An Intelligent Robot for Monitoring and Protecting Toddlers

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***Abstract* - In today's fast-paced world, parents find themselves navigating a complex web of responsibilities, from demanding work commitments to the daily rigors of domestic life and the ever-present demands of parenting. In the midst of this juggling act, the task of ensuring the safety and well-being of their toddlers can become an increasingly daunting challenge. Nevertheless, 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 potential for further development of this robot extends beyond the realm of individual households. Its capabilities can be expanded to encompass the monitoring of children in nursery schools, play areas, and childcare centers. By adapting the robot's functionalities and incorporating features specific to these environments, this technology can be effectively utilized to ensure the safety and supervision of children in broader settings.**

Keywords – Toddler following, Animal repellent, Alerting, Cry detection, Sound Sampling, Threat detection.

I. Introduction

In an era defined by the relentless pace of modern life, parents in the fast-paced modern world, parents have many obligations. Their busy schedules, household tasks, and parenting issues frequently leave them exhausted. The monitoring of energetic toddlers, when safety and well-being are crucial, shows this battle. Our new solution a technology companion aims to ease the worries of parents of 2- to 5-year-olds. Our plan involves a technological marvel: an intelligent robot that remotely monitors kids and informs parents in real time. This invention might create playgrounds, nursery schools, and daycare centers. Modern technology will be used to create a reliable child monitoring system. This robotics-based technology will create a physically proficient and autonomous robot. AI and ML algorithms will let the robot understand its environment, recognize and categorize items, and make smart judgments based on real-time data. Image processing techniques and OpenCV (Open-Source Computer Vision Library) will allow the robot to recognize faces, identify risks, and monitor the child's behavior. The smart robot will stay with the child and avoid obstacles with its superior navigation. Even while the child is exploring or moving swiftly, this function enables constant surveillance. The robot will watch the toddler with advanced AI algorithms and visual processing. For safety, it will monitor the child's actions using real-time video analysis. The technology will inform parents or authorized caretakers of strangers around a youngster. The clever robot will recognize and respond to animal threats to youngsters. Images are recognized and classified. The robot distinguishes harmful and harmless animals. To protect the child, the robot will evict or discourage hazardous animals. Given its understanding of toddler needs, the smart robot will sense crying and restlessness. In such cases, the robot will play lullabies or other soothing noises to quiet the infant.

II. Literature Review

Virtual toddler environment and behavior tracking systems have gained attention recently. This comprehensive literature analysis critically analyzes these disciplines' research to identify important findings and knowledge gaps. This proposal identifies and fills research needs to advance this field. Animal detection and deterrent systems have become more important for many reasons during the past decade. Human-animal conflict damages crops, say S. Harish and Sudesh Rao. [1] They investigate ways to identify and repel animals without harming them to save farmland and reduce human-animal conflicts. Authors used PIR sensors and cameras to reduce human-elephant conflicts. Mat Lab identifies animals and humans in camera pictures using CBIC. Ultrasonic sound or bright light will repel animals.

This study indicates that agricultural and other industries use animal detection and deterrence devices. Image processing and animal detection and repelling algorithms will help the child monitoring and protection robot. [2]

Virtual monitoring methods for toddlers' environments, behaviors, and animal deterrents are stressed in the literature. To cover research gaps, the proposed study will construct a non-invasive, compassionate robot for virtual monitoring, threat detection, and animal deterrent. By closing these gaps, the effort will improve toddler monitoring technologies and help parents protect their children. Future research must evaluate the integrated system's efficacy, usability, ethics, and safety throughout implementation.

Researchers have developed efficient and reliable mobile robot navigation, sensor integration, and motion planning algorithms for years. [3] presents a mobile robot navigation and target tracking framework. Mobile robots need path planning and heading changes to achieve their destination. Computing intelligence theory improves navigation. This section covers path planning and obstacle avoidance. The function and architecture enable propped robot navigation. This scenario uses object avoidance and object following. Using Coco to create machine learning algorithms is also helpful.

The service robot navigation stack in this study includes waypoint and human-in-the-loop navigation with people following or leading [4]. This work presents a new way for robots, human or mobile, to follow dynamic objectives that change their position and orientation. The technique displays multi-modal distributions for global and local localization.

P. Ruthvi Raj Myakala and his team claim to have developed an intelligent infant monitoring system that accurately identifies crying. When a child cries, the system messages parents a photo depending on urgency.[5] This unique technique enables real-time speech signal algorithm and hardware monitoring. Signal processing processes real-time sounds automatically recognizes infant cry signals by extracting key information. The device alerts a human controller who can remotely control a smart robot over Wi-Fi when a cry signal is received. The smart robot sends live video to the controller to monitor the baby. A newborn scream is confirmed by the robot's microphone recording it again.[6] The technology informs parents of urgency after certification.

Our suggested system has an automated lullaby feature that plays calming music while weeping. Parents who cannot see their children can use this feature. Our automatic lullabies technology helps parents more than others. A music software lets parents make kid-friendly playlists.

In 2022, Zirui Zhang examined childcare robots' effects on kids. Robotic childcare and interaction technologies are innovative. Zirui Zhang studied how childcare robots effect children's cognitive, socioemotional, and physical development. Politicians, educators, and parents can learn about these robots' pros, cons, and ethics from this research.

Zirui Zhang studies infant development, technology, and social change. Socialization, emotional attachment, and responsive parenting promote healthy child development, according to research. As a new technique to supplement human care, childcare robots raise concerns about their efficacy. [7]

Interest in childcare robots is growing, but information gaps exist. Few research has explored childcare robots' long-term implications on children's well-being. Daily childcare robot use has unknown ethical concerns. More research is needed on how cultural, social, and individual aspects affect childcare robot acceptability and efficacy. Visuals may clarify the research division. See the image for theoretical, literary, and analogous system gaps. A solution or model can help childcare robot research cover knowledge gaps. See picture for a conceptual framework for studying childcare robots' effects on children. This paradigm analyzes juvenile features, robot design, social interaction, and long-term effects.[8]

Finally, Zirui Zhang's research on childcare robots and children provides valuable insights into a rising sector. This literature study identifies knowledge gaps to prepare for childcare robot research and understanding.

III. METHODOLOGY

Within this section, a comprehensive overview of the project is provided, delineated into four distinct sub-modules. Each sub-module is devised with specific objectives in mind. Firstly, a robot navigation system has been developed to ensure the robot can effectively track the movements of the toddler. Secondly, an animal detection system has been implemented to swiftly identify potential threats posed by animals. Additionally, a toddler behavior detection system has been engineered to recognize and respond to various behavioral cues exhibited by the child. Lastly, an automated music playing system has been seamlessly integrated to offer a soothing environment for the toddler during moments of distress.

A) Animal detection and expulsion system with environmental monitoring.

The study effort will begin by examining the current technological landscape for virtual child monitoring and animal risk identification.[9] The study will also examine sound frequencies that discourage animals while remaining inaudible to toddlers, preventing fear or anxiety. This research will involve a thorough review of research papers, book chapters, and technical reports.

The robot's environmental monitoring and animal-related capabilities will be examined in this system. This project requires a camera system that streams high-quality video to a computer or mobile device. The toddler's surroundings will be captured mostly by this camera. Our approach uses HD cameras with night vision and IP networking for best results. These high-tech digital cameras may transmit data over an IP network and integrate with virtual monitoring systems via Wi-Fi or Ethernet.

The project's main goal is to accurately identify illegal presence around the toddler. Thus, we will use a real-time Open-Source Computer Vision Library to enhance the robot's camera. This improvement will improve the camera's ability to identify animals, like cats and dogs, that could harm the toddler. The suggested project protects children by detecting and recognizing these creatures.

We used SSD mobile Net V3 Large COCO (Common Objects in Context) in the Single Shot MultiBox Detector framework to recognize animals. Mobile Net V3 Large is the backbone network, and COCO is the training dataset. Mobile Net V3 aims to reconcile model accuracy with computing performance. Depth-wise separable convolutions simplify calculations while capturing spatial information. The COCO dataset, which comprises many objects in different situations, is a popular computer vision benchmark. Over 80 object categories include individuals, animals, cars, home products, and more. SSD Mobile Net V3 Large COCO is trained to recognize and classify things. It predicts bounding boxes and class labels for object localization and identification. Transfer learning, where pre-trained models are fine-tuned on specific datasets or tasks, makes the SSD Mobile Net V3 Large COCO model powerful and efficient for object detection applications. [10]

The robot will also include an ultrasonic transducer to repel detected animals. This device emits inaudible high-frequency sounds to dissuade animals. The suggested technology uses these technical advances and intelligence functions to provide real-time monitoring, precise threat detection, and fast animal expulsion for toddler safety.

B) Following the toddler and obstacle avoidance-based navigation system.

The study project will analyze existing object following, safe mobility, and obstacle avoidance navigation technology. Additionally, the study will investigate numerous pathways. The robot must intelligently clear the area seamlessly and efficiently to safeguard both the robot and the toddler from the toddler's natural tendency to explore and disrupt the robot's operation. The suggested study will be rigorously evaluated using scholarly articles, book chapters, course materials, videos, and technical reports.

AI robot uses 'Mobile Net SSD v1 (COCO)' Machine Learning model for enhanced object tracking. This model lets the robot detect objects accurately. The system starts a tracking procedure to keep an object centered on the screen after recognizing it. The system optimizes object detection and tracking with TensorFlow Lite Python APIs. These APIs enable real-time machine-learning model deployment on resource-constrained robots.

The accurate and real-time 'Mobile Net SSD v1 (COCO)' model underpins object detection. The robot creates its visual perspective using OpenCV. OpenCV lets the robot capture and process live camera feeds with its extensive computer vision tools. OpenCV also lets you add bounding boxes or labels to the video stream to better comprehend the tracked objects. FLASK is used to make the robot's operation and visual perspective visible. (FLASK) is a lightweight and flexible Python web framework that lets robots run web servers. A regular web browser can visit this web server to view real-time video feeds or the robot's visual perspective during object tracking or following. In the graphic below, bounding boxes, the object's center, its offset from the frame's center, and the robot's direction and speed are changed while the object is in the frame. This illustration shows how far the object's center (the red dot) is from the frame's geographic center using X and Y values. The code created the 'Move Left' command because the horizontal deviation, 'X,' exceeds the tolerance.

The HC-SR04 ultrasonic distance sensor module is carefully combined with a Raspberry Pi 4 microprocessor in this research. A Python software efficiently calculates distances by transmitting and receiving ultrasonic waves. Additionally, an advanced system detects impediments within 30 centimeters. The robot is properly programmed to move backward when detected to avoid collisions. A coherent and continuous feedback loop allows real-time distance updates and robust obstacle detection in this complex operational procedure.

This work developed and implemented a Raspberry Pi 4 microcontroller-based ultrasonic range sensing robot navigation system. This study shows that the proposed approach is effective in robot navigation and obstacle avoidance. Future research could add sensors or explore different navigation algorithms to improve efficiency and expand self-governing robot uses.

C) Cry detection and automated lullabies playing system.

The cry detection and lullaby play parts of the automated lullaby play segment are crucial. This section revolves around cry detection. Machine Learning and sound sampling are used to detect sobbing. Sound sampling in machine learning involves carefully recording and accurately encoding audio data using digital samples. In this scenario, a carefully maintained and extensive audio sample library is essential. This dataset should include weeping events with various intensities, durations, and background noise. Making ensuring the dataset covers all crying noises is the goal. Before analysis, audio data is preprocessed to enhance appropriateness. This preliminary stage involves transcoding audio recordings, leveling volume levels, and removing noise and artifacts that could affect subsequent studies. [11]

The microphone records brief 2–3-second sound blocks of the baby weeping during cry detection. These sound blocks are then rigorously compared to the predetermined dataset using advanced algorithms. This comparison allows the system to automatically develop a lullaby response to calm the baby. An sophisticated framework covers the cry detecting part's flawless operation, ensuring an efficient and responsive lullaby distribution system.

We've chosen Spotify as the platform for our lullaby playback section to provide parents with an easy way to customize playlists for their children. This integration is achieved by combining the raspotify API with the Raspberry Pi 4 module. Configuring the system involves inputting Spotify premium account credentials, granting access to premium functions for a superior listening experience.

Our innovative approach uses the Raspberry Pi's high-quality microphone to generate lullabies matched to the child's cries through advanced sound analysis algorithms. The system also includes a built-in speaker for an immersive audio experience, allowing parents to use smartphones for playlist customization. Advanced technology and user-friendly interfaces precisely detect a toddler's cries, activating a preloaded lullaby playlist when distress signals are detected. This automated response helps parents quickly attend to their child's needs, creating a calm and peaceful environment.

4) Intelligent toddler Behavior detection and alerting System

Data collection for an intelligent robot to monitor and protect babies involved the following steps: In Sensors were carefully placed in the toddler's play area, bedroom, and kitchen. Sensors may include SIM chips and audio sensors. The sensors continuously recorded the toddler's movements, closeness to dangerous places, and sounds for Data Capture. Timestamped data was saved in a central database for analysis. Researchers watched the toddler kneel, stumble, and do unsafe things. These observations were labeled for behavior detection model training and validation.

To reduce noise and improve data quality, sensor data was cleaned, filtered, and preprocessed. Supervised and deep learning were used to train models to detect specific behaviors.[14] Models learned to distinguish kneeling, collapse, and exposure to danger. Alert thresholds were set for each conduct. This criterion was based on the child's traits and detected behaviors. Alert Generation alerted parents when behavior detection models detected a concerning activity. The alerting system may use notifications, push notifications, or other techniques.

These are tools. Data was collected using camera, SIM Module, and audio sensors in the research. A central database was used to store and handle sensor data. Train and build behavior detection models using open-source machine learning frameworks like TensorFlow and scikit-learn.[15] Real-time notifications and parent communication were the goal of the notification system. The strategy was chosen to correctly detect the child's thorough data collection. Behavioral detection models were created utilizing machine learning for accurate data analysis. Methods were chosen for their efficacy, accessibility, and compliance with research goals.

IV. Results and Discutions

1) Animal detection and expulsion system with environmental monitoring.

This section prioritizes collecting animal intrusions and identifying the creatures. This goal can be achieved by using the COCO dataset. The COCO dataset, which contains many annotated photos, makes animal classification based on look possible. [16]. This dataset helps train and refine algorithms that can reliably recognize and classify animals, enabling the robot's monitoring system to precisely identify captured creatures. The proposed technique is more effective and reliable when the COCO dataset is used for animal identification.

When an animal approaches the toddler, the robot's superior detecting capabilities precisely identify it. The robot will then emit the animal by making a high-frequency sound based on its features.

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frequency sound suited to animal frequency. This personalized strategy ensures that the sound repels the animal, protecting the toddler. The robot maximizes its ability to prevent attacks and protect the youngster by adjusting its response to each animal's frequency level.

The animal identification and expulsion system can be enhanced by improving detection algorithms through deep learning and computer vision. This would enable the robot to identify animals more accurately. Additionally, species-specific deterrents could be incorporated to make the system more effective. While the current method uses sound-based deterrence, future enhancements may include physical barriers or specialized technology for deterring animals, especially those that sound-based deterrence may not work for, such as snakes. Understanding animal behaviors and preferences can further enhance the system, allowing for the use of visual cues or specific odors to keep animals away, expanding the system's ability to protect the child from a wider range of animal threats in different situations.

2) Following the toddler and obstacle avoidance-based navigation system.

The toddler protection robot uses a reliable navigation system to protect small toddlers. In this section, we'll provide the robot's navigational evaluation results and analyze their consequences.

Raspberry Pi cameras take pictures.[18] Pre-processing the image helps the pre-trained Object Detection Machine Learning model. This model classifies 90 things in an image using COCO.[19] From the processed frame, TensorFlow Lite performs machine learning inferences. We infer four parameters. Consider position, object class, confidence score, and frame contents. Tracking logic starts with the object's location. LAN tracking parameters are sent to web browsers in real time. Monitoring parameters and tracking in real time enhances comprehension. The video feed snapshot covers all necessary characteristics. Creates frames and overlays with OpenCV.

As shown below, the location parameter returns the object's top left and bottom right coordinates, which are used to find its center. Red dots denote centers. As the object moves, the dot sticks to its center. The object's center must fall in the tolerance zone for tracking to stop. If the red dot (the object's center) is outside the tolerance zone, the robot will move and track it. Tolerance value determines tolerance zone size.

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Distance the object from the frame's center horizontally and vertically. The frame's 'X' and 'Y' show this distance. These values are compared to tolerance. Any value above tolerance is tracked by the robot. The object tracking method lowers robot X and Y values below tolerance. Left or right robot movement lowers X. Move the robot forward or backward to lower Y. Both X and Y are calculated in each frame.

During the implementation of object tracking and image following, I encountered a decrease in frame rate, which alludes to a slower visual update and a potential tracking lag in real-time. This decrease can be ascribed to factors such as the computational load of complex calculations, algorithm complexity, hardware limitations, and input data size/format. Optimization techniques, such as algorithm optimization, hardware upgrades, data pre-processing, system profiling, and investigating alternative frameworks or libraries, can be used to address this issue. additionally develop areas like Enhance the robot's perception capabilities by integrating advanced sensors such as LiDAR or depth cameras. This would enable the robot to better understand the environment, accurately detect obstacles, and make more informed navigation decisions. Develop the robot's AI to learn and adapt to the toddler's behavior over time. By analyzing patterns and understanding the child's preferences, the robot can proactively anticipate and respond to their needs, ensuring a safer and more engaging interaction. [20]

3) Cry detection and automated lullabies playing system.

The automatic lullabies playing system component detects toddler sobbing and plays an appropriate lullaby. This portion has two important parts: cry detection and play lullaby. Our solution uses machine learning algorithms to build and refine these two portions. We use machine learning and sound sampling technologies to detect crying in the cry detection portion. A large collection of crying infant sounds is collected in this context. Next, a speech detection module identifies a baby's sobbing or distressing vocalizations. These properly selected datasets allow the voice detection module to accurately detect crying scenarios.

Within the lullabies playing system, two speakers play the lullabies. Leveraging the raspotify API, the system plays lullabies and allows Spotify playlist modification. The voice detection module detects crying circumstances and automatically generates a lullaby after the automated cry detection capability is implemented. During cry detection, recognition accuracy decreases with microphone-sound source distance. Thus, the voice detection module struggles to distinguish sobbing. The technology uses sensitive microphones to mitigate these difficulties.

Future system versions may include modifications to increase functionality. A tool that automatically makes lullabies depending on a toddler's sleep and wake-up times is one improvement. This capability would greatly improve the system's crying detection and response. By adding such features, these systems can be more user-friendly and beneficial for parents and toddlers, making lullaby more personalized and convenient. Cry detection system accuracy can be improved by training a specific model with the raspberry pi module. This method has fine-tuning potential.

4)Intelligent toddler behavior detection and alerting system.

We created a prototype system using sensor technologies and machine learning algorithms to create an alerting system that reliably detects child behavior and alerts parents. We collected data from 3–5-year-olds throughout testing. The sensors tracked the child's kneeling, falling, and proximity to risky places. Data were analyzed using machine learning techniques to classify and analyze the child's behavior. The alerting system accurately detected the child's conduct. The technology immediately alerted parents when the child kneeled or fell. Text alerts were sent. The device also alerted parents immediately when the youngster was about to approach a dangerous place like stairs or a pool, allowing them to intervene.

This alerting system advances child safety technologies. The device helps parents protect their children from accidents and injuries by properly capturing and evaluating their behavior in real time. Our investigation revealed these significant findings:

The combination of sensors and machine learning algorithms achieved great accuracy in recognizing certain actions like kneeling, falling, and proximity to risky places. The system accurately distinguished between safe and dangerous movements, avoiding false positives and negatives.

Prompt real-time warning is essential for parents to respond immediately to potential threats. The real-time warnings allowed parents to respond and prevent accidents. Text alerts kept parents informed of their child's actions immediately.

The prototype system was intended for practicality and ease of usage. The prototype system accurately detected and alerted parents about a child's conduct, although it might be improved. The system's capacity to identify crawling, standing, and running would improve its comprehension of the child's actions. Location monitoring to follow a child's movement in a larger area would also improve the system.

This method has been shown to accurately detect a child's behavior and tell parents. We helped parents protect their children by combining sensor technologies and machine learning techniques. The system's accuracy, real-time alerting, practicality, and usability make it a potential child monitoring and accident prevention solution. This technique could dramatically improve child safety in diverse contexts with further development.

V. CONCLUSION

In conclusion, the introduction of an intelligent robot harnessing the capabilities of AI, ML, and OpenCV for the supervision and protection of toddlers offers a promising solution to the challenges faced by parents and caregivers in ensuring the safety, oversight, and holistic development of children. With its sophisticated functionalities encompassing toddler tracking, real-time monitoring, threat detection, child protection, timely alerts to parents in hazardous situations, and automated music playback, this innovative technology serves as a valuable asset for enhancing child safety and facilitating caregiver flexibility. By integrating cutting-edge features, the intelligent robot provides an indispensable tool that not only promotes the well-being of children but also empowers caregivers with a heightened sense of peace and confidence. Indeed, the potential for further development and implementation of this robot in childcare centers, playgrounds, and nursery schools is substantial. The intelligent robot's features, such as real-time monitoring, animal and obstacle detection, make it an ideal candidate for enhancing safety and supervision in such environments.

VI. REFERENCES

[1] Chikkamagaluru. D. of C. S. and E. Adichunchanagiri Institute of Technology, Institute of Electrical and Electronics Engineers. Bangalore Section, and Institute of Electrical and Electronics Engineers, *ICAIT - 2019 : First IEEE International Conference on Advances in Information Technology : proceedings : 24th - 27th July 2019*.

[2] R. Palaskar, S. Pandey, A. Telang, A. Wagh, and R. M. Kagalkar, “Final Year Students of Computer Engg,” *International Journal of Advanced Research in Computer and Communication Engineering*, vol. 4, p. 4, 2015, doi: 10.17148/IJARCCE.2015.41242.

[3] *2011 6th International Conference on System of Systems Engineering.* IEEE, 2011.

[4] G. Kahn, P. Abbeel, and S. Levine, “BADGR: An Autonomous Self-Supervised Learning-Based Navigation System,” *IEEE Robot Autom Lett*, vol. 6, no. 2, pp. 1312–1319, Apr. 2021, doi: 10.1109/LRA.2021.3057023.

[5] Institute of Electrical and Electronics Engineers, *2017 Seventh International Conference on Affective Computing and Intelligent Interaction Workshops and Demos (ACIIW) : 23-26 Oct. 2017*.

[6] *2010 IEEE 26th Convention of Electrical and Electronics Engineers in Israel.* IEEE, 2010.

[7] Z. Zhang, “Research on Child Care Robot and the Influence on Children,” in *Proceedings of the 2022 5th International Conference on Humanities Education and Social Sciences (ICHESS 2022)*, Atlantis Press SARL, 2022, pp. 225–233. doi: 10.2991/978-2-494069-89-3_26.

[8] D. M. H and C. Shivaraj, “ARTIFICIAL INTELLIGENCE FOR HUMAN BEHAVIOR ANALYSIS,” *International Research Journal of Engineering and Technology*, p. 1863, 2008, [Online]. Available: www.irjet.net

[9] P. Marcoň *et al.*, “A system using artificial intelligence to detect and scare bird flocks in the protection of ripening fruit,” *Sensors*, vol. 21, no. 12, Jun. 2021, doi: 10.3390/s21124244.

[10] W. Pedrycz and S.-M. Chen, “Studies in Computational Intelligence 867 Development and Analysis of Deep Learning Architectures.” [Online]. Available: http://www.springer.com/series/7092

[11] I. Silva, S. Wickramasinghe, G. V. I. S. Silva, and D. S. Wickramasinghe, “Infant Cry Detection System with Automatic Soothing and Video Monitoring Functions Non-contact 2D optical measuring algorithm View project Infant Cry Detection System with Automatic Soothing and Video Monitoring Functions,” 2017. [Online]. Available: https://www.researchgate.net/publication/342802422

[12] C. E. Dawson Jr, S. Mann, E. Roske, G. Vasseur, C. E. Jr, and C. Dawson, “Spotify: You have a Hit!,” 2021.

[13] T. O’rourke, “Temporal Trends in Music Popularity- A Quantitative analysis of Spotify API data Temporal Musical Analysis View project”, doi: 10.13140/RG.2.2.11551.71843.

[14] Y. Liu, “A Robotic Prototype System for Child Monitoring,” 2011. [Online]. Available: https://www.researchgate.net/publication/228992038

[15] S. B, R. P, M. M, and A. J, “Advanced Baby Care System,” *International Journal of Electronics and Communication Engineering*, vol. 2, no. 10, pp. 14–17, Oct. 2015, doi: 10.14445/23488549/IJECE-V2I10P104.

[16] Prajna P, “IoT-based Wild Animal Intrusion Detection System.” [Online]. Available: www.ijert.org

[17] A. Ghosh and B. Garg, “Smart Ultrasonic Animal & Insect Repeller Through IOT,” 2020.

[18] B. Leibe, J. Matas, N. Sebe, and M. Welling, Eds., *Computer Vision – ECCV 2016*, vol. 9905. in Lecture Notes in Computer Science, vol. 9905. Cham: Springer International Publishing, 2016. doi: 10.1007/978-3-319-46448-0.

[19] Z. tao Hu, L. Zhou, B. Jin, and H. jiang Liu, “Applying Improved Convolutional Neural Network in Image Classification,” *Mobile Networks and Applications*, vol. 25, no. 1, pp. 133–141, Feb. 2020, doi: 10.1007/s11036-018-1196-7.

[20] A. Srinivasan, S. Abirami, N. Divya, R. Akshya, and B. S. Sreeja, “Intelligent child safety system using machine learning in IoT devices,” in *Proceedings of*