International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-8, June 2020

IoT Applications for Animal Tracking and Monitoring

K Sai Vamsi, P. Pardha Saradhi, Visalakshi Annepu, Ravi Kumar C V, Kalapraveen Bagadi

Abstract*: This paper is about maintaining the surveillance of the wild animals to protect tribal and vice versa. As we know, tribal people who live in the forest areas have threat from the wild animals. So we have proposed an idea in such a way that it helps in protecting the tribal people. The idea says that firstly the wild animals are caught or brought together and a device is attached to them. With the device, we can track them in the forest or in the surrounding area with the help of GPS concept. Once a device or the animal which has the device gets tracked, the information or the data such as the proximity distance is immediately sent to the web application designed for this project. Further it alarms the villagers or the tribal people and informs to the forest officers, so that they can be taken under control. There is also a camera incorporated in the device. This will constantly capture the video surveillance from the animal's point of view. If there occurs any instance of hunting (human detection) of endangered animals or any wildlife, the images of the people who get captured in the video feed are sent to the web application along with the location of the device at that particular instant of time. Human detection will be done using Haar cascade. This will help us in locating the exact area of occurrence of hunting and take extra precautions for the animals in such areas.

***Keywords*: Animal tracking, web application, human detection, camera, GPS, video surveillance, Haar cascad.**

I. INTRODUCTION

Wildlife plays a major role in the ecosystem. It is our responsibility as a part of the social system to protect and maintain a good relation with all the other living beings. Unfortunately, due to present scenario, the wild animals are losing their shelter because man has grown greedy. Unable to know where to head, the animals sometimes make their way to the tribal villages near the forests or hills. When the people see these animals, they get tensed and either start running or attacking the animals.

Revised Manuscript Received on June 30, 2020.
***** Correspondence Author
K Sai Vamsi, School of Electronics Engineering, Vellore Institute of Technology, Vellore, India. Email: koyasai.vamshi2016@vitstudent.ac.in
P. Pardha Sarathi, School of Electronics Engineering, Vellore Institute of Technology, Vellore, India. Email: ppardha.saradhi2016@vitstudent.ac.in
Visalakshi Annepu, School of Electronics Engineering, Vellore Institute of Technology, Vellore, India. Email: annepuvisala@gmail.com
Ravi Kumar C. V., School of Electronics Engineering, Vellore Institute of Technology, Vellore, India. Email: ravikumar.cv@vit.ac.in
Kalapraveen Bagadi*, School of Electronics Engineering, Vellore Institute of Technology, Vellore, India. Email: bkpraveen@vit.ac.in

In return, as a reflexive mechanism, the animals will put up a fight and try to survive. As a part of this, there can be loss of life for both human beings and the livestock that they have. It is not the intention of the animals to harm the human beings and the same applies vice versa.

But due to the unfortunate condition of the present day, the circumstances lead to problems like this and the wild animals are killed in the crossfire that takes place. Because of this there are many social implications. The number of wild animals are decreasing making many species endangered. Slowly, the poor animals are getting scared and getting extinct. Also, the human beings are developing a disastrous ideology as to kill any wild animal that they see because they have this preoccupied mind that the wild animal will definitely harm them. This paper focusses on developing a device that can help both human beings from animals and animals from human beings.

This device will be apt for endangered animals that roam about in packs like the Asian Elephants and the Gorillas. This is because, it is apparently difficult for us to put up device on every animal and it is viable to put up one or two devices for a pack of animals. There is a camera in every animal device that detects the presence of human beings in the surroundings. Using this, we can detect the killers of animals and the region where the hunting is mostly taking place so that the government authorities can take special precautions in those areas. Something has to be done to act as a barrier between these elements of the nature and sustain peace.

This paper comprises four major components as discussed as follows:

Instrumentation for monitoring animal movements: Behavioral experiments often require continuous monitoring of the responses that animals make in different situations and in response to various stimuli. Formerly, recording visual observations of animals followed by the manual post hoc analysis of the data was the most commonly employed approach and has the advantage of being non-invasive. However, manual data extraction can be very time-consuming and introduces a risk of bias in identifying salient responses. Although techniques have been developed for specific applications to automate the analysis of behaviors, including some commercial solutions, many are not always adequate for the particular situation or sufficiently flexible to measure the desired movement. We have developed and implemented a relatively low cost system for video recording and reliably extracting data characterizing animal's kinetic responses.

This instrumentation has been successfully utilized in our investigations of pigeon head movements by enabling us to record and compare behavioral responses to different types of stimuli.

ZIGBEE based network architecture for animal health monitoring: Wireless Sensor Network is collection of sensor nodes which consist of sensing device, storage device, processing unit and antenna. These nodes may be placed in difficult physical environment for sensing an event, collecting data, processing data and forwarding it using wireless network to the sink, where data can be stored, processed and analyzed. Animal monitoring, Building monitoring and other are some application area of WSN. The sensor node requires enough battery power to collect and communicate data with other network device/s. WSN has several constrains, one of them is low battery power. It thus becomes important to conserve energy of a node in WSN. Due to hardware limitation for efficient energy consumption, researchers are required to work on mechanisms to reduce the energy consumption by sensor nodes. One of the ways to increase the battery life of sensor node is to implement energy efficient network architecture and communication protocol. In this paper we have proposed ZigBee based network architecture for Animal Health Monitoring.

Sensor for real-time animal condition and movement monitoring: A flexible, lightweight and minimally intrusive monitoring system has been developed to assess animals' behavioral responses. The system consists of wearable composite magnets and magnetic sensors integrated into a miniaturized wireless communication module with a flexible battery. The shape and size of the NdFeB-PDMS composite magnets are highly versatile, while the magnetic and mechanical properties can be tailored within a wide range by the powder concentration. The magnetic field of the composite magnet is sensed by a 3-axial magnetic sensor, and the measured data is wirelessly transmitted using Bluetooth low energy communication standard to a smartphone and dashboard. To withstand corrosive environments and enhance the durability the composite magnets are coated with 2 μm of Parylene C, while surface passivation of the wireless module is achieved with 5 μm of Parylene C. The system has been implemented for real-time monitoring of crabs, giant turtles, and giant clams, indicating its potential for novel and affordable animal monitoring applications.

IOT based wildlife intrusion system: This suffers electrocution with intense pain cause animals to In forest zone and agricultural field human animal conflict is a major problem where enormous amount of resources is lost and human life is in danger. due to this People lose their crops, livestock, property, and sometimes their lives. So this zone is to be monitored continuously to prevent entry of wild animals. With regard to this problem, we have made an effort to develop the system which will monitor the field. That is at first it will detect intrusion around the field using sensor, then camera will capture the image of the intruder and classifying them using image processing and then Taking suitable action based on the type of the intruder. Finally sends notification to farm owner and forest officials using GSM.

II. SYSTEM MODEL

A. Existing System

In the existing system there are no particular measures for animal security and monitoring. Only manual forest officers to monitor the animal as well as hunter. Hence this became a tough task to identify the hunters. Few major drawbacks are manual watching is needed, no additional security for animals and no facial capturing.

B. Proposed System

In this system a camera will be attached to each and every animal (endangered). Hence there's no need for manual checking as the cameras can take pictures if any human face is detected. So with the help of captured face it will send the images to local website and it is easy to find the hunters. Advantages can be no manual watching is needed, camera additional security and face capturing so that the hunter is identified. The methodology of the proposed system model is discussed as follows:

Our idea is actually a solution to the above mentioned problem. In our project, we try to implement a device that can be tagged to a wild animal. When any wild animal is first caught by the forest authorities, they will put this device on the animal (somewhere close to the neck because that way the device cannot be torn apart by the animal) and leave it back deep in the wild. This device contains a location tracking system that can send the latitude and longitude of the animal to the web application that is monitored by the forest authorities. The web application also has a database of the location of all the villages nearby. The device that is attached to the animal will send a signal every few seconds (keeping power constraint in mind) determining its location to the web application. Whenever the web application receives the coordinates from the device, it computes the distance between the villages that are nearby and the animal. There is a minimum threshold distance set by the forest authorities which is termed as safe distance.

Whenever the distance falls below this safe distance, an alert is raised in the forest officials' office and also an E-MAIL or an alert can be sent to the required personnel nearby. The alert can also be sent to some people living in the village so that they can alert themselves and get ready in case the wild animals attack. They can also get their livestock to a safer location. The safe distance is taken in such a way that even though the animal is moving with a great speed, the forest officials or the nearby security personnel can make it there in a short interval of time. They can control the situation and help avoid loss of life.

We can also include a camera in the device so that snapshots can be taken from time to time and can be sent to the web application. In this way, we can have an eye on the packs of animals. The camera is installed as a protection measure against hunting of endangered animals. Our focus here, is on the endangered animals and vulnerable animals which roam about in groups like the Asian Elephants, The Gorillas etc. Whenever we install a camera to the device, it will continuously run a video stream in which it detects human beings.

The system is trained with Deep Neural Networks model so that it accurately detects the presence of human beings in the running video stream. It can be accurate to a measure such that even when a part of the body is detected, we can the set the confidence value in such a way that even a minor activity is monitored. Whenever a human being is detected, an E-MAIL or an alert is sent to the email-address of the forest authorities. The forest authorities will then be able to see the images of the human being taken in the website and get the accurate location of the hunting incident. This information will helpthem to take further action.

The device has been implemented using raspberry pi, GPS module, camera and a laptop to host the website. The python codes have been written for human detection using deep neural networks, fetching latitude and longitude from the GPS module and calculating the distance between the villages and the device and hosting the website. All these codes are embedded in a shell file so that they can simultaneously be run. The website has been implemented in PHP. There are webpages in the website that enable us to do the following tasks:

(a) Change the e-mail address so that only that person will receive the email updates.
(b) Plot the current location of the device on a map using google api.
(c) Display the images of the human that are detected by the camera and also plot the location at which these images were taken.
(d) Set the location of the villages

The GPS location is fetched and the distance between that location and all the villages is calculated. If the distance between the device and any village is less than a threshold (mentioned in the code), then alert is sent to the email id that we listed in the website.

If the video stream detects human beings, then the image is sent to the website and also an alert or E- MAIL is sent to the same email ID mentioned in the website.

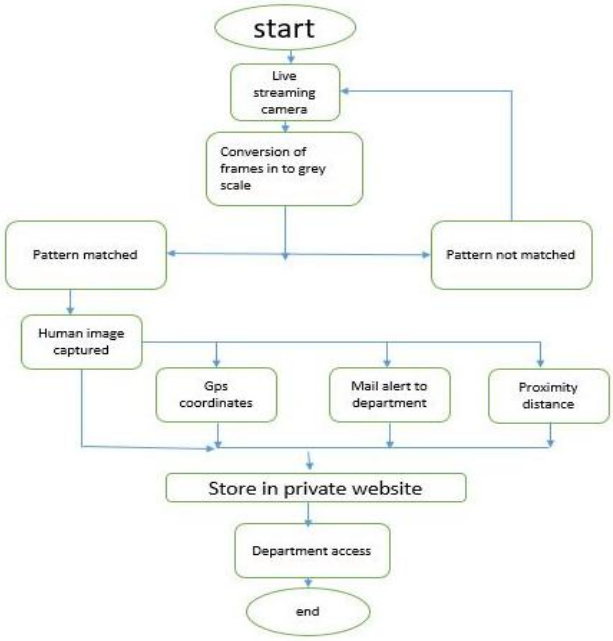


Fig.1. Methodology of proposed model.

III. HUMAN FACE DETECTION USING HAAR CASCADE

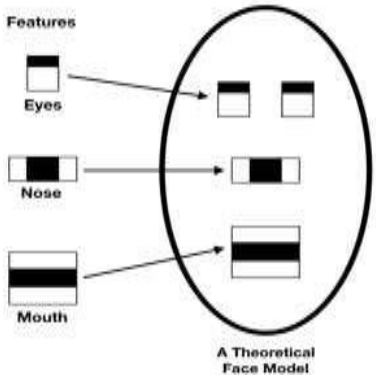


Fig. 2. Picture showing Haar-features.

Human face detection, which is the significant piece of this venture is finished by utilizing the Haar Cascade strategy which is an AI object identification calculation used to distinguish protests in a picture or video. The calculation is prepared to identify a face by utilizing a ton of positive and negative pictures. Initially, the image is changed over into a dark scale, and afterward it distinguishes Haar highlights grouping of square-formed capacities. At that point it utilizes classifiers to identify the face (1) and not a face (0). This face recognition occurs in four phases. The first being, recognition of Haar highlights, second being, utilizing necessary pictures, third stage is Adaboost and fourth is the course of classifiers.

Before Haar features, image pixel intensities were used for face detection which is a lot of effort and work, therefore Paul Viola and Michael Jonesused Haar wavelets which detect faces taking smaller subsections of a face at once into consideration compute sum of their pixel intensities and then find the difference between these sums. This is further explained in detail below. For black and white image pixel values are 0 or 1(ideal case) but in real cases, we have normalized greyscale image as shown in the bottom box containing pixel values which are usually between 0 and 1.

According to the Viola-Jonas algorithm, to detect Haar-like features present in an image, below formula should give a result closer to 1. The closer the value is to 1, the greater the change of detecting Haar feature in the image

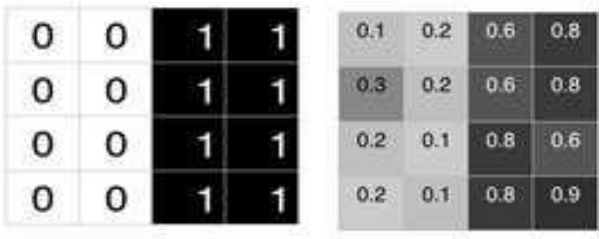
$$\Delta = dark - white \quad (1)$$

$$\Delta = \frac{1}{n}\sum_{dark}^{n} I(x) - \frac{1}{n}\sum_{white}^{n} I(x) \quad (2)$$

$$\text{Ideal case}: \Delta = \frac{1}{8}(8) - \frac{1}{8}(0) = 1$$

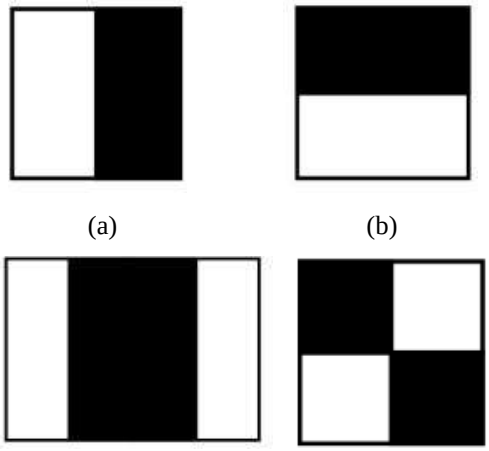
$$\text{Real case}: \Delta = \frac{1}{8}(5.9) - \frac{1}{8}(1.3) = 0.575$$

Haar features are very effective in detecting rectangle-like features, thereby making it a very functional face detection technique. For example, the figure 3(b) below can be an eye. The darker region being the eye and the lighter region corresponding to the cheek part of the face. As eyes are the darkest parts of the face compared to the rest of the face usually in the grey scale images or otherwise, they are detected first. Another example is figure 3(a) could be the nose as the bridge of nose is usually elevated and is darker than the cheek part of the face. This is how Haar features that are good at detecting lines and edges detect the face or subsections of the face first.



(a) (b)

Fig. 3. Pixel intensities of detected Haar-features (a) ideal case (b) real case.



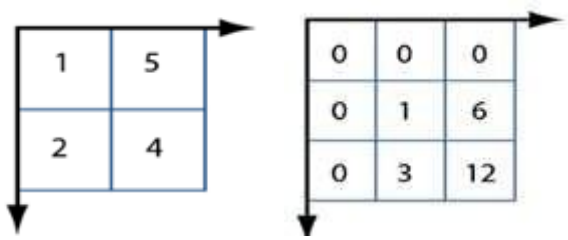
(a) (b)

(c) (d)

Fig. 4. Some common Haar features (a) vertical edge feature (b) horizontal edge feature (c) line feature (d) four rectangle feature

A. Integral Images

A huge measure of highlights are returned by the above calculation. To choose, what highlights ought to be thought about, indispensable pictures are utilized. It is a particular calculation intended to create the total of qualities in a rectangular subset of a network. The objective is to decrease the quantity of calculations expected to acquire the summations of pixel powers inside a window. So when a specific window is picked, this calculation registers total whole of the pixel forces push shrewd and section astute, which diminishes the quantity of tasks that must be performed to identify is a window is helpful or not. By valuable it implies if the window is a piece of the face we have to identify. In the event that we consider the underneath given boxes as a subset of a face where the numbers are pixel forces, we need to do 1+5+2+4 for the left side table, which is 12. While, on the right, we have a table with aggregate entireties, push astute and segment insightful, here you should simply 12+0-0-0, which is equivalent to 12. We have considered a straightforward calculation here, however with expanding sizes of subsets, the calculation utilizing fundamental pictures are a lot quicker, less tedious and powerful.



(a) (b)

Fig. 5. The generated sum of values in a rectangular subset of a grid. (a) input image (b) integral image

B. ADABOOST

Besides being numerous, features might also be irrelevant. Among the features, we obtain how can we decide which ones are good? Here good means a feature that is part of the face. Adaboost both selects the best features and the weak ones and trains the classifiers that use them. _Strong 'classifier is constructed as a linear combination of weighted simple _weak 'classifiers by the algorithm. Here a strong classifier means one which has less error rate, one which will definitely be a part of the face and a _weak' classifier is the one that has less than 50% error rate so we know that it mostly will be a feature that belongs in the face region. Therefore, we use Adaboost to combine these weak classifiers into on strong classifier that will lead to the detection of a face.

C. Cascade of Classifiers

In a picture, there are face-regions and non-face regions .We bunch the highlights that are identified from subsections into various phases of classifiers and apply them individually. The window that has bombed in the primary stage will be disposed of. We don't think about the rest of the highlights in it. The second phase of highlights will be applied and the procedure is proceeded with just in the event that it passes the primary stage. Required face area is the window that passes each stage. Consequently a course is utilized to spare time, vitality and exertion by not getting each subsection or window through all the stages. The window will experience all the stages if just it has a face highlight. At whatever point the course observes that it doesn't have a place in the face district, the window gets disposed of and all the littler windows that go through all the stages join to shape one major window which brings about the face that is being identified.

IV. RESULTS AND DISCUSSIONS

The human face is detected and the picture will be sent to the mentioned mail id. This mail id can only be accessed by the forest officials.

Also location of the animal will be displayed in longitude and latitude manner. Hence, this makes the forest officials to identify the hunter(human) and also to identify the location of the animal.

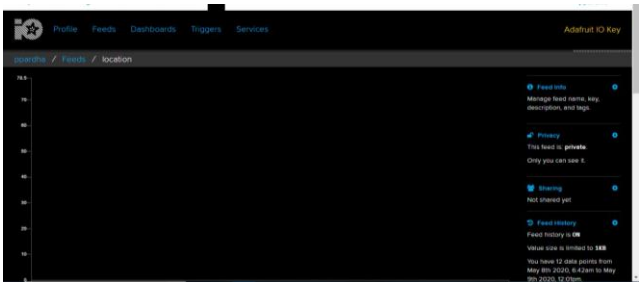


Fig.6. The website handled by the forest officials to monitor the animal.

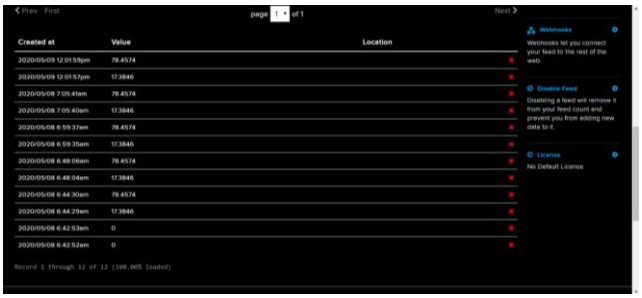


Fig. 7. The location of the animal is given in latitude and longitude manner. Here location is given by the "value".

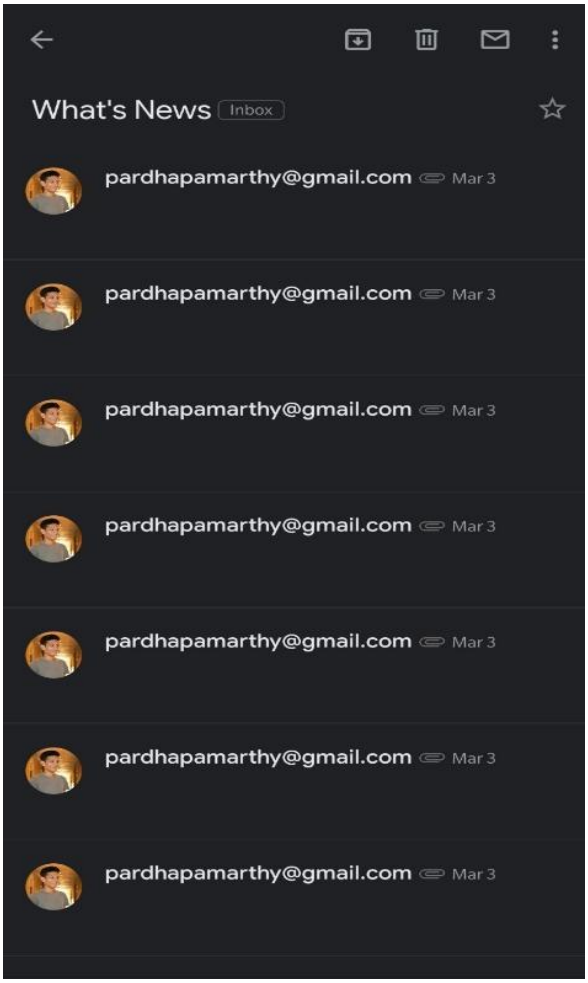


Fig. 8. When human is detected, the picture is sent to the mentioned mail id.

Fig. 9. This shows the image of the human detected which is received by the forest officials.

V. CONCLUSION

The device is capable to both calculate the distance as well as recognize human beings. It is a great asset to find areas where hunting of animals is supposedly going on. This will help animals from further becoming endangered to extinct. Also, this will also help human beings from the animals because sometimes during migration, the animals travel a long distance and mostly elephants thump the crops in their way. Such real time problems can be resolved using this device. Having said all that, this device also has its drawbacks just like any other wearable device. But keeping the scope of the project and the idea in the mind, its functionality is just as expected and does the job properly.

Power supply can be optimized by installing solar cells or any other mechanism so that the replacement of the device can be dealt with. The present prototype runs with a battery with huge capacity that can be charged with a solar cell. But a better alternative can lead to a better performance. This can be food for thought. Also network is a major concern in the forest or in the areas where wild animals roam. Improper network results in bad communication and the effectiveness of the idea will be degraded. So, there can always be alternative methods that can be searched for better implementation for communication method. More accurate training data can be obtained so that the false positive rate can be controlled. This will also ensure more seriousness to deal the issue right away.

REFERENCES

1. Fang, Y., Du, S., Abdoola, R., Djouani, K., & Richards, C. (2016). Motion based animal detection in aerial videos. *Procedia Computer Science*, *92*, 13-17.
2. Handcock, R., Swain, D., Bishop-Hurley, G., Patison, K., Wark, T., Valencia, P., ... & O'Neill, C. (2009). Monitoring animal behaviour and environmental interactions using wireless sensor networks, GPS collars and satellite remote sensing. *Sensors*, *9*(5), 3586-3603.
3. Kiani, F. (2018). Animal behavior management by energy-efficient wireless sensor networks. *Computers and Electronics in Agriculture*, *151*, 478-484.
4. Kadibagil, Mahesh & Guruprasad, H S. (2014). Position Detection and Tracking System. International Journal of Computer Science Information Technology and Security. 4. 67-73.
5. E. D. Manley, H. Al Nahas and J. S. Deogun, "Localization and Tracking in Sensor Systems," IEEE International Conference on Sensor Networks, Ubiquitous, and Trustworthy Computing (SUTC'06), Taichung, 2006, pp. 237-242.

6. Handcock, R., Swain, D., Bishop-Hurley, G., Patison, K., Wark, T., Valencia, P., ... & O'Neill, C. (2009). Monitoring animal behaviour and environmental interactions using wireless sensor networks, GPS collars and satellite remote sensing. Sensors, 9(5), 3586-3603. Dyo, V., Ellwood, S. A., Macdonald, D. W., Markham, A., Mascolo, C., Pásztor, B., ... & Yousef, K. (2010, November). Evolution and sustainability of a wildlife monitoring sensor network. In Proceedings of the 8th ACM Conference on Embedded Networked Sensor Systems (pp. 127-140). ACM.
7. Aemwal, V. B., Semwal, V. B., Sati, M., & Verma, S. (2011). Accurate location estimation of moving object In Wireless Sensor network. IJIMAI, 1(4), 71-75.
8. Rahman, A., Smith, D. V., Little, B., Ingham, A. B., Greenwood, P. L., & Bishop-Hurley, G. J. (2018). Cattle behaviour classification from collar, halter, and ear tag sensors. Information processing in agriculture, 5(1), 124-133.
9. Kan, W., Huang, Y., Zeng, X., Guo, X., & Liu, P. (2018). A dual-mode proximity sensor with combination of inductive and capacitive sensing units. Sensor Review, 38(2), 199-206.
10. Eren, H., & Sandor, L. D. (2005, February). Fringe-effect capacitive proximity sensors for tamper proof enclosures. In 2005 Sensors for Industry Conference (pp. 22-26). IEEE.
11. Boon Tatt Koik and Haidi Ibrahim, "A Literature Survey on Animal Detection Methods in Digital Images", International Journal of Future Computer and Communication, vol. 1, no. 1, June 2012.
12. Saieshwar Radhakrishnan and R Ramanathan, "A Support Vector Machine with Gabor Features for Intrusion Detection in Agriculture Fields", 8th International Conference on Advances in Computing and Communication (ICACC-2018) Procedia Computer Science, pp. 493-501, 2018.
13. Usha Kiran Divya and M Praveen, "IOT-Based Wild Animal Intrusion Detection System", International Journal on Recent and Innovation Trends in Computing and Communication, vol. 6, no. 7, 2018.
14. Prakash Kumar and Pradeep Kumar, "Arduino Based Wireless Intrusion Detection Using IR Sensor and GSM", International Journal of Computer Science and Mobile Computing, vol. 2, no. 5, May 2013.
15. B Vikhram, B Revathi, R Shanmugapriya, S Sowmiya and G Pragadeeswaran, "Animal Detection System in Farm Areas", International Journal of Advanced Research in Computer and Communication Engineering, vol. 6, no. 3, March 2017.
16. Sahane Pradnya Smabhaji, Salunke Nikita Sanjiv, Shirsath Vitthal somanth and Shukla Shreyas Sanjay, "Early Warning System for Detection of Harmful Animals using IOT", International Journal of Advance Research and Innovative Ideas in Education, vol. 5, no. 3, pp. 2395-4396, 2019.
17. Neha Bhadwal, Vishu Madaan, Prateek Agrawal, Awadesh Shukla and Anuj Kakran, "Smart Border Surveillance System using Wireless Sensor Network and Computer Vision", 2019 International Conference on Automation Computational and Technology Management (ICACTM), pp. 183-190, 2019.
18. Rakesh Kalshetty and Asma Parveen, A Various Surveillance and Detection Techniques Based on Wireless Sensor Networks, no. 1846, 2019.
19. Kalathiripi Rambabu, V. Haritha, S. Nikhil Srinivas and P. Sanjana Reddy, "IoT Based Human Intrusion Detection System Using LabVIEW", International Journal of Advanced Science and Technology 127, no. 1, pp. 162-166, 2019.
20. Anna Triantafyllou, Panagiotis Sarigiannidis and Stamatia Bibi, "Precision Agriculture: A Remote Sensing Monitoring System Architecture", Information, vol. 10, no.11, pp. 348, 2019.

AUTHORS PROFILE

K. Sai Vamshi. An under graduation student from Electronics and Communication Engineering, Vellore Institute of Technology, Vellore, India nts, with photo that will be maximum 200-400 words.

P. Pardha Saradhi. An under graduation student from Electronics and Communication Engineering, Vellore Institute of Technology, Vellore, India.

Visalakshi Annepu received the B. Tech degree in Computer Science and Engineering From JNTU Kakinada, India in 2011 and M. Tech Degree in Computer Science and Technology from Andhra University, Visakhapatnam, India in 2013. Worked as guest faculty in the department of computer engineering, Andhra University, Visakhapatnam, during Feb 2014 – May 2014. She also worked as assistant professor in the department of computer engineering, Sri Sivani Institute of Technology, Srikakulam, Andhra Pradesh, during June 2014 – May 2016. Currently she is pursuing Ph. D, in School of Electronics (SENSE), Vellore Institute of Technology, Vellore, India. Her areas of interest are wireless networking, Artificial intelligence, soft computing techniques and neural networks.

Ravi Kumar C. V. received the B.Tech degree in Elecetronics and Communication Engineering From Anna University, Chennai, India in 2006 and M.Tech Degree in Digital Electronics and Communication Systems from JNTU Ananthapur, India in 2009. Currently he is pursuing Ph.D and working as Assistant Professor in School of Electronics (SENSE), VIT University, Vellore, India. His areas of interest are wireless networking, MC–CDMA, Artificial intelligence, soft computing techniques and neural networks.

Kalapraveen Bagadi received the B.E. Degree in Electronics and Communication Engineering from the Andhra University, India in 2006 and M. Tech degree in Electronic Systems and Communication from National Institute Technology, Rourkela, India in 2009. He received Ph.D. degree in Wireless Communication from Department of Electrical Engineering, National Institute of technology, Rourkela, India in 2014. Currently he is working as Senior Associate professor, in the School of Electronics Engineering (SENSE), Vellore Institute of Technology, Vellore, India. His areas of interests include SDMA, MIMO, OFDM, wireless communication and Artificial intelligence. He has published several research articles in various Journals. He has finished four Ph. D thesis and currently guiding three Ph. D scholars. He is also reviewer for the journals like wireless personal communications, IET communications, Telecommunication Systems etc. His Google Scholar citations are about 275 with H-index 10.