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AI Based Harnessing Canine Emotion Recognition to Prevent Bites

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***Abstract*— The AI-based canine emotion recognition system is developed to prevent dog bites by incorporating several advanced technologies, such as microcontrollers, image processing, voice ICs, spray motors, and an offline voice recognition module. The overall system will collect visual, auditory, and physiological data from dogs and analyze their behavior in real time for detecting signs of stress, aggression, or discomfort. It is constantly processing such information using machine learning models, and the result is early warning so that owners, trainers, or handlers take their preventions before a potential bite incident could happen. An offline voice recognition module can be included, allowing the system to understand predefined voice commands from owners, resulting in immediate responses and control without reliance on an internet connection. Moreover, spray motors can help correct or prevent bad behavior. This system allows it to real-time monitoring, facilitate communication between humans and dogs, and greatly reduce the likelihood of dog bites to encourage safe human-dog interaction.**

Keywords*— *dog bite prevention, offline voice recognition, real-time monitoring, behavioral analysis, aggression detection, early warning system, predefined voice commands, human-canine communication, safety enhancement.

I. INTRODUCTION

Artificial intelligence is revolutionizing nearly every field imaginable, from learning animal behaviour. One of these applications is that of canine emotion recognition, applied to prevent bites from dogs—something that leads to significant risks in public health, with severally injured injuries, emotional damage, and cost in medical. Traditional ways of measuring emotions in dogs predominantly rely on human observation and are therefore subjective, inconsistent, and often prone to misinterpretation. In contrast, AI-driven systems provide an accurate and objective assessment by scoring a number of behavioural indicators including facial expressions, body language, and vocalizations that indicate early signals of aggression, stress, or anxiety. These systems can continuously monitor and interpret a dog's emotional state in real time by leveraging machine learning algorithms, providing timely alerts to owners, trainers, or the general public. Such technology can be implemented in various settings, including parks, homes, and veterinary clinics, to enhance human-canine interactions, ensuring safety and reducing the risk of dog bites. These systems also contribute to responsible pet ownership by helping individuals better understand and respond to their dogs' emotional needs. This paper delves into the development, functionality, and real-world applications of AI-based canine emotion recognition systems, emphasizing their potential impact on improving public safety and fostering harmonious relationships between humans and dogs.

II. LITERATURE SURVEY

1. EXISTING THEORY:

Existing methods for preventing dog bites primarily rely on owner vigilance, behavioural training, and physical restraints such as muzzles and leashes. While these approaches aim to control aggression and prevent incidents, they are largely dependent on human intervention and lack real-time monitoring, making them ineffective in unpredictable situations. Behavioural training, though beneficial, requires consistent reinforcement, which may not always be practical, especially in public spaces or high-stress environments. Physical restraints, while offering immediate control, can cause discomfort and anxiety in dogs, potentially escalating aggressive tendencies rather than mitigating them. Moreover, these conventional methods do not utilize technological advancements such as artificial intelligence, computer vision, or real-time behavioural analytics, which could provide valuable insights into a dog's emotional state and predict potential bite incidents before they occur. The lack of automated systems capable of detecting early warning signs, analysing canine behaviour, and providing timely intervention reduces the overall effectiveness of current bite prevention strategies. Without proactive, data-driven solutions, public safety remains at risk, and responsible pet ownership continues to face challenges in ensuring both human and animal well-being.

2. PROPOSED THEORY:

The proposed system will integrate Python-based image processing and sound recognition for high accuracy detection and analysis of canine emotions to proactively prevent dog bite incidents and enhance public safety. Using advanced image processing, the system will examine critical visual cues, such as facial expressions, posture, and body language, while the sound recognition module will detect and interpret vocal patterns, including barking intensity, growls, and distress signals. This dual-layered approach ensures that the emotional state of a dog is completely evaluated so that aggression, anxiety, or distress can be precisely identified. In case danger is detected, the system activates a voice IC that gives an audible warning to alert the people around to take immediate precautions. At the same time, a spray motor allows a specifically formulated calming spray designed to placate the dog and de-escalate the situation before it turns into an attack.

In addition, the system is integrated with a real-time location tracking mechanism that updates the corporate officials and ensures swift intervention by relevant authorities when necessary. With the inclusion of real-time image and sound analytics in automatic intervention mechanisms, the system helps to ensure an increased precision rate in the detection of aggression besides offering timely measures to stop these incidents from arising. It minimizes dog bite risks through enhanced community safety with a much more efficient, less inhumane approach toward tackling aggressive behavior among canines within public environments.

III. TECHNOLOGY USED

1. Hardware Requirements

The AI-based canine emotion recognition system uses a microcontroller to process data from sound recognition and image systems for aggression detection. Supporting components like a voice IC, relay board, and pump motor enable real-time interventions. This integration ensures timely warnings and calming actions, enhancing public safety and responsible pet management.

1.1. Microcontroller – ESP32

Description:

ESP32 is a powerful, low-cost System-on-Chip (SoC) microcontroller with built-in Wi-Fi and Bluetooth, making it ideal for IoT applications.

Specifications:

- Dual-core 32-bit LX6 microprocessor (up to 240 MHz)
- 34 GPIOs, 18 channels of 12-bit ADC, 2 channels of 8-bit DAC
- 802.11 b/g/n Wi-Fi with speeds up to 150 Mbps

1.2. Power Supply (Adapter & Battery)

Description:

Provides stable power for the microcontroller and connected components.

Specifications:

- Input Voltage: 220-230V AC
- Output Voltage: 12V DC
- Output Current: 1A

1.3. Wireless Sensor Network (WSN)

Description:

A network of connected sensors that help in real-time monitoring and data transmission**.**

Specifications:

- Uses ESP32 for communication and integrates with cloud-based platforms.
- Operates on battery or energy harvesting techniques, with sleep modes for energy efficiency
- Supports wireless protocols like Wi-Fi, Zigbee, and MQTT for real-time data transmission to cloud platforms.

1.4. Voice IC (DF Player Mini MP3 Player)

Description:

A small, low-cost MP3 player module that plays pre-recorded alerts and warnings**.**

Specifications:

- Supports MP3/WAV/WMA formats
- 24-bit DAC output with 90dB dynamic range
- Built-in 3W amplifier

1.5. Sound Recognition Module

Description:

Detects and analyzes barking patterns and growls to evaluate canine emotions.

Specifications:

- Operates at 3.3V - 5V
- Supports UART/I2C communication
- Onboard microphone with sensitivity of -28dB

1.6. Relay Board

Description:

Controls the enablement of external element for example, the calming spray motor.

Specifications:

- Input Voltage: 12V DC
- Driver Unit: ULN2003A
- Fast switching capacity for motor operation

1.7. Pump Motor

Description:

Movable pump with a calmed mist that releases upon sensing aggression.

Specifications:

- Input Voltage: 12V DC
- Reduced noise operation
- Compact and energy-efficient

2. Software Requirements

The AI-based system uses real-time image and sound recognition of canine emotions, which is powered by the Python programming language. It improves public safety by giving early warnings and automated interventions to prevent dog bites.

2.1. Embedded C

Description:

Used for programming the ESP32 microcontroller to process the signal efficiently and control in real time. It is widely applied for real-time control, signal processing, and efficient resource management in embedded applications.

Specifications:

- Direct access to processor registers and I/O hardware

- Optimized for DSP-based applications
- Minimal latency in time-sensitive applications such as motor control and sensor data acquisition.

2.2. Arduino IDE

Description:

Used for writing, compiling, and uploading code to the ESP32 microcontroller**.**

Specifications:

- Supports C/C++ programming
- Includes a serial monitor for debugging
- Extensive Library Support – Includes built-in and third-party libraries for handling Wi-Fi, Bluetooth, sensors, and other peripherals.

2.3. Python

Description:

Used for image processing and machine learning-based canine emotion recognition**.**

Specifications:

- Image & Audio Processing: Uses OpenCV for face and body analysis, and Librosa for bark and vocalization recognition.
- Machine Learning Models: The CNNs are used to classify the dog emotion by features derived from this model.
- Real-Time Processing: Optimized for live surveillance in public spaces to detect potential aggressive behavior.

2.4. Model Deployment & Data Processing

Description:

Deals with the processing of collecting, preprocessing data and real time deployment for precise identification of dog emotion.

Specifications:

- Dataset Preparation:

  Uses public (Kaggle, ImageNet, Stanford Dogs) and custom datasets, with image resizing (224x224) and pixel normalization ([0,1] scaling).

- Feature Extraction & Deployment :

  Makes use of the pre-trained CNN models for extracting features and further deploys it on the IOT devices for constant monitoring.

- Optimizes models using quantization and edge computing to ensure low-latency emotion detection in live environments.

IV. WORKING

1. Data collection and processing

The system uses a central processing unit that is ESP32, incorporating image and sound recognition based on Python to understand canine behavior properly. A camera module continuously captures real-time images and videos focused on key visual cues such as facial expressions, ear position, body posture, and tail movement, which are critical indicators of a dog's emotional state. Alongside this comes a microphone sensor that detects auditory signals that are made up of barking patterns, growls, and whimpering, which further helps in identifying signs of aggression, anxiety, or distress. These multi-modal inputs are further processed by machine learning algorithms that classify the dog's emotional state with very high accuracy by using data from both visual and audio.

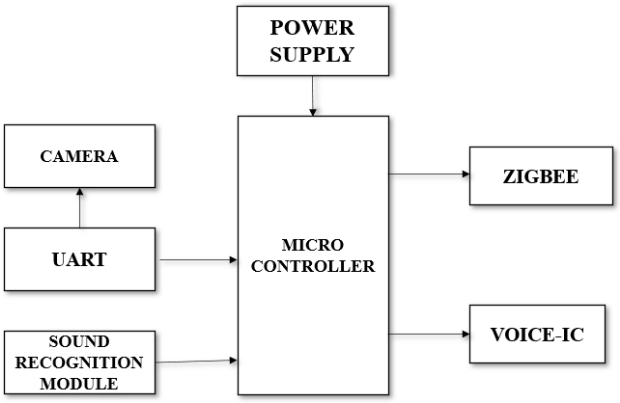

Fig:1 Block diagram for monitoring section

2. Communication and control system

It utilizes a WSN and a UART interface for communication and data transmission, which are vital in the smooth functioning of the system. The ESP32 will then process the analyzed data to find an appropriate intervention through external communication. The module plays a vital role in recognizing particular sound patterns indicating aggression, distress, or excitement. By incorporating real-time wireless connectivity, the system allows processed information to be shared instantly with pet owners, security personnel, or corporate officials responsible for public safety. This ensures proactive decision-making and enhances situational awareness in monitored areas.

3. Automated response mechanisms

When the system determines aggression, hyper barking, or distress, it automatically launches a response aimed at de-escalating the situation and preventing public danger. The Voice IC module plays prerecorded warning messages to the people around him, alerting them to potential danger while potentially distracting the attention of the dog. This is an immediate audible intervention that will prevent panic or allow people time to take their precautions. Simultaneously, a spray motor is turned on to release a calming mist containing pheromones or natural relaxants that will soothe the dog and decrease its aggressive tendencies. If the dog continues to display heightened aggression, the system will engage a relay and motor control mechanism to activate mild deterrents such as gentle vibrations or ultrasonic sound cues. These harmless and non-intrusive deterrents break the cycle of aggression by momentarily distracting the dog. Audio alerts, calming interventions, and distraction techniques combined in this intelligent response mechanism ensure effective and humane behavior management, making public spaces safer while promoting a more balanced human-animal interaction.

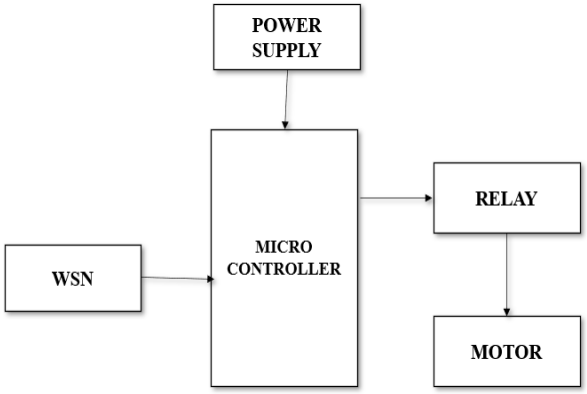

Fig:2 Block diagram for receiving section

4. Real time monitoring and public safety

One of the critical features of the system is the real-time monitoring and alerting feature, through the ESP32's wireless communication feature. Any possible threat that has been sensed by the system sends real-time alerts and location updates to concerned authorities, be it corporate officials, pet owners, or security personnel. Thus, it prevents incidents of dog bites in public parks, residential neighborhoods, and commercial spaces due to quick intervention. The intelligent system integrates image and sound recognition with IoT-driven automation to present an efficient, scalable, and proactive solution in monitoring canine behavior. It will not only ensure public safety but also promote better human-dog interactions, which will ensure a safer and more harmonious environment for all.

V. CONCLUSION AND RESULT

AI-powered emotion recognition in dogs is a revolutionary leap in understanding and managing dog behavior, particularly in dog bite prevention and enhancing human-dog relationships. The technology uses artificial intelligence to decipher a broad range of behavioral and physiological signals, such as facial expressions, posture, tail wag, vocalization, and biometric signals such as heart rate and temperature changes. With large databases of dog behavior having been used to train deep learning algorithms, AI systems can identify even slight changes in emotions that may be difficult for humans to discern. Through early warning signs of stress, fear, anxiety, or aggression, AI provides a more objective and data-driven alternative to traditional approaches based on human judgment, which are subjective and prone to error or bias. The ability to standardize emotional assessment with greater accuracy and consistency makes AI a very valuable instrument in dog behavior analysis.

Applications of this technology cross over various sectors, transforming human-dog relationships in public and private life. In public places like parks and city squares, AI-powered surveillance systems can monitor the behavior of dogs in real time, detecting potential aggression before conflict arises. This enables authorities or owners to intervene in time, ensuring public safety and preventing accidents. In veterinary clinics and animal shelters, where dogs experience high levels of stress, AI-powered emotion detection can assist veterinarians and caretakers in individualizing treatment to reduce anxiety and make medical or shelter facilities more humane. Similarly, in family homes, intelligent collars coupled with AI technology can provide pet owners with real-time emotional indicators, allowing them to understand the moods of their dogs, anticipate their needs, and respond to distress or discomfort signals in time. This technology not only enhances the health of pets but also enhances the dog-owner relationship through enhanced communication and responsiveness.

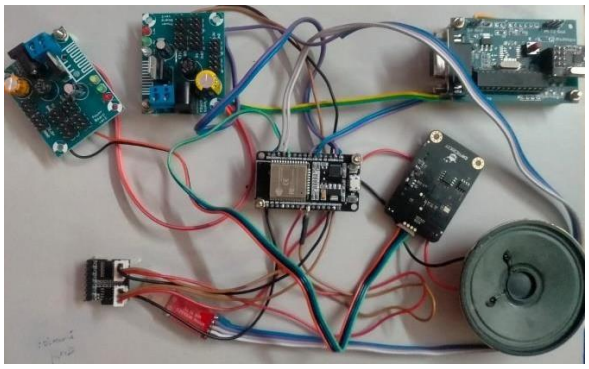

Fig:3 Monitoring section

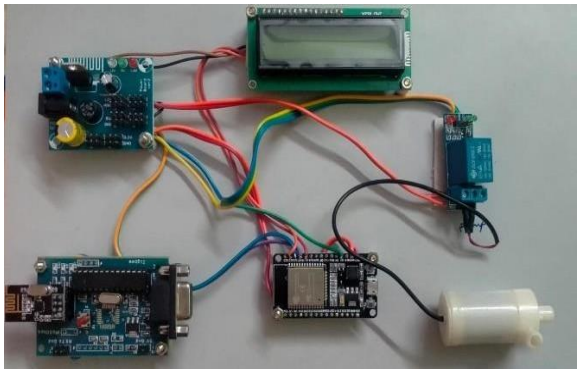

Fig:4 Receiving section

Beyond safety and emotional monitoring, AI-based emotion detection has vast potential for improved canine training and socialization. AI data can be utilized by dog trainers and behaviorists to develop personalized training programs based on a dog's temperament and emotional response, leading to more effective training outcomes. Service animals and emotional support animals can also be assisted with this technology, as AI-aided monitoring ensures their emotional balance is maintained, maximizing the trust and effectiveness of their relationship with handlers.

As technology in this area continues to evolve, AI-aided canine emotion detection will become increasingly prevalent in everyday life as wearable devices, smartphone applications, and home automation systems. A partnership between AI researchers, veterinarians, animal behaviorists, and pet industries can revolutionize pet welfare, ushering in an age where technology is the answer to advancing the safety, happiness, and understanding of humans and dogs. By opening the door to the potential of reading the emotional life of dogs, AI not only reduces the risk of dog bites or ferocious attacks but also ushers in an age of more empathetic, enlightened, and harmonious human-dog relationships.

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