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Timely Detection of Fire and Animal Intrusion in Agricultural Land Using IoT and CNN

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ABSTRACT

Agricultural fields near forest areas often become the centre of human-animal conflict. Due to increased deforestation and destruction of wild-life habitat, animals venture out of forest areas in search of food. Other major consequence of deforestation is forest fire and poaching. As solution to the issues specified, technology can help to detect and warn potential human-animal interference near forest areas. On detection of fire near the agricultural land, pump is turned on automatically to put off the fire. On detection of movement through IR sensor, camera is turned on to identify the animal or human intruder using YOLO (You Only Look Once) algorithm. If an animal is detected, animal specific sound repellent is played to drive the animal away. If any human with weapons is identified, then an alarm is raised to alert neighbours of possible poacher and intruder. The farmer is alerted by means of an alert message.

Keywords *– Arduino, Flame sensor, Gas Sensor, IoT, IR sensor*

1. INTRODUCTION

The propulsion of industrial developments has led to the conversion of forest areas into human settlements. This has led to the destruction of the wild-life habitat as well as deforestation. As a result of this, agricultural land near forest areas face threat of both animal attacks and propagation of wild fire from nearby forests. This causes scarcity of food and water resources leading to animals wandering in search of food and water. It is extremely difficult to monitor the animals because of their continuous movement.

Invasion of elephants, bears, monkeys and even some domestic animals like cows, sheep which eat crops are also a threat to food security. If destruction is large-scale, so is the loss. Elephants cause maximum damage to infrastructure and inflict injuries to human beings. Farmers and local residents have limited ability to bear the direct costs of these conflicts and any such adverse situations decrease the tolerance towards wildlife and their attitude becomes hostile, which leads to retaliation attacks, injuries and killing of animals many of which are extremely disturbing incidents.

Table 1: Types of Crops Damaged by Animals

Animal	Types of Crops Damaged
Elephants	Sugarcane, paddy, jackfruit, cashew, pineapple, plantain, coconut
Bear	Paddy, maize, beans, berries, nuts, resin, oak seeds
Monkey	Banana, guava, grapes, litchi, pear, peach, mango
Cow	Cereal grains like corn, wheat, oats, barley, sorghum
Sheep	Wheat, canola and grains

According to data released by the Indian government, human-elephant violence kills 100 elephants and 500 people every year. Animal poaching also pose a serious threat. Conflict easement is a two-sided issue. Both animals and humans are at odds, and the goal is to promote coexistence and resource sharing to some degree. Increased concern for animals and the willingness to participate in long-term processes like land use planning and economic growth are crucial for achieving human-animal coexistence.

2. RELATED WORK

Agriculture is the backbone of any country. Agricultural production has been aided by technological advancements and government reforms. In agriculture, WSN may be used to keep track of a variety of events in the field. S Mohandas et al. [1] has used LoRA WAN network for communication, CNN for image classification. The YOLO algorithm is faster than CNN but was not considered in this study. Jeevitha, S et al. [2] proposed an animal intrusion warning system that uses wireless sensors to send an automatic alarm using image processing techniques. Ram et al. [3] invented the system where animals are detected by comparing the image acquired using a vision-based camera. Warning signals are generated. This technology minimises the amount of time it takes to identify the presence of animals. The benefits of using WSNs in agriculture have been stated by Konstantinos et al. [4]. WSNs' ability to track the field for longer periods of time and make decisions from afar makes it an apt choice to be used for agricultural applications. Pierce et

al. [5] established a sensor network on-site During frost prevention incidents, these networks can be used to measure the air temperature. Two types of radios were considered by the authors – base radio and roamer radio. Star topology was used to deploy the base radios. The base radios that are deployed gather information from the environment. They send the data that is gathered to roamer radio. Finally, agfrostnet software is used to analyse the data obtained from the device. Shu-ming et al. [6] created a system to monitor the acoustic emission signal caused by tension due to crop water. MTS310 sensor boards and MicaZ nodes were used for this purpose. Use of inter-cluster multi-hop routing was examined. Gutierrez et al. [7] devised a method for automatic irrigation. This optimises the use of water in a farming area automatically. Two types of sensors are attached to the plant's root system. The authors, however, have left unnoticed the problem of theft in the agricultural field as a result of intruders.

3. PROPOSED METHODOLOGY

The proposed system uses Arduino UNO R3 board which forms the heart of the system. IR sensors, flame sensor and smoke sensor are interfaced to the board and a camera is also installed on the boundary of the agricultural land.

The whole system can be described in following parts.

A. The Controlling System
B. For detection of fire and smoke and automatic dousing of fire
C. For detection of motion, identification of animal and poacher

3.1 The Controlling System

The Arduino is programmed in the Arduino IDE software, which allows us to monitor all of our machines. It is powered by a 5 Volt battery. The Arduino Board is used to control the flame, smoke and IR sensors.

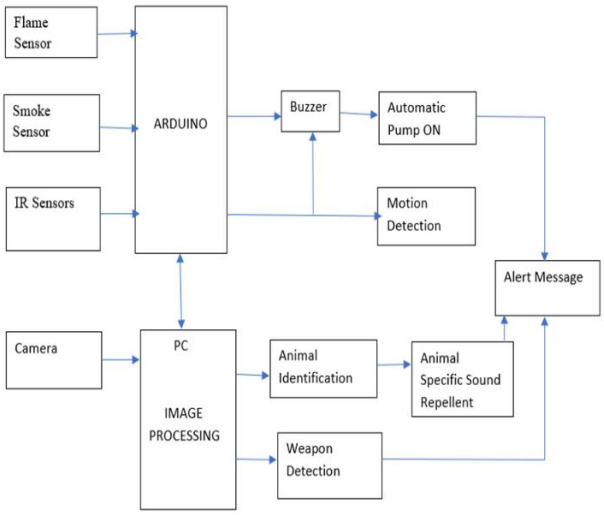

Fig 1: Block diagram of proposed system

3.2 For detection of fire and smoke and automatic dousing of fire

Fire can be detected using the flame sensor near the agricultural field. Its operation is centred on the YG1006 sensor, a high-speed, high-sensitivity NPN silicon phototransistor. This sensor is sensitive and because of its black epoxy, it emits infrared radiation.

The flame sensor comes in handy when trying to locate the source of the fire. When the sensor detects the flame, the LED on the sensor will light up and the D0 pin goes LOW indicating that fire has been detected. The moment the flame sensor goes HIGH; the submersible water pump will be enabled to start pumping water automatically to put out the fire without the need for human interference. This function is critical as fire can spread in seconds thereby causing extensive damage to the cultivated crops. Also, a MQ-3 gas sensor is used to detect smoke. MQ-3 is a sensor that is heater-driven. It is for this reason that the Anti-explosion network is made up of two layers of fine stainless-steel mesh. When the sensor detects smoke, this element ensures that the heater element within the sensor does not cause an explosion. Buzzer is activated if any or all of the sensors go HIGH.

3.3 For detection of motion, identification of animal and poacher

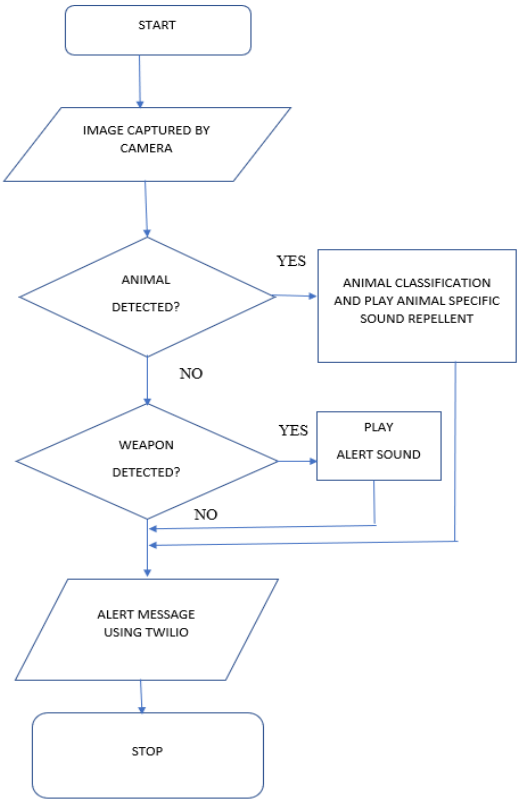

Fig 2: Flowchart for animal identification and weapon detection

The moment motion is detected within the range of the IR sensors, the IR sensors go HIGH and the camera will turn on, capturing the animal's image and allowing the animal to be identified. YOLO (You Only Look Once) algorithm is used for animal detection. The YOLO architecture is like FCNN (Fully Convolution Neural Network). The aim is to predict an object's class and the bounding box that specifies its position. YOLO usually trains on full images and it optimizes the detection performance. The COCO dataset (Common Objects in Context) is a widely used dataset for object detection. The COCO format defines how high-level image metadata such as height, distance, and image sources and annotations like bounding boxes, object classes are stored on disk. To compare expected and real-world artefacts, the IoU threshold is used. The default value is 0.5. The IoU parameter can be customised. Once the image of the animal is captured, based on the type of the animal, an animal specific sound repellent is played using the play sound module available in Python. Parallelly, an alert message will be generated automatically and sent to the farmer's registered number using twilio module available in Python thereby alerting the farmer about the intrusion. The farmer will also be sent a suggestion on his/her registered mobile number about an alternative way to divert the animal if the animal specific noise repellent fails. Another challenge is due to human intruders into forest land.

These human intruders are not only a threat to animal-bird - insect species due to their poaching activities but continued deforestation and smuggling of sandalwood and other important resources pose a danger to the ecological balance. The camera that will be deployed on the border of the agricultural land can be used to identify possible poachers by capturing images of humans with weapons like axe, gun etc and immediately generating a siren to alert the neighbours and send an alert message to the farmer so that he can inform suitable forest officials.

4. RESULTS

YOLO (You Only Look Once) algorithm is used for animal and weapon detection which is faster than R-CNN. YOLO is a single shot detector and hence it has good FPS (Frames Per Second). It works on 45 frames per second and used for detecting multiple animals and weapons in a single video frame.

Snapshot 1: Fire detection and automatic turning on of the pump. This shows the fire that is detected by the flame sensor placed at the boundary of the agricultural land and the pump would automatically switch on to put out the fire until it spreads to a wider area.

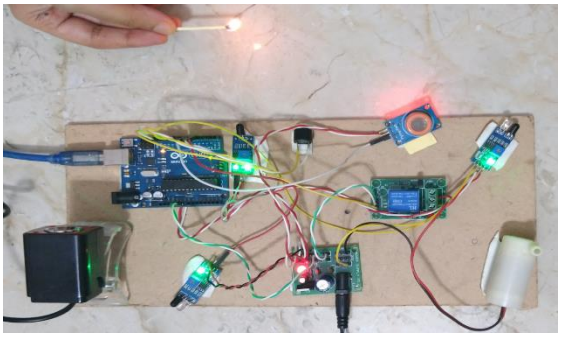

Fig 3: Fire detection

Snapshot 2: Elephant detection and automatic alert message to the farmer. The camera installed at the agricultural land's boundary detects the elephant and automatically plays bee sound and a warning message is sent to the farmer.

Animal	elephant
Confidence	0.5839

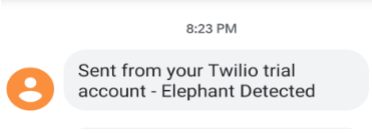

Fig-4: Elephant detection and alert

Snapshot 3: Bear detection and automatic alert message sent to farmer. The camera installed at the agricultural land's boundary detects the bear and bear-specific sound repellent is played and a warning message is sent to the farmer.

Animal	bear
Confidence	0.8275

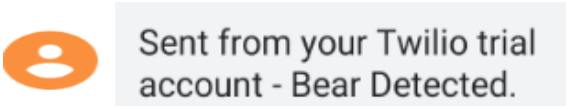

Fig 5: Bear detection and alert

Snapshot 4: Sheep detection and automatic alert message sent to farmer. The camera installed at the agricultural land's boundary detects the sheep and loud sound repellent is played and a warning message is sent to the farmer.

Animal	sheep
Confidence	0.8945

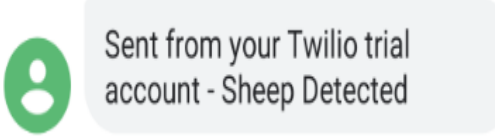

Fig 6: Sheep detection and alert

Snapshot 5: Axe detection and automatic alert message to the farmer. This shows the weapon carried by any possible human intruder or poacher who can destroy trees in the forest or poach animals.

Weapon	axe
Confidence	0.8754

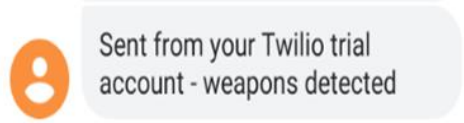

Fig 7: Weapon detection and alert

Snapshot 6: Handgun detection and automatic alert message to the farmer. This shows the weapon carried by any possible human intruder or poacher who can poach animals.

Weapon	gun
Confidence	0.8726

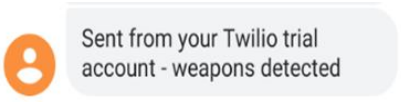

Fig 8: Weapon detection and alert

Snapshot 7: Representation of intruding animals and their confidence values as a graph.

Tble 2: Types of Intruding Animals And Confidence Values.

Animal	Confidence value (in %)		
	Count=1	Count=2	Count=3
Elephant	58.39	65.25	72.88
Bear	82.75	72.00	70.33
Sheep	89.45	85.62	80.66
Cow	93.00	70.22	59.62

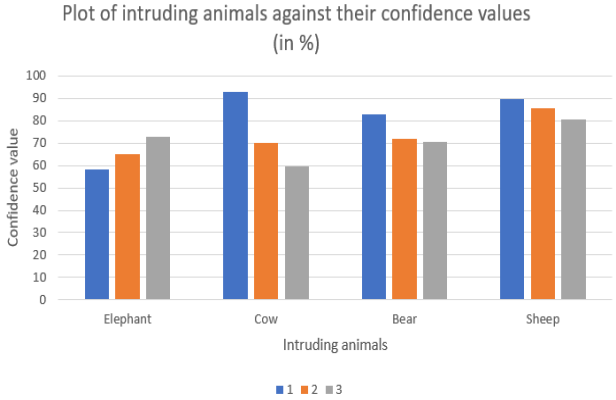

Fig 9: Graph of intruding animals versus their confidence values

From the graph, it can be noted that the algorithm performs differently with varying count of the intruding animal as well as its type.

5. CONCLUSION

The phenomenon of animals vandalising crops has become a big social issue in recent years. So, too, is the problem of crop destruction caused by fires. It necessitates immediate attention and a viable solution. As a result, this initiative has a lot of social significance because it tries to solve a problem. A cost-effective and energy-efficient smart farmland defence system is developed. The main goal is to avoid crop loss by identifying and warning of possible fire and animal attacks and to protect the region from poachers using the YOLO (You Only Look Once). The advantage of using YOLO is that it is extremely fast when compared to CNN and it can perform multiple detections from a single video frame. Since YOLO (You Only Look Once) is used on real-time image and video streams, the confidence values predicted will vary based on the detection. Farmers will benefit from such a system because it will help them protect their orchards and fields, saving them money and eliminating the need for unproductive attempts to protect their fields.

In future, alternative suggestion messages can be made farmer friendly by using regional languages.

6. REFERENCES

[1] S Mohandass, S Sridevi, R Sathyabama. A Unified Approach To Animal Intrusion Detection For Preventing Human-Wildlife Conflict And Crop Protection. JCR. 2020; 7(19): 7686-7698.

[2] Jeevitha, S., & Vengatesh Kumar, S., "A Study on Sensor Based Animal Intrusion Alert System Using Image Processing Techniques", Third International conference on I-SMAC (IoT in Social, Mobile, Analytics and Cloud) (I-SMAC), 2019, ISBN: 978-1-7281-4365-1

[3] Aswin, V.P. Ram et al., "A Self-Induced Warning System for Wild Animal Trespassing Using Machine Vision System", International Conference on Intelligent Computing and Communication for Smart World (I2C2SW), 2018, ISBN: 978-1-5386-9432-9.

[4] K. Konstantinos, X. Apostolos, K. Panagiotis, and S. George, "Topology Optimization in Wireless Sensor Networks for Precision Agriculture Applications," in International Conference on Sensor Technologies and Applications, October 2007, pp. 526–530.

[5] F. J. Pierce and T. V. Elliott, "Regional and On-farm Wireless Sensor Networks for Agricultural Systems in Eastern Washington," Computers and Electronics in Agriculture, vol. 61, no. 1, pp. 32–43, April 2008.

[6] X. Shu-ming, W. Liang-Min, Q. Xiao-qian, and Z. Yong-Zhao, "Application Research of WSN in Precise Agriculture Irrigation," in Environmental Science and Information Application Technology, 2009. ESIAT 2009. International Conference on, vol. 2, July 2009, pp. 297–300.

[7] S. Misra and S. Singh, "Localized Policy-based Target Tracking Using Wireless Sensor Networks," ACM Transactions on Sensor Networks, vol. 8, no. 3, pp. 1–30, Aug. 2012.

[8] B. Lilly and K. Shenai, "Wireless sensor networks with embedded intelligence for agricultural applications," in 27th International Conference on Microelectronics Proceedings, May 2010, pp. 311–314.

[9] Salha M.Alzahrani's sensing for the "Internet of Things and is Applications".2017 5th International Conference on Future Internet of Things and Cloud Workshops.

[10] S,R.Choury P.A.Amale, N.B. Bhawakar's "IoT based wireless sensor networks for prevention of crop from wild animals"`IETE Zonal Seminar "Recent Trends in Engineering & Technology" - 2017

[11] A. Rodriguez de la Concepcion, R. Stefanelli, and D. Trinchero, "A wireless sensor network platform optimized for assisted sustainable agriculture," in IEEE Global Humanitarian Technology Conference, Oct 2014, pp. 159–165.

[12] Pooja G,Mohmad Umair Bagali "A smart farm land using raspberry pi crop vandalization prevention and intrusion detection system".(IJARIIEISSN(0)2395-4396)

[13] Bindu D,Dilip kumar M D,Mamtha B,Prashanth P "Prevention of wild animals entering into the agriculture field"(NCETEC-2017) Gavade,P.H.Kulkarni: "Arduino based Wireless Robatoc hand using zigbee",IJAREAEI,May 2017.

[14] S. Misra and S. Chatterjee, "Social choice considerations in cloud-assisted WBAN architecture for post-disaster healthcare: Data aggregation and channelization," Information Sciences, vol. 284, pp. 95–117, Nov 2014.

[15] A. Rodriguez de la Concepcion, R. Stefanelli, and D. Trinchero, "A wireless sensor network platform optimized for assisted sustainable agriculture," in IEEE Global Humanitarian Technology Conference, Oct 2014, pp. 159–165.

[16] I. F. Akyildiz, S. Weilian, Y. Sankarasubramaniam, and E. Cayirci, "A survey on sensor networks," Communications Magazine, vol. 40, no. 8, pp. 102–114, November 2002.

[17] Raviteja, U. et al., "An animation-and-chirplet based approach to intruder classification using PIR sensing", IEEE Tenth International Conference on Intelligent Sensors, Sensor Networks and Information Processing (ISSNIP), 2015, ISBN: 978-1-4799-8055-0.

[18] Tarun, C. et al., "Human Crawl vs Animal Movement and Person with Object Classifications Using CNN for Side-view Images from Camera", International Conference on Advances in Computing, Communications and Informatics (ICACCI), 2018, ISBN: 978-1-5386-5314-2.

[19] Stefano, G. et al., "IoT solutions for crop protection against wild animal attacks", IEEE International Conference on Environmental Engineering (EE), 2018, ISBN: 978-1-5386-4182-8.

[20] Vergin Raja Sarobin, M. et al., "Forest Fire Detection using IoT Enabled Drone", International Journal of Pure and Applied Mathematics, Vol. 119, No. 12, 2018, 2469- 2478.

[21] Eni Dwi, W. et al., "Real-time forest fire monitoring system using unmanned aerial vehicle", Journal of Engineering Science and Technology, Vol. 13, No. 6, 2018, 1587 – 1594.

[22] 1264-2015 - IEEE Guide for Animal Deterrents for Electric Power Supply Substations.

[23] Albert, J. B., & William, D. G., "On the Utility of Chirp Modulation for Digital Signaling", IEEE Transactions on Communications, Vol. 21, Issue No. 6, 1973, 748 - 751.

[24] R.Newlin Shebiah, B.Deeksha,S.Aparna "Early warning system from threat of wild animals using raspberry pi".(ICRTECITA-2017).

