Sonar Acoustic Defense System using sonic waves (SADS)

Mr. S. Dharageswaran, Department of Electronics and Communication Engineering,
P. A. College of Engineering and Technology, Pollachi, Tamil Nadu, India.
Email: sdhamuvkl@gmail.com

Abstract-- **Human-elephant conflict is a major problem leading to crop damage, human death and injuries caused by elephants, and elephants being killed by humans. A comprehensive discussion on design of a wireless sensor network and acoustic Communication system to detect and deter elephants without harming them and not affecting other external animal's environmental lifestyle as an early warning system which can act as a virtual barrier covering elephant corridors or villages. Elephant intrusion in areas with high human movement can prove lethal for both human beings and elephants. The elephant habitats are being continuously reduced due to increasing population and changes in the land-use patterns. Thus, human elephant conflict has been increasing and remains unsolved regardless of various solutions developed. The proposed system is a virtual barrier by emitting sonic waves in unidirectional path rather than a traditional technique. A prototype system to detect and deter elephants and send a warning message to the authorities and the villagers has been implemented.**

I. INTRODUCTION

There are only 50 countries in the world that can be considered as natural habitats for wild elephants. Of this, only 13 of these countries are in Asia while rest are from the African continent. Today only a total of 51,000 to 66,000 elephants are living in Asia, and of these elephants only 35,000 to 50,000 are living in their natural habitats. The situation is that there is a drastic decline in the number of wild elephants during these recent years due to increase in the human population and deforestation which leads to an overlapping of the human habitats with those of natural habitats of elephants, and hence this in tum-leads to the human elephant conflict.

The Asian elephant (Elephas maximus) is highly threatened by habitat fragmentation, habitat loss, and human-elephant conflict. India hosts 60% of Asian elephant population, nearly two-thirds of the elephant population lives either close to or within human-dominated landscapes. Southern India harbors half of India's elephant population containing about 6300 elephants. The increase in human population in India propelled by agricultural and industrial growth has led to the conversion of the forest lands into human settlements. Due to this, the wild elephant and other animal populations face acute shortage of resources such as water and food, making them move often into the human habitat. Hence, there has been severe man-elephant conflict.

The conflict has been on the rise in the forest border areas with herds of wild pachyderms straying into human habitation. The surveillance and tracking of these herds are difficult due to their size and nature of movement. The time to recover from the danger is negligible. hence, the loss due to destruction in the farms is more. The elephants are also subject to attack by humans resulting in danger to the life of elephants. Poaching for ivory had indeed become a threat with 100–150 tuskers being lost annually to illegal killings.

II. AREA OF STUDY

Human-elephant conflict (HEC) is a key example of the growing competition between people and wildlife for space and resources throughout Africa and Asia. This study explores the correlation of reported HEC incidents within 58 villages between 80 km from the boundary of Kallar to Walayar, Coimbatore, Tamil Nadu, India. Habitat loss and fragmentation is the biggest threat to the continuing survival of Asian elephants in this region. In addition to food crops, forests are being logged for their timber or cleared to make space for cash crop plantations such as rubber, tea, and palm. As the human population has inexorably risen, the forest wild lands in which elephants live have been disappearing.

Human-elephant conflict is on the rise and it is a battle that the elephant is losing. As elephant habitat diminishes, the elephants are pushed into increasingly smaller areas. This increases the population density to beyond sustainable levels and food availability grows short. The shortage of fodder has a negative impact on rates of reproduction. hence, normal birth rates begin to decrease. The serious consequence of the shortage of wild food leads to a corresponding increase of crop raiding and incidents of human-elephant conflict.

III. AREA OF RESEARCH

Human-elephant conflict is a rapidly expanding area of research, with conservationists working hard to understand the circumstances under which tensions are the highest between humans and elephants. A number of factors contribute to such conflicts, including population density of humans, elephant habitat structure, weather, time of year, and animal life. A study made in the region of interest shows that elephants move into human habitation due to many reasons.

(i) Fences and trenches compromised by people who need access to forests.

(ii) Farm lands may funnel them to unprotected adjacent villages.

(iii) Badly planned barriers that do not take elephant behavior into consideration.

(iv) Denying elephant access to a critical water source or foraging area.

(v) Human activities create abundant secondary vegetation that brings elephants closer to human settlements.

(vi) Artificially maintained water sources attract elephants during drought.

(vii) Traditional migration routes severed by human intervention (e.g., canals, power installations, and cattle fences).

The obvious conclusion to be drawn is that there is no single cause or explanation to account for human-elephant conflict; situations are circumstantial and complex. Rather, elephants and agriculture mix in numerous ways with varying consequences. Human population growth and land occu- pation for settlement may heighten conflict with elephants. However, it is generally the borders of forests that are the focal points of conflicts. Minimizing human-elephant conflict to reduce the risk of life of both human beings and elephants is of utmost importance. Elephant conservation issues can be divided into two distinct categories:

(i) activities that affect elephants directly such as hunting/poaching and capture;

(ii) developmental activities and human activities leading either to the loss of elephant habitat or its qualitative degradation.

Many methods are followed to avoid HEC. Construction of elephant proof trenches is being done all over the world. In[5] Fernando et al. discussed solar fencing to avoid elephant- human conflict. In [6], King et al. presented the concept of using beehives to mitigate elephant crop depredation. In [7], Loarie et al. discussed about the role of the artificial water sources which allow elephants to reside in forests during dry seasons. In [8], the authors discussed the potential use of satellite technology for conflict mitigation. The elephants tagged with radio collars react violently and damage it and even the elephants die. In [9], Venter and Hanekom proposed the possibility of using the elephant-elephant communication (elephant rumbles) to detect the presence of a herd of elephants in close proximity, In this work, the authors have recorded the low frequency infrasound pattern, but they do not compare with that of other animals to confirm an elephant occurrence. In [10], Vermeulen et al. proposed unmanned aircraft system to survey elephants, in which the elephant images are acquired at a height of 100 m but the small flight time and being expensive do not make it viable. In [11], Dabarera and Rodrigo proposed appearance based recognition algorithms for identification of elephants. Given the frontal face image of an elephant, the system searches the individual elephant using vision algorithms and gives the result as, already identified elephant, or as a new identification. In [12], Ardovini et al. present an elephant photo identification system based on the shape comparison of the nicks characterizing the elephant's ears. In [13], Goswami et al. addressed identifying elephants from photographs, and comparing resultant capture recapture-based population parameter estimates using supervised visual identification of individual variations in tusk, ear fold and lobe shape. The authors show that this is a reliable technique for individ- ual identification and subsequent estimation of population parameters. But in real time, the capture of elephant's front image is not possible.

It is easier to chase elephants before they enter fields and therefore most damage can be averted [3]. Guarding from watch towers, patrolling, and trip wire alarms provide farm- ers with advance warning of approaching elephants. Once the animals are detected, active crop guarding devices using light and noise are deployed to chase them away. An early warning system to minimize the human-elephant conflict in the forest border areas is proposed in this paper. The system helps mitigate such conflicts in two ways:

(i) providing warning to people about the anticipated entry of elephants into human habitation;

(ii) providing advance information to the authorities to take action to chase the pachyderms back to the forest.

Due to the lack of habitat, elephants enter new territory, which often coincides with agricultural areas or human villages. Different efforts have been undertaken to alleviate this conflict, such as the establishment of electric fences, which is, however, not practicable to cover larger areas. Early warning systems are required that monitor travel routes of elephants and alert humans to avoid involuntary confrontations. Elephants communicate with each other by low-frequency sounds, which travel distances of several kilometers'. The most common elephant call is the rumble, which extends into the infrasound band.

The rumble is a harmonic sound with a fundamental frequency in the range of 15-35Hz and duration between 0.5 and 5s [15]. Fig. 1&2 shows a typical rumble with a high signal-to-noise ratio (SNR).

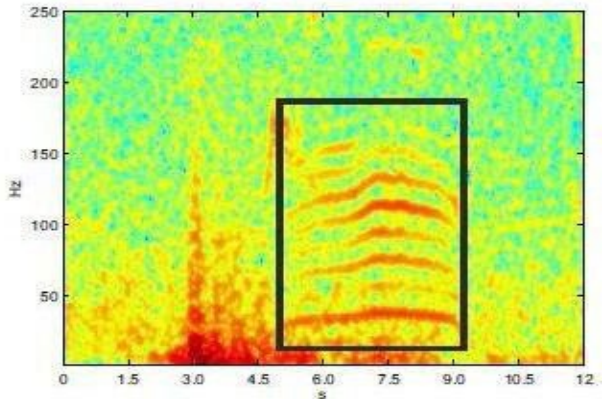

Fig.1: Elephant's rumble

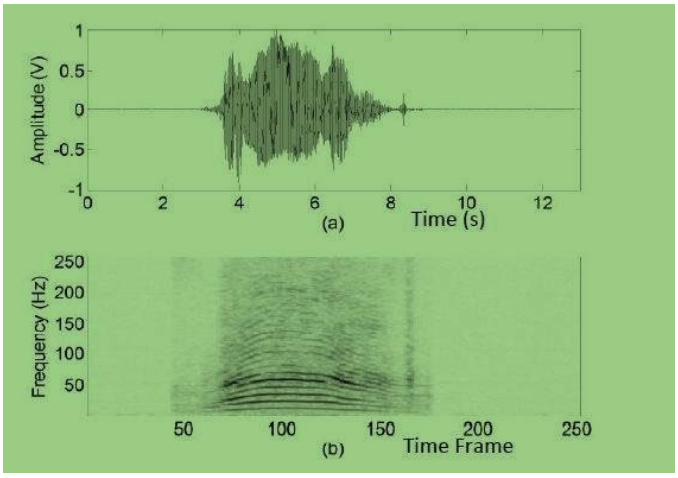

Fig.2: Audio waveform of an elephant infrasound call

IV. EXISITING METHODOLOGY

Today, the main issue with prevention of crop raiding by elephants is not whether or not it can be achieved, but rather how it can be actualized at a favorable cost-benefit ratio. In most cases, the problem is that the economic value of crops cultivated is very low. Although the total loss due to elephants can be considerable, the damage per-unit of cultivation is generally very low. Therefore, while many methods can be utilized to effectively safe guard crops from elephants the cost per unit of safeguarding can be comparatively high, preventing their employment on a wide scale. A multitude of traditional methods [Fig.3] have been developed through the ages to reduce and prevent crop raiding by elephants in conflict prone areas. The growth of human-elephant conflict in the past few decades and technological advances have resulted in development of additional methods to address the problem. In general, traditional methods are easy to use, have low costs and are more effective at low levels of conflict. With increasing conflict, more technical and sophisticated methods need to be used which carry higher costs. The various techniques employed in human- elephant conflict mitigation range from chasing elephants by shouting, drum-beating, noise-making, use of fire crackers, lights and torches, to engaging koomkies (trained elephants) and specially trained and equipped teams of people, construction of elephant barriers such as rubble walls, ditches and canals, biological and electric fences, deployment of alarms, development of communication systems, capture, translocation and culling of problem animals [2], use of highly sophisticated technology such as satellite telemetry, and compensation and insurance schemes.

Fig.3: Harmful Traditional methods in Human-Elephant conflict

Activities such as noise-making, shouting and throwing objects are more reactive and confrontational. Such activities may also indicate to elephants that their presence is detected, and that they have to contend with aggressive humans. Lighting fires has been a universal method of guarding crops against elephants and other wild animals since ancient times Presence of humans, noise making, fires etc. keep elephants away from crop fields or their vicinity by presenting clues that are clearly associated with humans. Such activities tend to lose their effectiveness in protecting crops as elephants become habituated with increased exposure to them, and the realization that such methods are not backed by any real physical threat or harm. Males appear to habituate to traditional methods of crop protection more readily than females in herds. When these methods fail - as they are bound to with eventual habituation - the animosity towards elephants begin to increase, as does the perception of the crop-degradation being significant. Furthermore, confrontational methods increase the risk of injury and death to farmers from elephants as the aggression levels increase on both sides.

V. PROPOSED SYSTEM

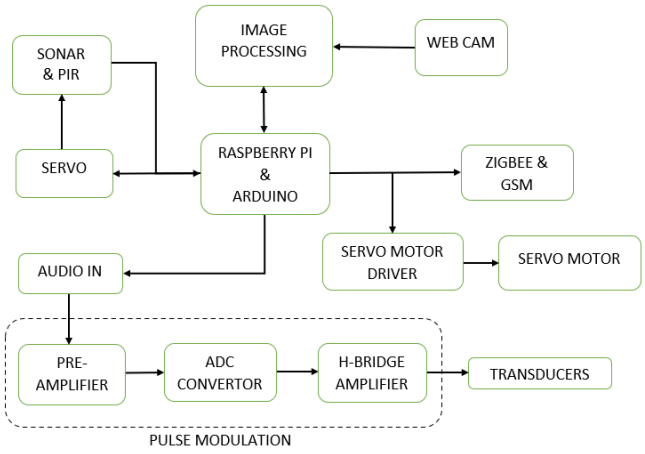

Fig.4: Block diagram for the Elephant Entry Prevention method

In fig.4 shows the system proposed to detect the presence of wildlife elephants and deter without harming them. At the same time send the warning message to farmers, villagers and forest officials. Basically, this device consists of three main sections there're,

- Detection section,
- Communication section,
- Emitter section.

A. DETECTION SECTION

In detection section to detect the presence of wildlife animals we using PIR sensor to detect the number of infrared rays emitted from elephants. And we also using SONAR sensor to map the surrounding environment. For more advanced detection and identification, we performing image processing to detect elephant's thermal signature's by using thermal Imaging camera shows in fig. 5.

Fig.5: Thermogram of wildlife elephants

B. COMMUNICATION SECTION

In fig. 6 shows once a device detects any presence of wildlife elephants. It automatically sent warning message to nearby farmers, villagers and forest officials to intimate them. It using GSM for cellular mobile communication and also use ZigBee to communicate shorter distance and it can also connect with other devices to form a mesh network.

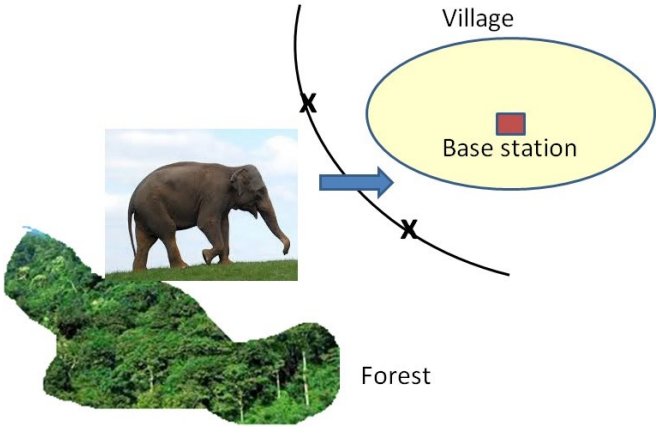

Fig.6: Elephant detection

C. EMITTER SECTION

In emitter section we perform Pulse Width Modulation (PWM) to modulate the honeybee's infrasonic sound waves to Ultrasonic sound carrier frequency (40-50KHz range) depends on properties of transducers shows in fig. 7.

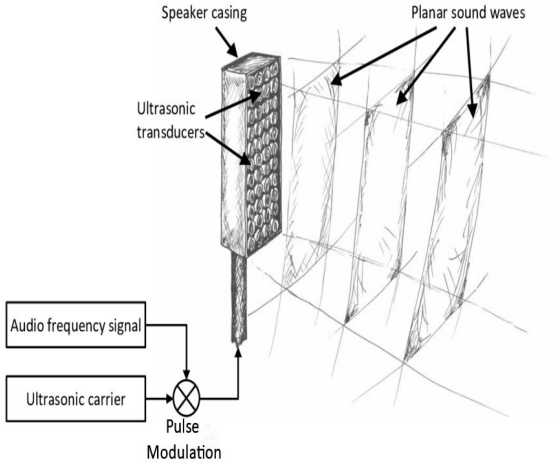

Fig.7: Emitter section

Honeybees rumbling frequency sound signal is goes to pre-amplifier circuit to increase gain and power of signal then it goes to STM32F103C8T6 microcontroller to perform ADC conversion and Pulse Width Modulation (PWM) shows in fig. 8.

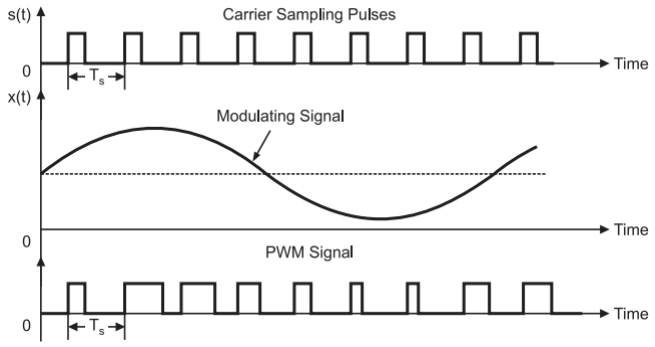

Fig.8: Pulse Width Modulation

Then modulated signal goes to H-Bridge amplifier to further amplification after it travel to array of ultrasonic transducers. It emits modulated sound waves in unidirectional path. When this modulated sound waves hits any object, it can demodulate and demodulated sound waves hear by particular direction in higher gain.

VI. RESULT AND ANALYSIS

Fig.9&10 shows the complete setup. The entire Project has been tested with a help of spectrum analyzer and Digital storage oscilloscope (DSO). The completed system detects and deter wildlife elephants without harming them. And it successfully sent warning message via GSM and Zigbee to users.

Fig.9: Real time setup model

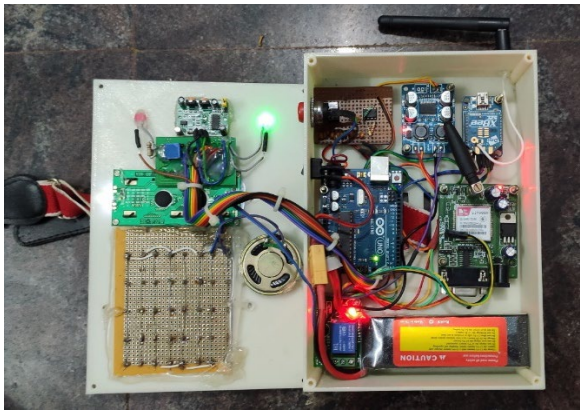

Fig.10: Real time setup inner view

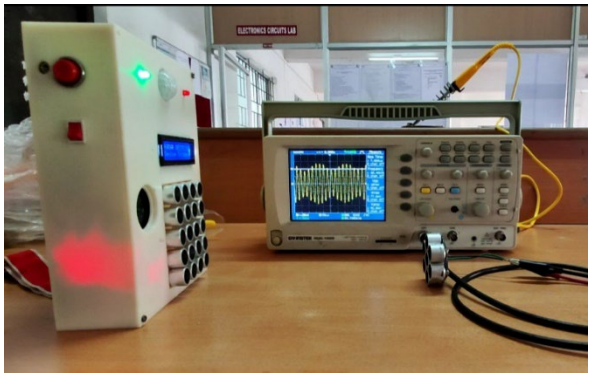

Fig.11: Project setup output

Fig.11 shows the modulated sound waves are emitted from device. The emitted sound waves received by another ultrasonic transducers array it vibrates the transducers it can seem in the DSO.

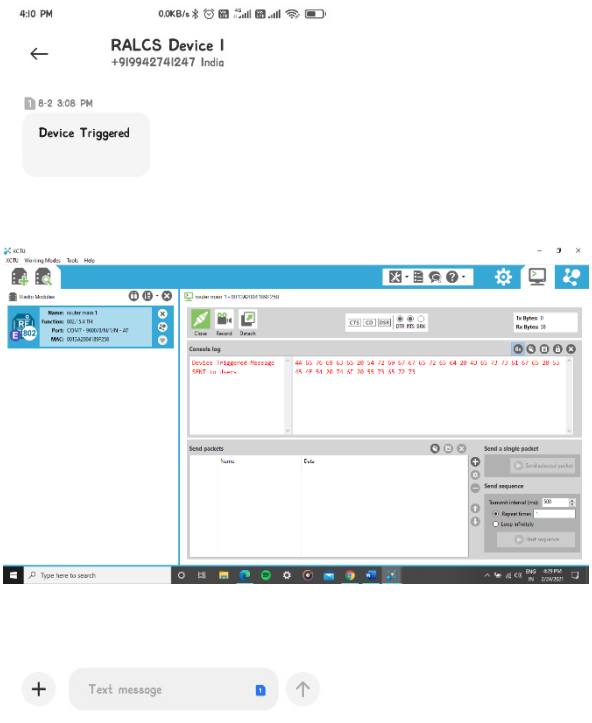

Fig.12: GSM & Zigbee output

Fig.12 shows device sending warning message through GSM to Mobile Phone and Zigbee to nearby forest officials and farmers.

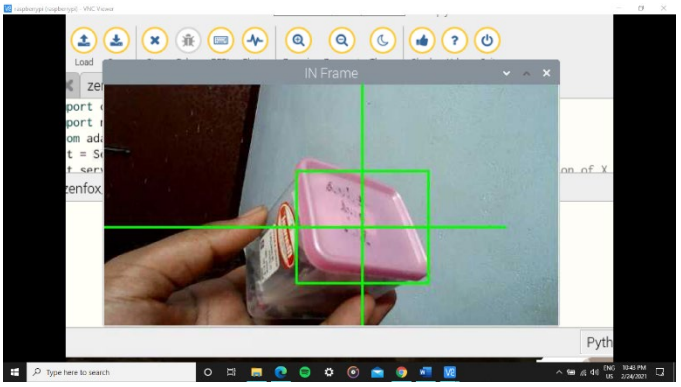

Fig.13: Real time image tracking

In Fig.13 Image Tracking was performed by using OpenCV. It can track in X&Y axis of 180 degree of angle.

VII. CONCLUSION

With this system elephant detection and desertion are performed. And early warning system also obtained. For this wildlife elephants are detected early and warning message sent to farmers, villagers and forest officials. At the same time, deters elephants without harming them. From that Human-Wildlife Conflict (HEC) will be controlled.

VIII. FUTURE ENHANCEMENT

In Future, this method can be developed to detect different sounds of many wild animals by implementing Hardware Module. Also, image recognition can perform by Thermal Image Sensor for further more identification of Elephants. And by using Artificial intelligence (AI) & Machine Learning (ML) we can detect other wildlife animals in that region. We also try to emit infrasonic sound waves by vibrating ground.

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