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Suspicious Activity Detection and Tracking through Unmanned Aerial Vehicle Using Deep Learning Techniques

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ABSTRACT
This paper focuses on crime detection that is extensively used in real world visual monitoring applications like video surveillance. Crime prevention is widely implemented in some countries, through police force and in many cases, private policing methods such as private security and home defense. Implementation of such private and public security could not completely eradicate such awful crimes. Therefore, there's a requirement for credible and effective surveillance in order to diminish the brutal and skeevy crimes. The reason for occurrence of many offences is late communication and unestablishment of authentic security or surveillance system .It's tragic that more than 20000 people lost their lives in Hit-and-run cases in India alone. Many notorious criminals who deserve dreadful punishment for their recklessness fly the coop due to the lack of evidence. Many other instances can be drawn out where there's a requirement for an organized system of surveillance like ATM's, shopping malls, etc. To stop such awful offences there's a need for genuine security system. The idea of an Intelligent Unmanned Aerial Vehicle (UAV) proposed in this paper, is inspired from various sources [1], that is capable of monitoring its surroundings constantly for suspicious or illegal activities. Whenever it encounters a suspicious activity, it automatically captures and processes the scene, sends out an alert to the administrator and waits for his/her command. The main intention is to constantly monitor the surroundings using a bird shaped surveillance device, with very minimal human intervention.

Key words: Convolutional Neural Networks, Radio Frequency Identification, Recurrent Neural Networks, Unmanned Aerial Vehicle.

1. INTRODUCTION

Invention and creation of intelligent devices, capable of flying around with an equipped camera to capture the surroundings from an aerial view, in a technological field can be termed as path -breaking. Unmanned Aerial Vehicle's (UAV) capable of flapping around the sky with minimum human interventions are termed as 'DRONES'. Over the past few years, drones have gained an utmost importance especially in the field of business and governmental organizations. Also considering the sales of UAV machines, they were on the rise with each passing year, and more and more people are embracing the idea of owning such devices. With all this attention, these unmanned aerial vehicles are now finding more practical and innovative uses and applications. This paper supports the implementation of one such practical application of UAV device which is capable of gliding in the sky and constantly monitoring the surroundings to track suspicious activities. Our device resembles the shape of an aerial creature like bird, embedded with various technologies and hardware components. It constantly keeps flying around the sky like a usual creature and triggers a click of an unusual activity, which later transfers it to the administrator and waits for his/her command. It is capable of following the suspect on the request of the administrator and can constantly share its GPS location to its nearby police station to notify the officials. Our device helps the government officials to catch the brutal criminals with minimal human intervention.

This work could be implemented with an integrated use of software technologies and hardware components. The component which resembles the shape of a bird, designed to fly around is affixed with an effective processor RASPBERRY PI 3 [6]. It is extended with a camera module and performs the task of image processing for the captured image. It finally delivers a processed image to the administrator. It waits for the administrator command, if the administrator commands the bird to follow the suspect, then /the intelligent device switches on its GPS location and shares it with the nearby police stations along with an alert regarding crime. The communication link between the device and administrator is laid through Radio Frequency Identification (RFID) and between device and police station through GPS/GSM technology [7]. The device uses the shortest path

algorithm (Dijsktra's) to find the nearby police station. Invention and implementation of such intelligent device is very much necessary to control the tremendously increasing crime rate in current world.

There are many areas in our country that are highly sensitive and need micro monitoring as it will be a very tedious task to manually monitor these places. This device serves this purpose in relieving manual efforts required and has a wide range of scope in multifold industries of the society. Some of the applications where the UAV can be used:

- One of the primary application can be in military, especially near the LOC to monitor any threats in advance and take appropriate actions. This device can also be used to surveillance any potential attacks from enemy countries at the border and counter-act accordingly to avoid risk of loss of life.
- In archaeology, this UAV can be used to protect sites from squatters, builders and miners.
- Outside Banks and ATMs to detect any suspicious activities of theft and send an alert to the nearest police station to help victims.
- In less crowded/remote areas and other highly sensitive areas where human intervene is not possible.
- Pipeline security, VIPs home security, road patrol and antipiracy.

Similar solutions have been proposed over years to detect suspicious activities using UAVs. This paper focuses on crime and criminal offence, if any abnormality appears in the surveillance video, the spy air vehicle reports to the administrator [1]. It uses Deep Neural Networks (DNN) to learn and predict future frames. For this in the preprocessing step, raw video is considered and converted to frames in input dataset which are further converted to grayscale. Then CNN is used for feature extraction and classification [2]. The usage of the UAV along with conceptual design is shown [3].

2. PROBLEM STATEMENT

The world has witnessed an immense growth in technological advancement and implementation of knowledge into human welfare, still there are enormous cases where we are unable to track and punish the convicts committing brutal crimes. Miserable crimes like money laundering, robberies in the crowded areas, hit and run cases, etc are posing a great threat to the country's fame and economic trend in the global market. Most robberies are committed by the offenders using some type of weapon against a lone victim. According to the surveys from many reputed organizations, the money robberies at ATMs are generalized as follows:

1. Most occur at night, with the highest risk between midnight and 4 a.m.
2. About 15 percent of victims are injured.
3. The average loss is between $100 and $200.

Even after committing such atrocious crimes, convicts are hopping away due to the late communication and an unorganized surveillance system. Implementation of CCTV camera have somewhat minimized the ATM thefts and robberies at initial stages, but now the criminals are using their brain power to manipulate the cameras and swiftly completing their atrocious activities with evil mind.

Therefore a powerful device is necessary which keeps track of its surroundings guarding from dreadful crimes. The problems that pose a threat to the implementation of genuine surveillance are generalized as follows:

- Most of the CCTV cameras installed in the highly crowded areas like malls, or sparsely populated areas like ATMs are macro sized which could be visible to everyone. Is there an alternative to hide them from the criminals? Can we implement any such micro sized surveillance?
- Is it possible to implement a surveillance which informs the police during the occurrence of crime?
- Even if a convict succeeds in committing the crime, can he be tracked till the police reaches the crime scene?

The answer is 'YES'. Our concept depicts the process of creating an intelligent device which resembles the bird's architecture and put on its surveillance every minute without human intervention

3. OBJECTIVE

Our prime objective is to design an artificially intelligent device that will work as a spy and can detect the suspicious activities happening within its vicinity and send an alert to the administrator for his/her command and track the suspect accordingly as depicted in the Figure 1. This helps in establishing a secured society with limited human intervention by constantly monitoring the activities around it and intimate to the nearest police station on detecting any suspicious activity.

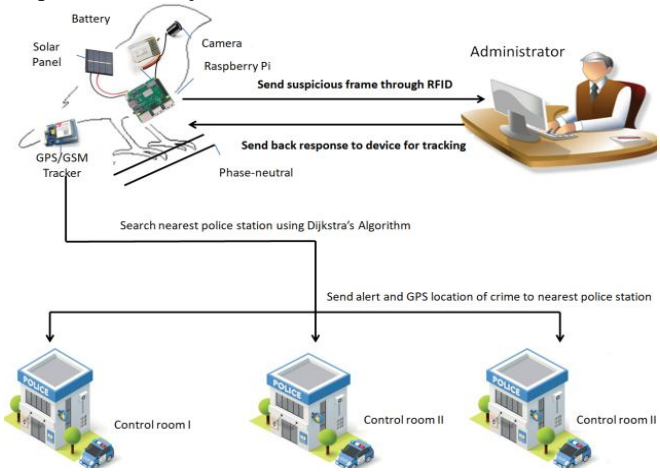

Figure 1 : Block diagram shown above depicts the establishment of a wireless network in the Robot Bird with the administrator and also with the traffic control unit

4.TECHNICAL DESCRIPTION AND METHODOLOGY

The smart device which flutters around the sky inspecting its surroundings comprises of various hardware components. It consists of a high-quality camera which resembles the shape of an eye, through which continuous surveillance is being performed. It is embedded with a highly effective microprocessor Raspberry pi 3, which could be trained to detect the suspicious activities through 'Image Processing' techniques [5]. Whenever a suspicious or a criminal activity is detected the corresponding frame is classified and sent to the administrator for approval and perform the tracking of the suspect as per the instructions given by the administrator.

4.1 Suspicious Activity Detection Mechanism

The mechanism of detecting the suspicious activity can be performed by convolutional and recurrent neural networks [5]. The trained image processing model classifies the captured frames into three classes as shown in Figure 2:

- Criminal activity
- Suspicious Activity
- General or Safe Activity

Figure 2: The above figure gives brief idea of how the classes can be defined in the dataset

4.2 Convolutional Neural Network

Convolutional Neural Network is used for the purpose of extracting high-level features of the frames and reducing the complexity of the input [8]. A pre-trained model called inception developed by Google, could be used in this network model. Inception model is trained with the Large Visual Recognition Challenge dataset called ImageNet [4].

Transfer learning is a technique that plays a key role in optimizing the training by procuring a fully trained model for a set of categories like ImageNet and retrains from the existing weights for new classes. The transfer learning technique could be used in this model to perform effective classification of the detected frames.

4.3 Recurrent Neural Network

The second neural network used could be a recurrent neural network, the purpose of the above-mentioned network is to sense the sequence of the actions portrayed. As shown in the Figure 3 comprises of a LSTM cell in the first layer, followed by two hidden layers with corresponding activation functions and the output layer is a three-neuron layer, which gives the final classification .

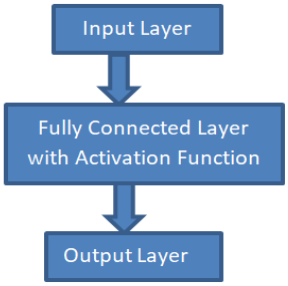

Figure 3: Flow diagram of Recurrent neural network where the output layer gives the final classification of the frame set

4.4 Methodology

The flying device continuously monitors the activities and extract the frames from the live streaming video. Figure 4 below depicts the video classification flow, where the frame is extracted periodically every 0.2 seconds and the prediction is made using the inception model. Instead of extracting the result of the last pooling layer that had a feature map of a single frame, sequence of frames can be fed to the RNN system. This is carried out in order to classify a segment of the video instead of individual frame.

Therefore, fifteen feature maps generated by the inception model prediction are stored, which is equivalent to three seconds of video. Then, the fifteen obtained feature maps are grouped into one single pattern, which will be the input of the second neural network i.e, the recurrent neural network to obtain the final classification of the extracted feature frames.

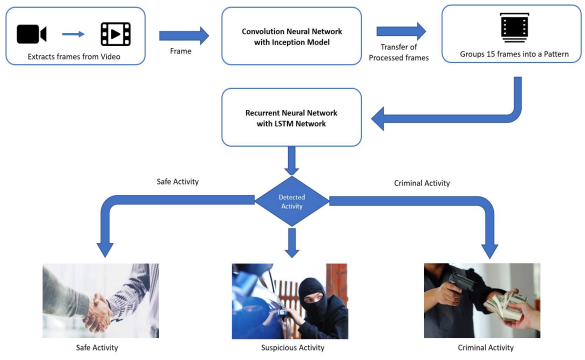

Figure 4: Video classification architecture that describes the flow of image processing performed to detect the suspicious activity

At the end, the video in real-time is classified every three seconds into either safe, suspicious, or criminal activity. Once the class of the frame is detected an alert is sent to the administrator along with the suspicion detected frames in case of suspicious or criminal activity through RFID

technology. The administrator reviews the frames and sends the command to the device which in turn sends an alert about crime to the nearest police station using GSM technology and tracks the suspect with the instructions from the administrator.

5. TRAINING DATASET

The dataset that can be used for training the network comprises of 150 minutes of screening divided into 38 videos. Most of these videos are recorded on security cameras of stores and warehouses. This considers each 0.2 seconds video as a single frame thereby creating a dataset with 45,000 frames feasible for training the model. The whole dataset is labeled as per the requirement and divided into groups: 80% for training and 20% for testing.

6. HARDWARE AND SOFTWARE REQUIREMENTS

The bird-like UAV device is designed to have a camera fixed on the bird's eye that provides 360 degrees view for absolute surveillance. Raspberry Pi can be used as processor to facilitate image processing. Image processing is carried out by transfer learning technique using a two layered neural network. This two layered network can be implemented with a Convolution Neural network and Recurrent Neural Network. A battery which is always charged through the phase-neutral pair of overhead supply, is used to provide power at the time of its flight. It also has a solar panel installed along with the battery which stores and retains solar energy which can be utilized to increase its flight time when the battery requires recharge. GPS tracker unit is integrated in the device to fetch device's current location. The data transmission between the administrator and the device can be achieved by RFID technology. In case of any suspicious activity, alerts with location details are communicated with the nearest police station using GSM technology.

7. IMPLEMENTATION

This mechanism can be implemented with python. The Python's OpenCV module can be used to segment the video into frames and resize them to required pixels. Once the frames are extracted, the prediction is made using the inception model. Transfer value obtained as the result of each prediction represents high-level feature map extracted from the corresponding frame, which can be saved in the transfer_values variable and its respective labels in the label_training_set variable. Once these variables are obtained, these can be divided into groups of 15 frames. The result is stored in the resultant_transfer variable. The code to obtain transfer_values is as follows:

```
frames_num=15
count = 0
resultant_transfer =[]
for i in range(int(len(transfer_values)/frames_num)):
    inc = count+frames_num
    resultant_transfer .append([transfer_values[count:in    c],la
bel_training_set[count]])
    count =inc
```

The obtained data can be used to train recurrent neural network. This network can be implemented using Keras. The following code can be used for model creation:

```
from keras.models import Sequential
from keras.layers import Dense, Activation
from keras.layers import LSTM
chunk_size = 2048
n_chunks = 15
rnn_size = 512
model = Sequential()
model.add(LSTM(rnn_size, input_shape=(n_chunks, chunk
_size)))
model.add(Dense(1024))
model.add(Activation('relu'))
model.add(Dense(50))
model.add(Activation(sigmoid))
model.add(Dense(3))
model.add(Activation('softmax'))
model.compile(loss='mean_squared_error', optimizer='adam
',metrics=['accuracy'])
```

The code above describes the construction of the model. The next step is about training it:

```
data =[]
target=[]
epoch = 1500
batchS = 100
for i in resultant_transfer :
    data.append(i[0])
    target.append(np.array(i[1]))
model.fit(data, target, epochs=epoch, batch_size=batchS, ver
bose=1)
```

Classification of videos can be done after the model is fully trained.

8. CONCLUSION

Intervention of artificial intelligence in replacing tedious manual monitoring of surveillance videos has always yielded amusing results. In this paper, a UAV device is used for crime detection in surveillance videos. The major advantage of the current approach is the usage of Raspberry Pi to facilitate effective and efficient Image processing at the device level. The earlier proposed approach [1] suggested the use of Arduino Uno, which does not support efficient image processing and video stream is processed at administrator

side. Due to this every frame captured needs to be continuously transmitted to the administrator that requires. CNN model is used for detecting suspicious activity and RNN is used for matching that improves performance. Implementation of this architecture is the focus of my future work.

9. FUTURE SCOPE

The device application can be extended to other streams with further enhancements in battery power, size, algorithms based on surveillance specific requirement and technology advancement. This device can be used in Agriculture to monitor vast fields and extract any abnormal crop images, making sustainability in prior by assessing crop health, spot bacterial or fungal infections on trees, with a slight modification in GPS/GSM technology to send out alerts to nearest police station. Human intervention can be reduced by implanting artificial intelligence in the device so that it can track the suspect autonomously.

The bird size can be further reduced to microscopic level so that it does not come under notice at all. Motion detection algorithm can be used so that image processing will be initiated only when motion is encountered in the scene, which can reduce battery consumption involved in continuous processing.

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