a child interacts with or destroys it.
- Ability to engage in non-threatening human-robot interaction with a toddler.

3 METHODOLOGY

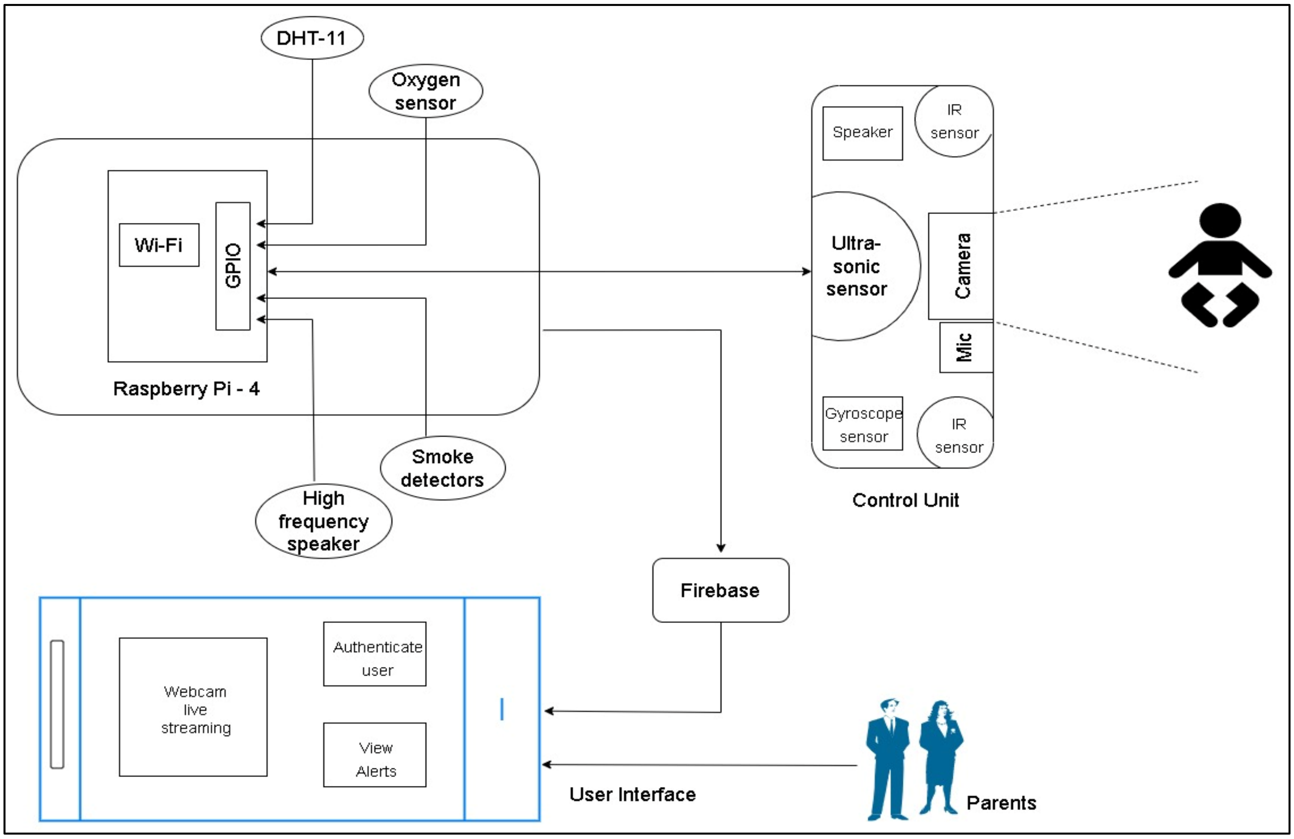


Figure 3.1 Proposed System Diagram

Figure 3.1 is a depiction of the operational procedure that would be followed by the proposed infant monitoring system. In this configuration, the primary controller will be an Arduino Nano module that we provide ourselves. The Arduino Nano is a low-cost microcontroller that is about the size of a credit card and has the ability to output data when it is connected to a monitor.

This project will use a microphone to listen to a baby's cries and transmit that information to an Arduino Nano. This system will also include a PIR motion sensor to detect when the baby is moving. PIR sensors utilize pyroelectric sensors, which can determine the amount of infrared radiation present. Every object emits a trace amount of low-level radiation, and the greater the object's temperature, the greater the amount of radiation it emits.

In addition to being a distinguishing characteristic of this system, it will be equipped with a camera that will record video of the infant's holding area. A notification will be sent to the parents whenever the baby's voice is identified via the GSM module. The Camera Module is a unique accessory that we designed specifically for you. The board will be attached to the model using one of the two tiny sockets located on the top of the board. One can use the camera module to record video, allowing for the intelligent combination of still images, slow-motion video, and time-lapse video.

Moreover, an LCD monitor is included with the system. and awake, as in the hardware configuration. If the MIC detects sound, it will transmit a signal to the GSM Module, causing the camera to begin recording: the lights to turn on, and the camera information to be sent to whoever is in charge. When the PIR sensor detects the infant's movement, an alert is sent to the parent. As a result, the system would send a text message to anxious parents informing them of their children's status and generate a video depicting their current condition.

To effectively manage the entire model, two Arduino Nanos are required. One Arduino nano controls the voice recognition module. In contrast, the other nano controls additional Internet of Things (IoT) devices such as servos, IR sensors, ultrasonic sensors, GSM modules, and motor drivers. A signal is sent to Arduino nano 1 when the speech recognition module identifies the baby's voice. Arduino nano one then transmits the signal via Arduino nano 2 to the GSM module, allowing the guardian or parents to receive a message regarding the baby's condition. Utilizing infrared and ultrasonic sensors permits the detection of any infant movement.

3.1 Implementation Of Navigation System

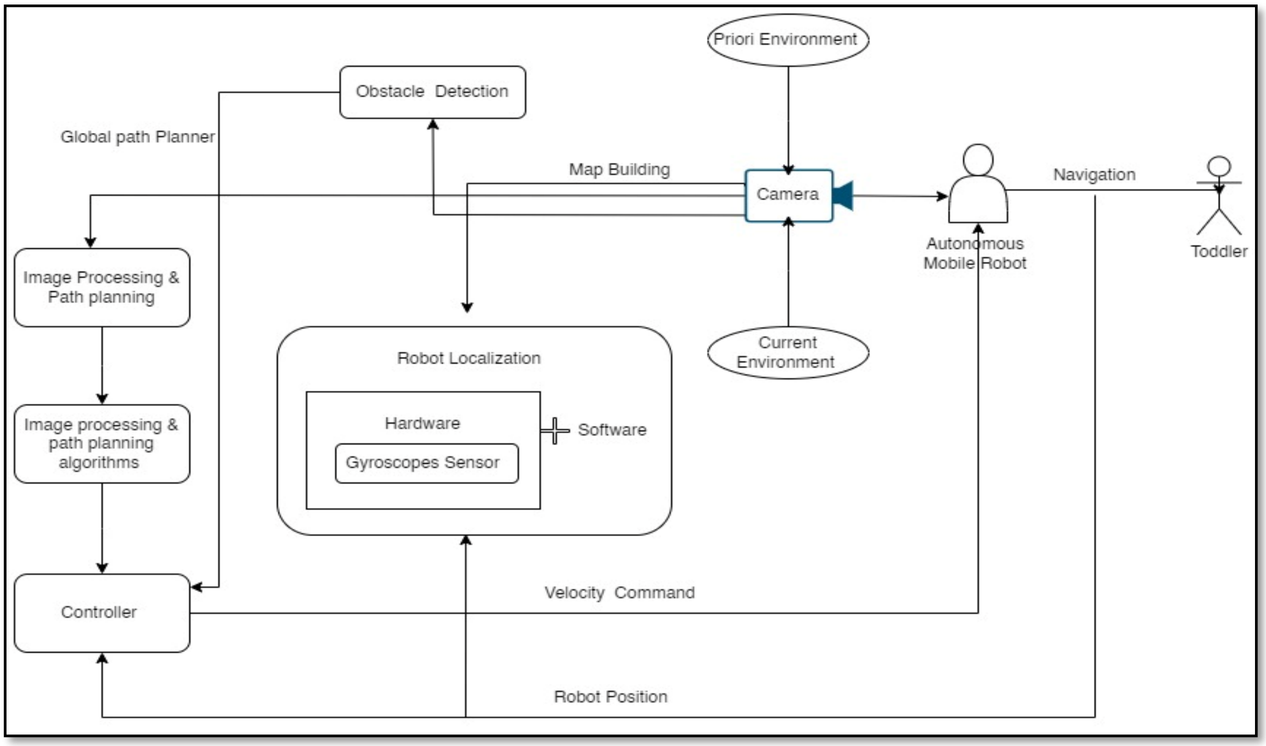


Figure 3.2 : Navigation System Overview Diagram

Above Mention The block diagram that explains the procedure for designing and constructing the navigation system can be found in Figure 3.1.There are six different parts that make up the hardware implementation phase.

- HC-SR04 Ultrasonic Sensor
- SG-90 Servo Motor
- Arduino Nano
- L298D Motor Driver IC
- Power Supply and ESP32 Cam
- Left DC Motor and Right DC Motor

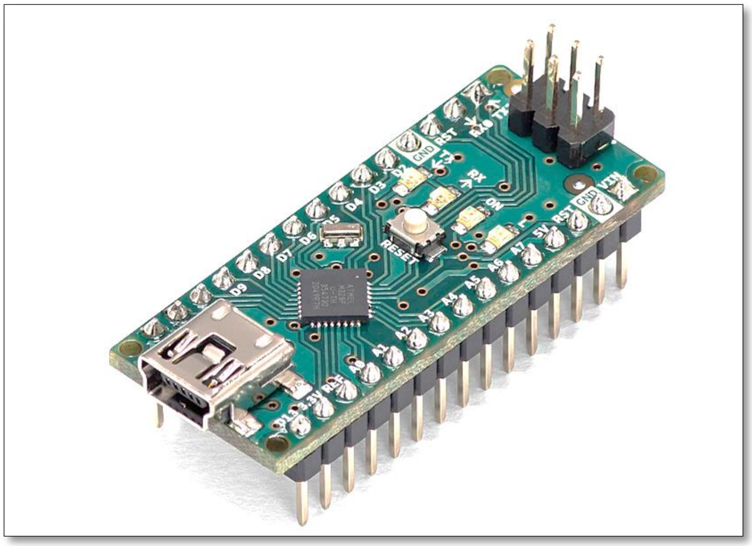


Figure 3.3 Arduino Nano

The Arduino Nano, a single-board microcontroller introduced in 2008, is complete, compact, and compatible with breadboards. It uses the ATmega328P as its base chip.It has the same connections and technical specifications as the Arduino Uno board but a more compact design. Arduino Nano has 30 male I/O headers arranged similarly to DIP-30, and it can be programmed using the Arduino Software integrated development environment (IDE), which is accessible both online and offline and is shared by all Arduino boards. I/O headers on the Arduino Nano are organized similarly to DIP-30s. The board can be powered by either a 9 V battery or a mini-USB type-B connection.

Figure 3.4 Ultrasonic Sensor

In order for ultrasonic sensors to function, a sound wave that is audible to humans but outside the ultrasonic frequency range must be broadcast. The sensor's transducer functions as a microphone capable of receiving and transmitting ultrasonic sound. Similar to many other manufacturers, our ultrasonic sensors use a single transducer for both the transmission of a pulse and the reception of an echo. The sensor can calculate the distance to a target by timing the interval between the transmission of an ultrasonic pulse and its reception by the target.

It is important to broadcast a sound wave that can be heard by humans but does not fall into the ultrasonic frequency range in order for ultrasonic sensors to function properly. The transducer of the sensor functions as a microphone, and it is able to both receive and send ultrasonic sound in both directions. Both the transmission of a pulse and the receipt of an echo are handled by a single transducer in our ultrasonic sensors, just as it is in the ultrasonic sensors produced by a great number of other manufacturers. The sensor is able to calculate the distance to a target by measuring the length of time that elapses between the delivery of an ultrasonic pulse and the time that it is received by the target. This allows the sensor to determine the distance to the target.

HC-SR04 Ultrasonic Sensor – Applications

- Used to avoid and detect obstacles with robots like biped robots, obstacle avoiders robot, path-finding robot, etc.
- Used to measure the distance within a wide range of 2cm to 400cm.
- Can be used to map the objects surrounding the sensor by rotating it.

Figure 3.5 : L298D Motor Driver Shield

The L293D is a monolithically integrated 4-channel driver that features high voltage and high current. The takeaway from this is that we can use this chip to drive DC motors with power supplies of up to 36 Volts, and the chip has the capacity to supply a maximum current of 600mA per channel. H-Bridge is another name for the L293D chip that's commonly used. H-bridges are typically electrical circuits that allow a voltage to be supplied across a load in either direction to an output, such as a motor. This is made possible by the H-shaped design of the bridge.

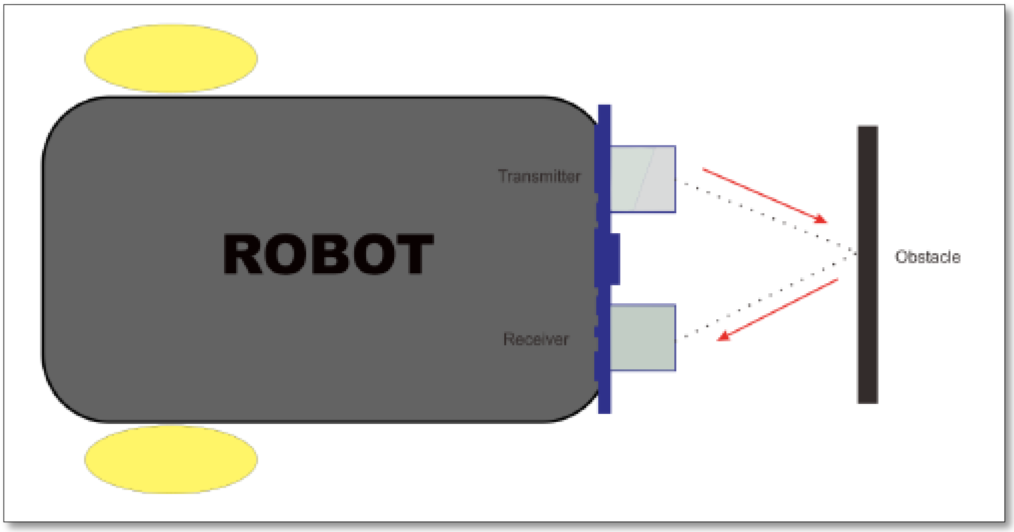
Figure 3.6 ESP32 Camera

The ESP32-CAM is a tiny camera module that utilizes the ESP32 platform and has low power needs. In addition, it comes equipped with a TF card slot and an OV2640 camera. The ESP32-CAM can be utilized in a wide variety of innovative Internet of Things applications, some examples of which are wireless video monitoring, Wi-Fi image uploading, and QR recognition.

Figure 3.7 Servo Motor

Servo motors push or spin objects precisely. Servo motors rotate objects at particular angles or distances. It's merely a servo-driven motor. DC servo motors are DC-powered, while AC-powered ones are AC-powered. High-torque servo motors are tiny and light. These properties make them useful in toy cars, RC helicopters and planes, robotics, machines, and more. Servo motors are controlled by electrical pulses and have circuitry next to them.

3.2 Implementation of the System



The robot's ultrasonic distance sensor is employed to determine the distance that lies in front of it. When the robot detects that the distance between itself and the obstacle has shrunk to a certain level, it understands that something is blocking its route. When the robot comes across an impediment in its way, it immediately comes to a halt, retreats a few centimeters in the other direction, turns in the direction that appears to have more open space in front of it, and then continues in that route. Moreover, this mechanism can clear the space between toddlers and robots when under attack.

When we construct the robot component, we conclude the hardware implementation. To complete the robot navigation task, we must utilize technologies such as AI | ML | Open CV.

First ML gather data from sensors like cameras, LIDAR, and sonar. To reduce noise and inconsistencies, preprocess this data. For instance, they may want the robot to avoid obstacles, follow a path, or reach a specified area. The reinforcement learning algorithm is commonly used for navigation tasks, where the robot needs to learn how to navigate through an environment and reach a goal. The algorithm is based on trial and error, where the robot receives feedback through rewards or penalties based on its actions—preprocessed data to train the selected algorithm. This entailed giving the algorithm inputs and desired outputs to learn to predict. Test the algorithm on new data after training and Evaluate its accuracy and error rate. Once you are satisfied with the algorithm's performance, install it on the robot's navigation system. This may include integrating it with other software and hardware. Finally, monitor and update the navigation system. Further data, algorithm retraining, or implementation changes may be needed.

Another technology use in is OpenCV. It is a vast, open-source image processing, machine learning, and computer vision library. It plays a vital part in real-time operations as well. With the use of the OpenCV library, photos and videos may be quickly processed to identify objects, faces, and even the handwriting of a human presence in the file. This lesson will solely cover object detection from photos using OpenCV. We will learn how to use Python and OpenCV to find objects in an image using a supplied image.

4 GRANT CHART

1–2: Research

The first two months will be spent reviewing research articles, conference proceedings, and technical reports on virtual child monitoring and animal and fire detection. This research will inform robot design and development.

3-4: Hardware Design

Months 3-4 will design robot hardware. Camera, sensors, and speaker. The initial two months of research will inform the design.

5-6: Software Development

The video stream analysis and sensor/speaker control software will be developed in months 5-6. OpenCV and Python will construct the software.

7-9: Prototype Development

A robot prototype will be created from hardware and software in months 7-9. The prototype will be rigorously tested to guarantee that it can provide a robot's navigation system of a toddler's surroundings, detect unlawful presence, and flag potential safety hazards.

10-11: Evaluation

In months 10-11, the robot will be extensively tested in a controlled setting. Robotic navigation Robot usefulness and friendliness will also be assessed.

Month 12: Wrap-up

Project reports will be completed in the final month. The report will cover research, robot design, and performance evaluation. The study will also suggest further investigation.

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

Figure 4.1 : Grant Chart

5 CONCLUSION

In today's bustling environment, the best option for parents to keep an eye on their children is via a baby monitoring system. It is only an application of modern technology that has no effect on the parents' daily activities. As stated at the outset, our objective is to design a monitoring system that provides a high level of baby safety and whose security method is unique. In addition, the Arduino nano is a low-cost chip that can make the system more economical than existing alternatives. This technology can concurrently output both audio and video. It can be utilized at home and when providing newborn care. The parents' boredom and tension can be alleviated by the efficient application of this strategy. Also, this approach supports the baby's safety concern. This system is currently in use, however it can yet be upgraded and enhanced.

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