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Quality Circle Approach Equipped with AI To Solve the Issue of Stray Cattle Detection and Identification in Small Cities to Avoid Accidents.

Raj Kumar[1], Ankur[2]

[1]Professor (Mech. Engg. Dept.), Chandigarh University, Gharaun
[2]Turbo Project Engineer, Wipro Technologies (Greater Noida)

Abstract
The quality circle (QC) approach through its various problem identification tools has got the fame by solving several issues in Industries as well as in-service sectors. The present paper is focused on the issue of stray cattle roaming here and there and contributing to scattered trash, fatal accidents, and road blockings in various cities of India. To understand and identify the actual reasons this work is carried out and solutions have been proposed for a small town of Haryana. The quality circle was established with an aim to sort out the issue only with all the available resources like CCTV cameras, GOSHALAS, and social workers. The authors adopted a qualitative approach with a micro-level study for a small town. The quality circle approach equipped with Artificial Intelligence has been chosen to sort out the Stray cattle detection and identification issue to resolve the problem of scattered trash, fatal accidents, road blockings, and saving valuable lives of humans and animals.

Keywords - Quality Circle, Artificial Intelligence, Stray Cattle detection, and recognition.

1. Introduction: -

"Stray cattle population chokes arterial roads of Panchkula " (Singhal Pallavi, 2021) "Open house: What steps to be taken to contain stray menace" (Sohal N. P. S, 2021) "Stray cattle menace on rising" (Tiruchi C. J, 2021) was the headlines of leading newspapers and enough to advocate the worth of this work. Fig. 1 shows the free and uninterrupted movement of cattle on roads. While crossing the road by cattle causes the halt of traffic on roads for hours. Most of the time it has been observed that villagers collect the cattle due to overpopulation or by considering it as non-profit items and leave them in the lurch in nearby cities (Nair B. Rajesh, 2020). In cities, these cattle roam around in search of food and shelter and cause all the miserable issues discussed above. This is a social problem that is there on the agenda of governments and other social activists in many states of India. In a study, it has been found that two-wheelers affected in 92% of cases. Stray dogs account for 69% of cases followed by cattle for 21% of cases. 41% of all road accident victims had polytrauma. Patients with road accidents due to impact with ox were found to have higher injury severity scores (ISS) (Mohanty *et al.*, 2021)

Fig. 1 Uninterrupted movement of cattle on road.

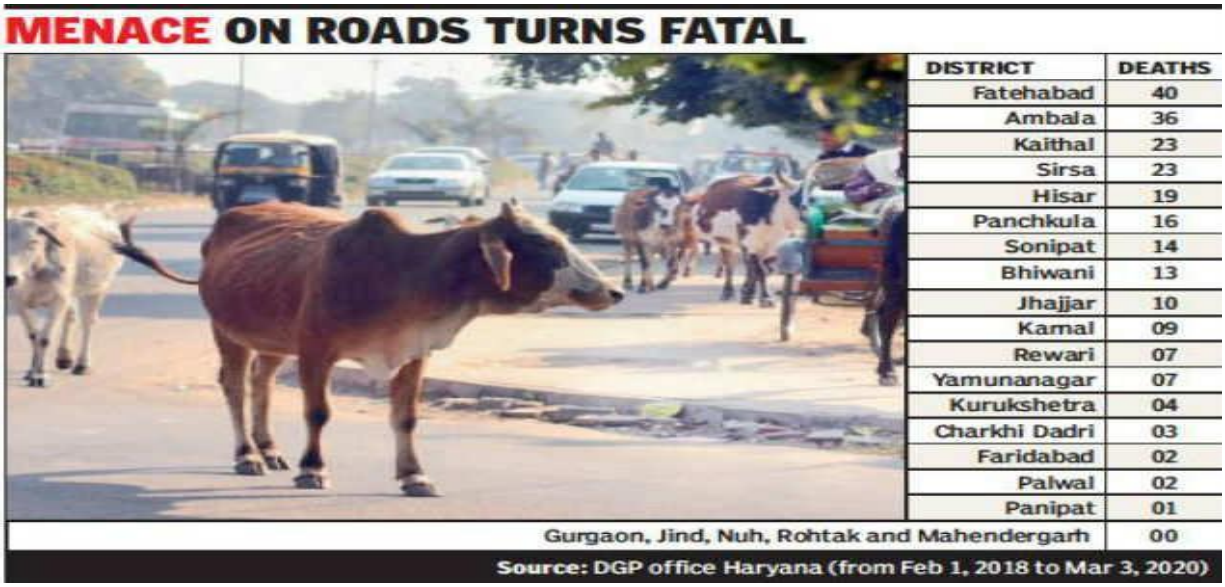

Fig. 2 Death toll in Haryana from Feb. 1st 2018 to March 3rd 2020 due to stray cattle.

2. Case Study:

The present case study was conducted in a small city of Haryana as this city is facing all the above-mentioned issues of stray cattle. The city is well connected with NH- 1, State Highway – 6, and other roads coming from all nearby villages. It had a population of around 11lac people and this large population holds a good number of two as well as four-wheelers along with all the vehicles of state transport and other goods carrying vehicles approaching from other states. Due to its historical background and other historical places nearby, it is the prime site for the pilgrims to visit this place in a year on many occasions. This stuff makes the roads of this small town overcrowded throughout the year. In the light of the above stray cattle menace and accidents is at its peak (Surya Ajay, 2020), (Beniwal Jitender, 2021) and due to this many problems arise (Fig. 2).

3. Research Methodology

Based on the literature available the quality circle approach is the best approach to find the root cause of such issues and then provide an appropriate solution. Various elements of the quality circle are the steering committee, co-coordinator, facilitator, leader, and circle members (A Jayakumar Anand and Krishnaraj C, 2015). Problem Identification Techniques used in this case study.

- Brainstorming sessions
- Data Collection
- Ishikawa diagram

A quality circle was established (A Jayakumar Anand and Krishnaraj C, 2015) to sort out the issue of stray cattle menace as discussed above with a team creation as mentioned in Table 1.

Table 1 Quality Circle team and roles.

Quality Circle		
S. no.	Team Member	Role in Quality Circle
1	Steering Committee	A senior person from society who had a good say how with administrative authorities for all necessary permissions
2	Facilitator (Corresponding Author)	To establish a Quality Circle with help of like-minded persons. To organize meetings to understand and identify the problem with help of various problem identification techniques. To analyze and communicate the possible solutions.
3	Coordinator (Co-author)	To provide all technological support to the circle
4	Circle members	A senior school teacher as a leader and five young social workers from different areas of Kurukshetra

4. Problem Identification

In the first meeting, the facilitator discussed quality circles (Sampangi Gopi, 2019) such as its concepts, philosophy, characteristics, objectives, techniques, and organization to the leader and its members so that they can get themselves familiar with various activities of the circle. Circle members decided to meet after one month and then regularly after two months till the problem was solved.

In the Second meeting taking stray cattle was taken as a burning issue for the brainstorming session. The session helped to find out possible issues related to stray cattle. All the points were noted down by the facilitator and those repeated and out of way were discarded. The following possible reasons were listed for further brainstorming sessions and decision-making.

1. Movement of stray cattle at night from nearby areas as their owner left them in the lurch, considering them useless.
2. Due to its religious values, plenty of food is offered by residents of Kurukshetra to stray cattle.

3. Movement of stray cattle at night on the roads while looking for shelter as per weather conditions.
4. Almost zero visibility of cattle on road at night or on fog days.
5. Social activists did not know the exact location of the stray cattle so that action to survive can be taken care of.

The five possible reasons when studied in detail and it was found that the

- Points 1st and 2nd belong to one category i.e., the residents of villages and Kurukshetra.
- Points 3rd and 4th are connected with local authorities and
- Point 5th needs to be solved with some expert of technology.

In the third meeting, all the points had been discussed in length and it had been decided for the facilitator to make a framework along with the Coordinator (Turbo Project Engineer, Wipro Technologies) on the 5th point i.e., location and identification and then information to be sent at different places for quick action. This point is one if cured speedily rest of the points can be taken care of by giving knowledge to residents of villages and Kurukshetra by storytelling the achievements in nearby states to sort out the issues.
The fourth meeting was specifically dedicated to the aim of detection and identification of stray cattle and during the meeting, for detection, various ideas were shared by circle members like

1. Use of detectable collars but collars can only detect if someone tries to detect the stray cattle with all the arrangements in hand, but it is not feasible as new cattle are kept on adding and also economically very costly. By this detection methodology, we will not be able to share their detection with concerned people, who will act immediately to send them away from roads to safer places.
2. Sometimes it is found that some domestic cattle along with their caretaker were also present on roads and in that case, we don't want to waste our energy by detecting and identifying
3. We were in the mood to use the resources of Govt. and the Public to sort out the issue, so it has been decided to take the help of CCTV (Closed-circuit television) cameras of Govt. authorities as well as shopkeepers of key points.
4. The next issue was what to do after detecting how to intimate the information to concerned persons. Looking into the issues above 100 CCTV camera locations (Fig. 3) have been identified and a mobile app has been planned to develop. This work has been assigned to the coordinator (Project Engineer, Wipro Technologies).

Fig. 3 Key Locations of CCTV in city

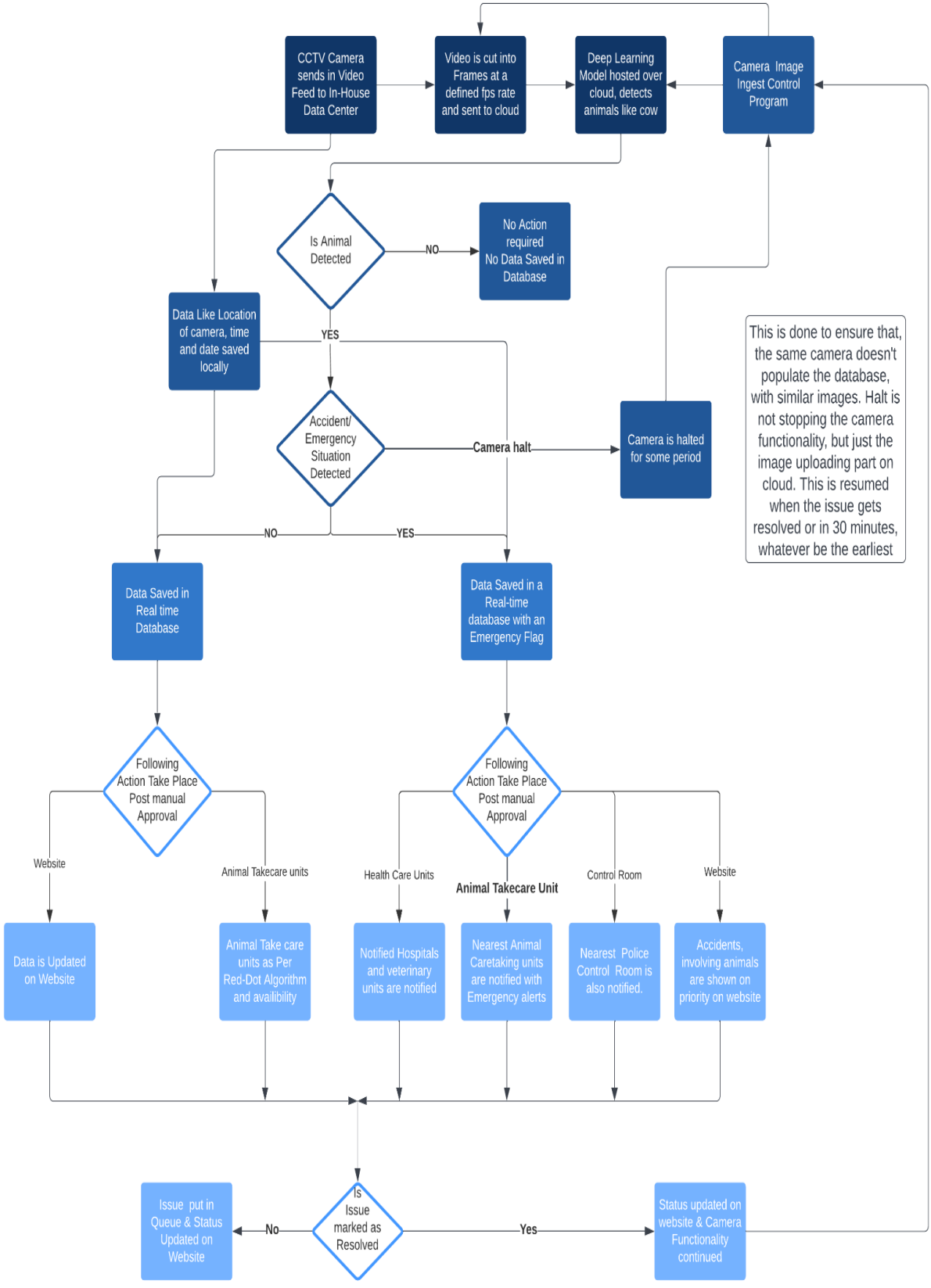

Fig. 4 Flow chart of Detection and Identification process

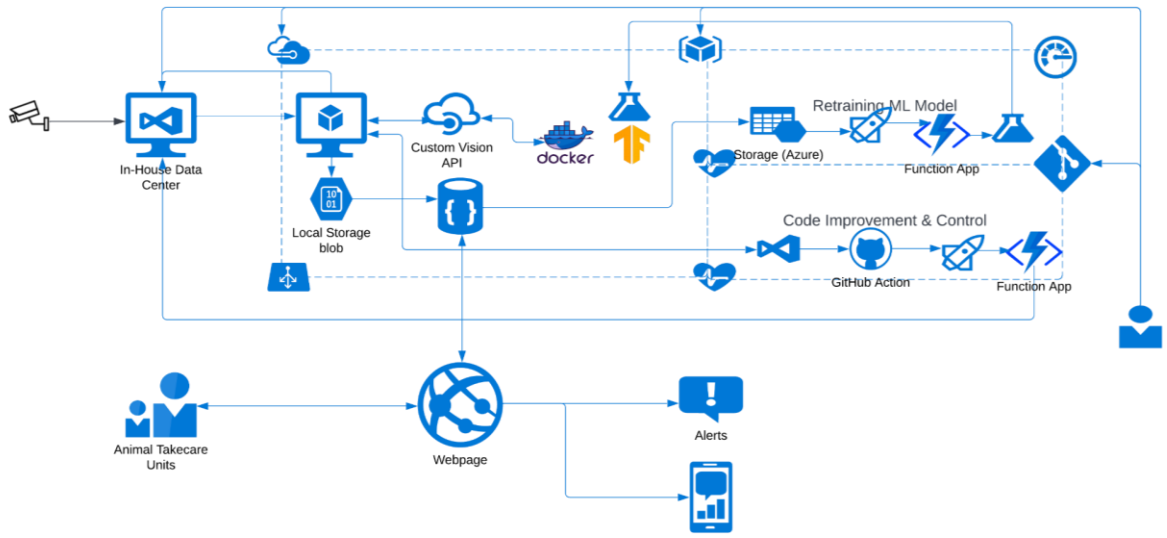

Fig. 5 Data Pipeline Diagram

As per flow charts Fig. 4 and Fig. 5 provided by the expert 100 Key points have been fixed for CCTV images, but how CCTV will detect stray cattle as such and send the relevant pics to the database center for action, was our next hurdle.

Artificial Intelligence, deployed over CCTV (Sur Aihik, 2021), seems to be the most convenient way to resolve the issue. Deep Learning Algorithms, fed with surplus amounts of Data can detect cows in an image. The location issue can be resolved using devices like a GPS sensor, which gives accurate location information, up to a few meters.

The Biggest challenge in developing such an accurate Deep learning model, is data. For this purpose, actual 5000 images Fig. 6 of cows from the locality were collected with the help of a Senior school teacher (leader) and five young social workers (Students). These images were taken from different angles, and during different times of day at varied locations. Web scraping was also used to get images of Cows from the Internet. To remove the possible confusion between cows and similar common animals like buffalo or Blue Bull, their images were also collected and used as negative images while training the Deep Convolutional Neural network (Khan *et al.*, 2020).

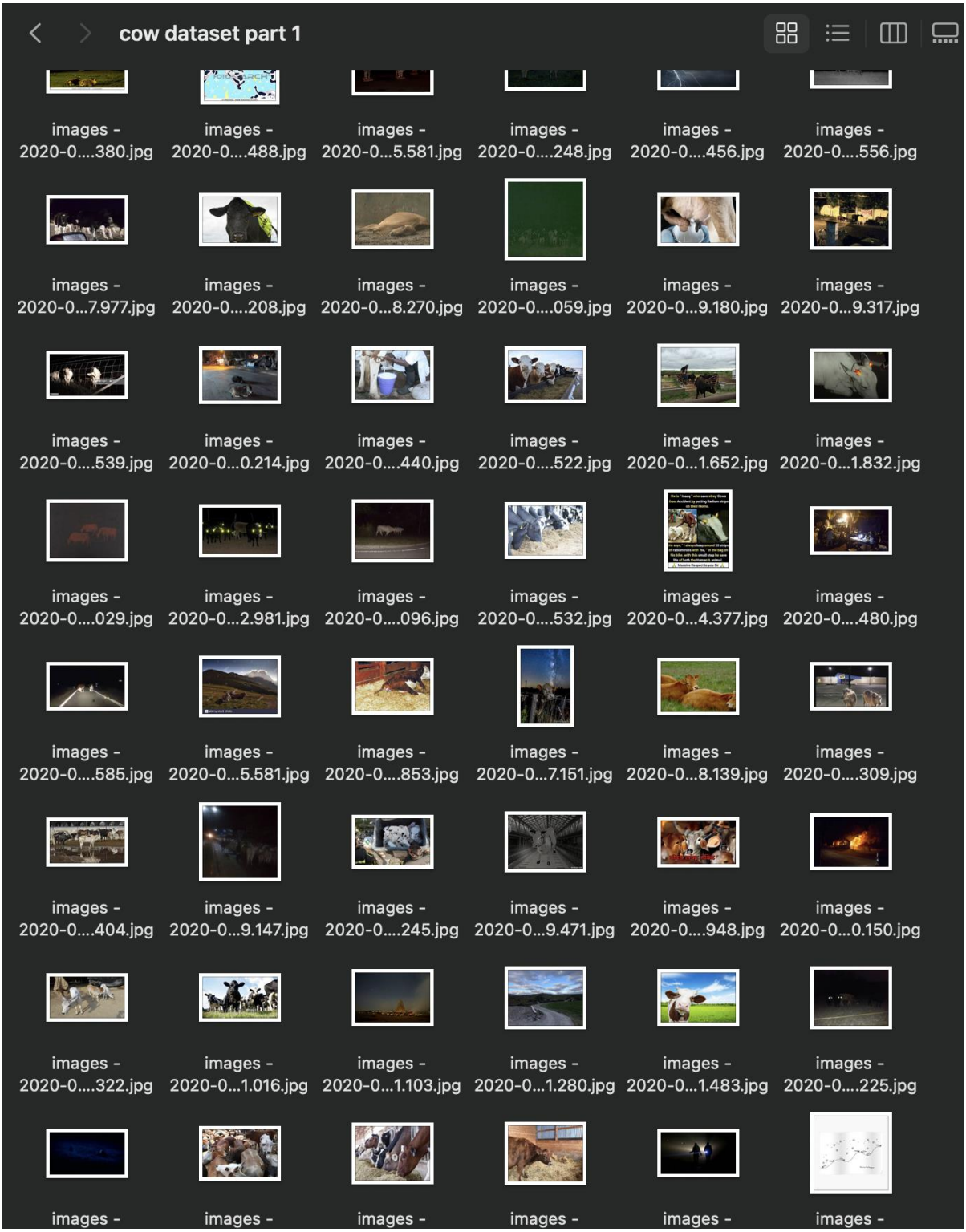

Fig. 6. Images of Cows to train the cameras.

The next challenge that the team faced, was image data cleaning and pre-processing, which will have to be followed by manual Image segmentation, to mark out areas in an image, where the cow is actually located. All the collected images were initially resized and reshaped to bring them to a uniform size and center cropped to a size of (224x224x3), this size was particularly selected for its compatibility with DCNN like Resnet (Khan *et al.*, 2020), VGGNet, etc, which were infect used at a later stage in the project.

To resolve the issues of overfitting, the dataset was further populated using Image augmentations by applying multiple transformations and filters.

For the purpose of Image augmentation, the following transformations were selected:
1. Upto 50 deg. Rotation 2. Horizontal Flips 3. Brightness 4. Zoom Levels
5. Shearing 6. Rescaling 7. Height Shift 8. Width Shift

Although all these transformations were applied at training time using the Tensorflow library, since it is a part of image processing, it's being mentioned over here. In addition to these transformations, Standard Deviation Normalization was applied overall images. Hence, to conclude there were 2 classes of positive (cow) images and negative (Cow like Animals - Buffalo, Deer, Blue Bull), each class with over 5000 Images.

Microsoft's VoTT tool was used to manually segment out and label Cow in each and every image. This step was very crucial as any deviations in marking segments can cause underfitting while training and wrong objects can be classified as cows. This process was followed on all the images and each Image was segmented as a cow or not cow. The dataset was now ready for Image segmentation purposes and the next step will be including, training the Image segmentation model and developing a DevOps cycle.

Transfer Learning is a powerful tool in Machine Learning that enables developers to utilize Deep Convolutional neural networks without explicitly coding them (Yamashita *et al.*, 2018). Tensorflow provides many DCNN like ResNet and VGGNet. Initially, ResNet was chosen, and hence its architecture and trained weights for the Image Net dataset were taken from the TensorFlow library (Weber *et al.*, 2021). However, later it was decided that since the entire pipeline was to be developed and deployed across Microsoft Azure, the image cleaning, processing, and ML model training, prediction and deployment shall be moved completely on the cloud premises. In practical application though, the Inhouse servers funded by local governments can be utilized instead of Microsoft Azure for the purpose of cost reduction and latency improvement.

Azure Cognitive service, called Custom Vision was utilized to prepare an Image segmentation model and deploy the same. The Image dataset was loaded on the cloud and Azure notebooks were used to prepare scripts that access Images present in blob storage and to process them to achieve a trainable dataset. Finally, the Custom vision model was trained and published and a precision of 72% was achieved, the results on real-world test images were also very satisfactory, and hence it was decided to move forward with this model at an initial stage. The deployed Docker contained the prediction instance, and an endpoint with REST API call could be used for prediction.

The next challenge was to prepare a scalable End to End pipeline to perform tasks including getting data from CCTV feed all the way to notify the concerned authorities. It was at this moment, also decided to make the pipeline almost infrastructure-independent, so that it can be deployed over govt-funded servers at a later stage, to reduce latency and cost. The pipeline majorly had 5 nodes:
1. Data Collection – User Mobile App/ CCTV with Raspberry Pi or Server
2. Real Time Db to store location and collected images, and to trigger next nodes of pipeline

3. Image Processing Script and ML model (Cow predictor)
4. Database to store all transactions
5. System to notify nearest concerned authority over telegram message, SMS, and E-mail (Fig. 7)

Fig. 7 Detected and identified cow whose pic has been sent to nearest nodal point for further action.

CCTV cameras of the city have to be connected to some kind of local server, and for testing purposes, a Raspberry pi with a simple OpenCV script to extract images from a continuous video feed was used. The pi device is also powered by a GPS device that helps in getting location data and Open Weather API is then used to extract weather data. The raspberry pi then uploaded these images and location, and weather data almost immediately in real-time No-SQL storage like Firebase. The Database, in return then triggers the next node of the pipeline, which extracts these images, processes them, and passes them to the deployed ML model.

The ML model returns a lot of vital information. The type of animal (Is cow present or not), number of animals with the accuracy and precision score. A threshold of 93% (Adjusted after multiple test runs) was chosen on the accuracy score to ensure no glitches. This piece of information is then stored in a database with a pending status and the authority spot nearest to the place of complaint filing is notified using Red Dot Algorithm. Red Dot algorithm is a newly devised algorithm that selects the nearest and the most effective node that can help to catch the animal (Dahiya *et al.*, 2016)

Red dot algorithm selects a node based on the following parameters:
1. Geographically nearest to the location of complaint registration
2. The number of pending/ unresolved complaints
3. Amount of workforce present

Once a node is selected it can accept/reject or pass the request for animal catching and if accepted, the status in the database gets changed to unresolved, until the animal is caught. A manual double-check can be kept on this part of the pipeline.

After detecting and identifying the cattle, the data center flows the information to the nearest nodal point/Social activist, who in continuation accept the request and move towards the cattle location to distract it from the main path to some fixed secure location. The cost content in this practice is very nominal Table 2 shows the cost factor for the recommended method.

Table: 2 Cost involved in CCTV with AI method.

CCTV Cameras Click pics every 15 mins (avg size 2mb)	Storage and web hosting Need **+Analytics +Crash Analysis +A/B Testing** (₹50 p.m DNS+ storage+db+Auth)	Computation Needs - 10call/sec **+Storage +Analytics +Reinforcement learning + ₹1000 VM instance**	SMS and other costs **{reduces with time and amount of sms}**	Total price for Government (Including Maintenance, Service, Cost to Company)	Cost per Image per month
30*24*(4) = 2,880 images p.m	5.76 GB: ₹9.62 +₹50	2,880 calls : ₹380 (₹0.132/image) +₹1000	2880 sms: ₹288 (10p/sms)	₹ 3000 p.m	₹1.041

5. Solutions and recommendations.

During Quality circle meetings on the issue of stray cattle following problems were identified out of which technological solution is possible for only one issue and for the rest problems certain recommendations have been given Table 3 to authorities and society as follows:

Table 3 – Identified problems and recommendations.

Problems Identified	**Recommendations**
1. Movement of stray cattle at night from nearby areas as their owner left them in the lurch, considering them useless. 2. Due to its religious values, plenty of food is offered by residents of Kurukshetra to stray cattle. 3. Movement of stray cattle at night on the roads while looking for shelter as per weather conditions.	It is recommended that through all public advertisement and social activities like 'Nukad Natika' a clear message has to be given to all residents who are looking after cattle at home must keep them with themself when cattle will at their old age. However, if the Govt. and the public consider it, then a good number of Goshalas Fig. can be created where such stray cattle can be taken care of by social activists. This can sort out the issue of shelter and food for stray cattle due to which they had to move here and there.

	However, detected and identified cattle can also be kept here when removed from accidental sites.
4. Almost zero visibility of cattle on road at night or on fog days.	It is recommended that proper light arrangements on roads and at key positions must be ensured.
5. Social activists did not know the exact location of the stray cattle so that action to survive can be taken care of.	After detection and identification of stray cattle by CCTV data collection centers send this information to the nearest noodle center operated by social activists and if a good number of GOSHALAs will be present this problem can be sorted out.

Punjab Govt. had resolved this issue by sending these stray cattle to 'Pashu Mandi' and from where some can be sold out and the rest can be sent to Goshalas Fig. 9. Social activists bring such cattle from all nearby areas to Pashu mandi which is held fortnightly at a fixed place (Jagga Rakhi, 2019).

Fig. 8 Gaushalas in the city.

6. Concluding Remarks and future scope

The conflict between humans and cattle is on the rise. This conflict has a negative impact on human well-being, health, and safety, as well as significant economic and societal costs. It also has an adverse effect on human health and safety. The ever-increasing number of stray animals is a major concern for the state government. The government has launched a number of initiatives to address the problem. However, no comprehensive remedy has been devised so far. In light of research, the current study has offered valuable recommendations to find a solution to the problem. Many innovative methods have been proposed to

address the problem of stray animals and to improve the situation, the control of these stray animals Government-led public awareness campaigns can aid in the implementation of this systematic shift.

- Using the available resources this research had made a significant solution, but at a large level Govt. has to take such tasks into its hands to sort out the issues.
- To make this solution at other heights a mobile app can be developed and distributed among the residents so that if they found such stray cattle anywhere they can click the pic of same and can send it through the same app to the data collection center so that such stray cattle can be detected and information can be sent to the nearest nodal center for further remedial action. The mobile apps can help to locate stray cattle exactly.
- A limitation has been detected that CCTV or mobile apps can tell only the present location of cattle, however, when social activists reach the same location there is a possibility that cattle may move on. Artificial Intelligence can provide solutions to such issues if used properly.

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