

Raspberry pi based Surveillance Robot for Real Time Intrusion Detection and Tracking

Aniruddh Bhagwat 405B005

Manav Chouhan 405B018

Rohit Kshirsagar 405B036

Prashant Kumar 405B049



Introduction

Robots can be used at a number of places, making our daily life easier. Raspberry-pi based robots are easy to implement, require minimum cost input and solve important problems.

We propose to build a raspberry-pi based robot for intrusion detection.



Problem Statement

Make a surveillance robot to ensure safety of the house, identify the intruder, track him and alert the owner.



Motivation

With increase in workforce of the country, the houses remain vacant when it's members are out there in offices. Hence there is :

- Need to ensure security of house.
- Need of an assistant for house.
- Need to alert owner if someone unwanted comes in.

We aim to build a surveillance robot that solves the above needs.



Objective

Once completed the robot will solve the following requirements:

- Identify the person, when the person enters the premises.
- Alert the owner, send an image of the person to the owner.
- Identifies the person as known or unknown while following.
- Take next set of instruction from owner and work accordingly.
- Send the captured activity to the owner after getting reset command.
- Return to its original position.

Idea Evaluation Matrix



Scoring 1 = Low 2 = Moderate 3 = High	Different or Better	Delivers Value	Doable, Practical	Potential for early adopters	Score
Person Identification, Communication & Tracking Robot	H	M	H	H	11
Domestic Help Robot	M	H	L	M	8
Home Automation Robot	L	H	M	H	9

IDEA MATRICES



I Matrix

IDEA	Deliverables	Parameters Affected
Increase	It increases the security of the house.	Performance
Improve	The communication between user and robot	Integration between human and robot.
Ignore	Stops following if person is known.	Identification

IDEA MATRICES



D Matrix

IDEA	Deliverables	Parameters Affected
Deliver	Delivers efficient performance by following person.	Tracking and communication
Decrease	Decreases the concern of security of house.	Security
Drive	Facility to send videos, tracking.	Navigation, Identification

IDEA MATRICES



E Matrix

IDEA	Deliverables	Parameters Affected
Educate	Educate people regarding security	Project Users
Eliminate	Eliminates the risk of intrusion.	Security

IDEA MATRICES



A Matrix

IDEA	Deliverables	Parameters Affected
Accelerate	Accelerates the communication with user	Communication
Associate	Works with a processing unit to process data.	Processing
Avoid	Avoids latency in communication by using UDP protocol and telegram for communication. Avoids risk of intrusion.	Communication and Security



Hardware Requirements

- Raspberry Pi 3B
- Ultrasonic Sensor Module HC-SR04
- ROBOT Chassis
- Wheels, DC Motors
- Raspberry pi 5MP camera
- Bread Board
- Resistor (1k)
- Motor Driver L298 2A
- Connecting wires
- Power supply or Power bank



Software Requirements

- Python3 and necessary libraries.
- Text Editor
- Raspberry pi OS
- VnC Server
- Telegram app

Literature Survey

Title	Published Year	Basic Idea
Human Detection using HOG-SVM, Mixture of Gaussian and Background Contours Subtraction	2017	<ul style="list-style-type: none">●Human detection using HOG-SVM algorithms
Human Detection and Tracking for Video Surveillance: A Cognitive Science Approach	2017	<ul style="list-style-type: none">●Detect human beings in any frame.Find the movement patterns of the humans in the frame.
Obstacle Detection and Avoidance Robot	2018	<ul style="list-style-type: none">●Detect and avoid any obstacles in the path.Focuses on the edge detection for higher accuracy.
Design and Implementation of an Autonomous Indoor Surveillance Robot based on Raspberry Pi	2019	<ul style="list-style-type: none">●Identify the person and alert the owner.●Take necessary actions through the commands given by the owner.

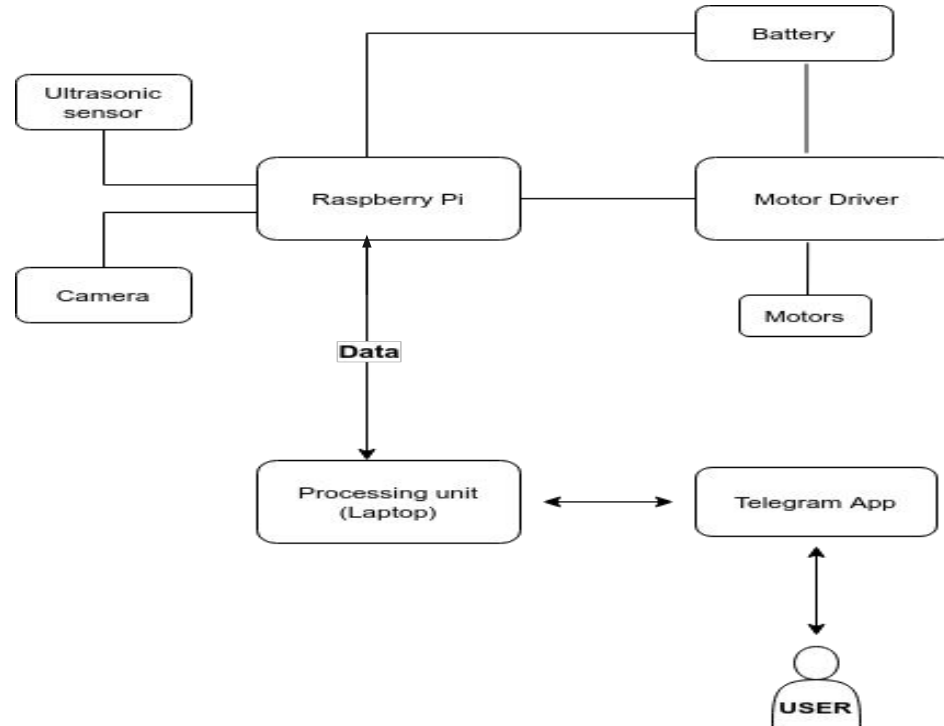


System Overview

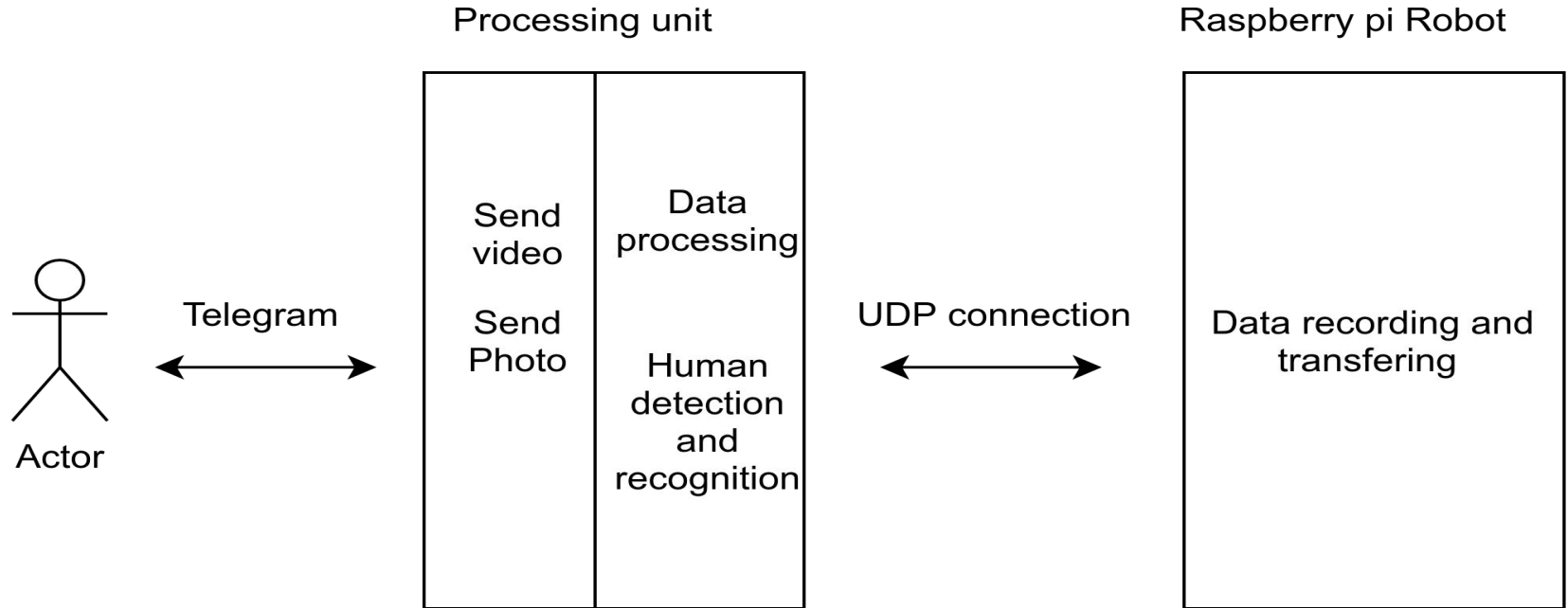
The product is a **robot** which is being developed to ensure security of a house. It is a raspberry pi based module with a camera ultrasonic sensor mounted on it. It is navigable, the wheels are moved by the motors installed which are powered by a battery.

There is also a processing unit (Laptop) on which the processing of data received from robot takes place.

System Architecture



Component Diagram



Requirements



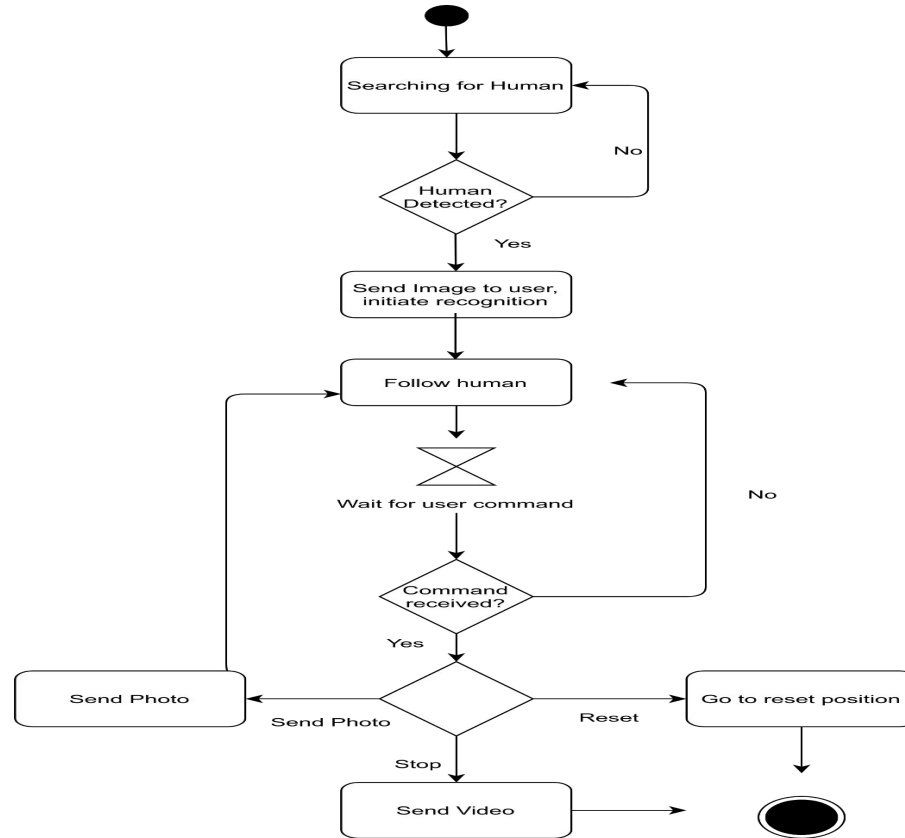
Functional Requirements:

1. Identification of person, alerting the owner.
2. Communication between user and the robot.

Non-Functional Requirements:

1. Performance: The performance of the system depends highly on accuracy of the machine learning algorithms.
2. Security: Only the authenticated user should be able to send commands to the system. The images/videos captured from the system should be sent to the appropriate user only.

Activity Diagram



Methodology



How it's going to work:

1. Communication between raspberry-pi and the processing unit(Laptop) through UDP connection.
2. Communication between the processing unit(Laptop) and the user over Telegram App.
3. User gives commands to raspberry pi through processing unit.



Single Shot Detection Algorithm

Single Shot detector takes only one **shot** to **detect** multiple objects present in an image using multibox. It is significantly faster in speed and high-accuracy object **detection** algorithm.

SSD divides the image using a grid and have each grid cell be responsible for detecting objects in that region of the image. **Detection** objects simply means predicting the class and location of an object within that region.

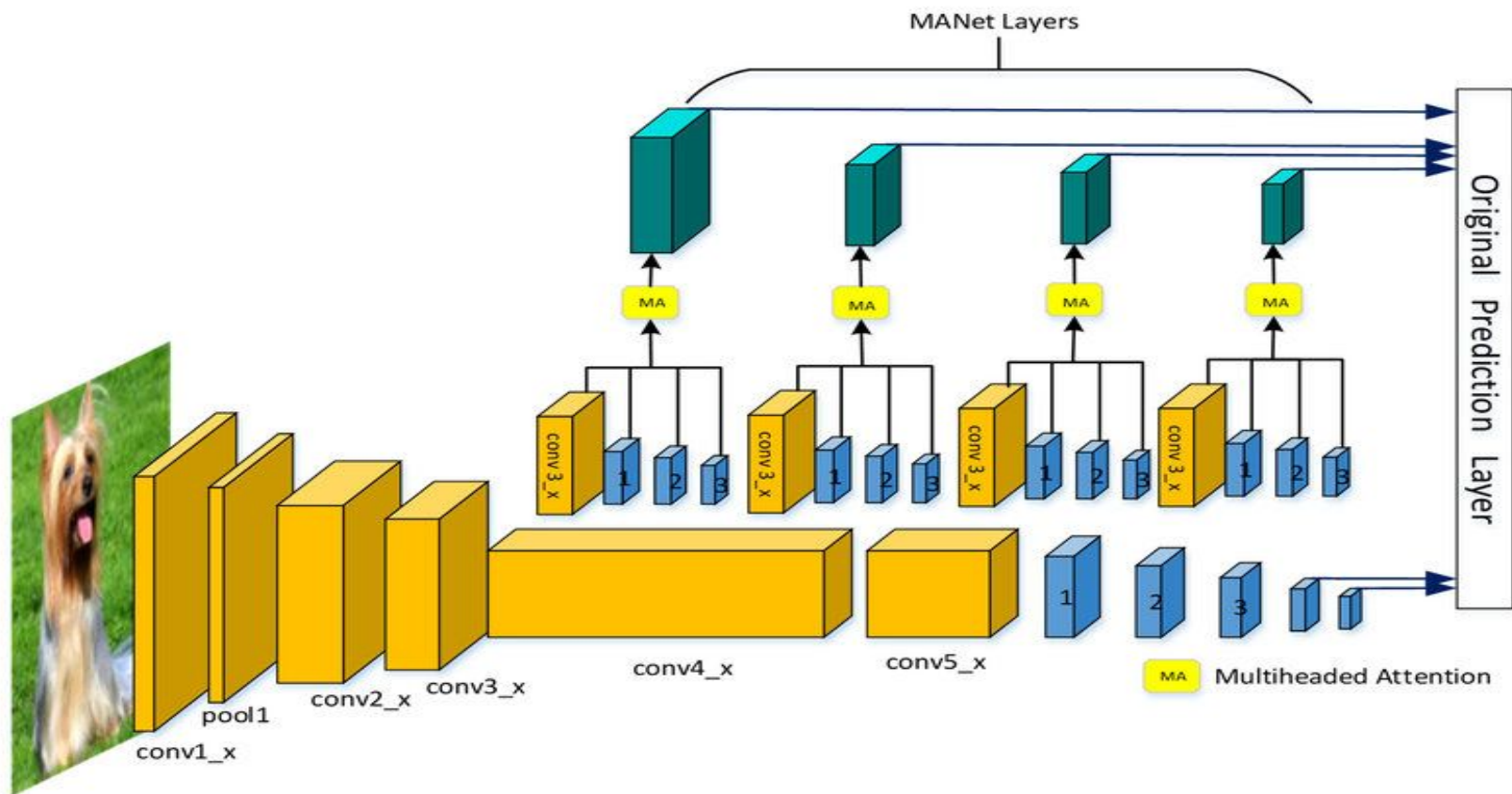


Fig: Single Shot Detection Algorithm

Local Binary Pattern

Local Binary Pattern (LBP) is a simple yet very efficient texture operator which labels the pixels of an image by thresholding the neighborhood of each pixel and considers the result as a binary number.

The algorithm uses a concept of a sliding window, based on the parameters radius and neighbors.

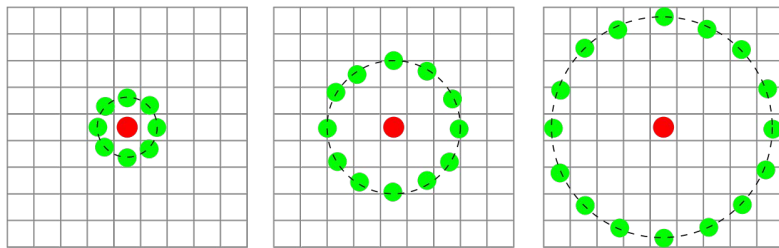


Figure: Three neighborhood examples used to define a texture and calculate a local binary pattern (LBP).

Frontend Images





Conclusion

Even though the development cost is kept as low as possible, the system is capable of navigating while engaged in surveillance, recognizing intruders via facial recognition.