Robot Navigation using Arrows

Project Supervisor:
Dr. Tanmoy Hazra

- Priyanshu Barua (111815029)
- Shubham (111815037)
- Shreyansh Gupta (111816034)
- Raushan Kumar (111816029)

Outline

The project can be divided into the following phases based on skills and techniques that we will learn and implement

- Literature survey
- Data collection and dataset building
- Training and testing of neural network
- Building the robot and incorporating the neural network

Introduction

- The project will involve building a four wheeled autonomous robot that will navigate using images of arrows.
- We will train a neural network on a self-made dataset of arrow images. The dataset will have the image matrix as it’s input and a direction corresponding to it as the target output.
- Based on the arrow shown the robot will move in the respective direction.

Motivation

- The first step towards computer vision. The motive of this project is solely educational.
- The culminated knowledge from our past project to build a voice controlled robot and the knowledge from this project all connects to our final goal.

“A fully autonomous robot that can be a constant companion and support to people whether in their houses, schools or offices.”

Literature Survey

1. Customizing kernel functions for SVM-based hyperspectral image classification – Baofeng Guo, Steve R. Gunn, R. I. Damper
2. Hyperspectral image classification using two channel deep neural networks – Jingxiang Yang, Yongqiang Zhao, Chen Yi
3. Robot navigation using camera by identifying arrow signs – Jongan Park

Customizing Kernel Functions for SVM-based Hyperspectral Image Classification.

- Support vector machines have been used for image classification. The paper suggests a kernel function different from the usual kernel functions like the Gaussian Kernel, Histogram Kernel and Chi Square Kernel.
- Kernel functions are used for increasing the dimensionality of input features thus allowing more complex decision boundaries for classification.
- The weighted kernel proposes that only relevant features should be complexed and not all the features to prevent unnecessary complication of the function causing overfitting.

Customizing Kernel Functions for SVM-based Hyperspectral Image Classification.

Research Gaps

- Support vector machines for multiclass classification requires the One-vs-All algorithm. Which complicates the classification process. This can be achieved much more easily using neural networks with cost of higher training time.
- Selecting the features to apply the kernel function takes time. In the case where different features are relevant to different inputs, the advantage SW kernels is lost.
- The paper does not state the accuracy gain from using weighted kernels.

Hyperspectral Image Classification using Two Channel Deep Convolutional Neural Network – Jingxiang Yang, Yongqiang Zhao, Chen Yi

- Convolutional Neural networks are the most popularly used approach for image classification and recognition.
- The activation function suggested in the paper is the sigmoid function or the ReLu function (Rectified Linear Unit). The ReLu function has an advantage over the sigmoid function as it has a well defined slope. Whereas sigmoid function has very small values of slope as it approaches 1 or 0 hence gradient descent slows down towards the end.
- The two channel refers to the two deep convolutional layers. First for restoring the outline of the target in the image and the second to extract detailed texture information to form relevant features for classification.

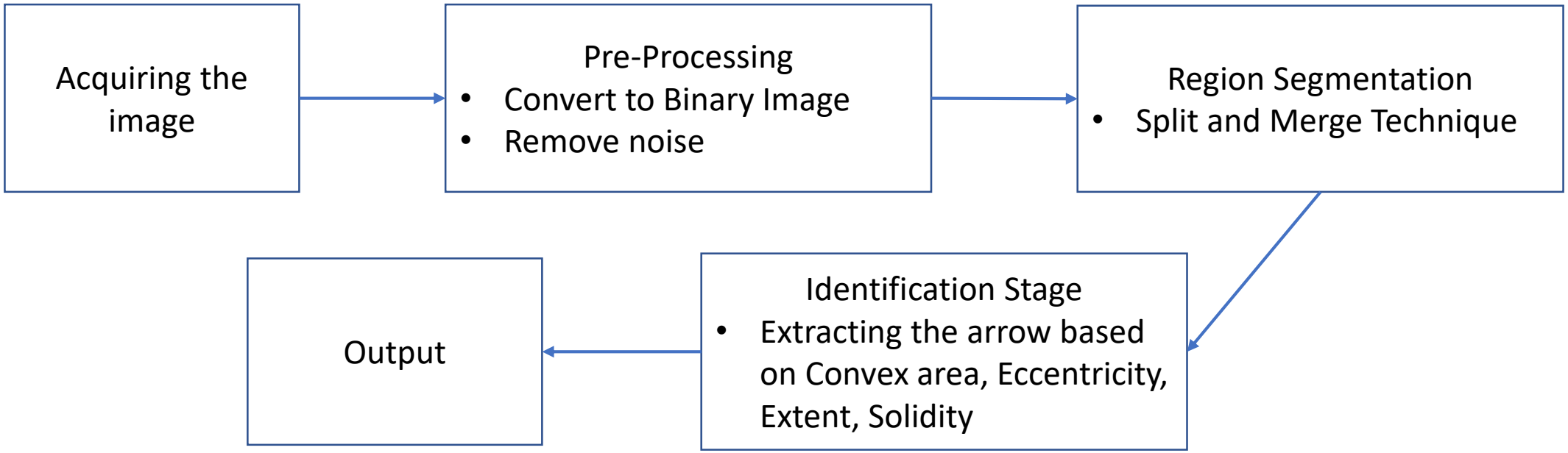
Hyperspectral Image Classification using Two Channel Deep Convolutional Neural Network – Jingxiang Yang, Yongqiang Zhao, Chen Yi

Research Gaps

- As it is a deep neural network extracting large number of complex features from the image, a large training, cross validation and testing set is required to achieve satisfactory results.

Robot Navigation using Camera by Identifying Arrow Signs

- Suggests image processing algorithms that can be used to achieve highly accurate robot navigation.



Robot Navigation using Camera by Identifying Arrow Signs

Research Gaps

- It suggests a brute force approach for identifying the arrows. As a result of this, every direction has to be explicitly programmed.
- The paper tests the proposed method on only two directions: left and right.
- As it involves a large number of steps the method proves to be inefficient in the case of real time image classification when a large variety of images have to be classified.

Problem Statement

The project will involve

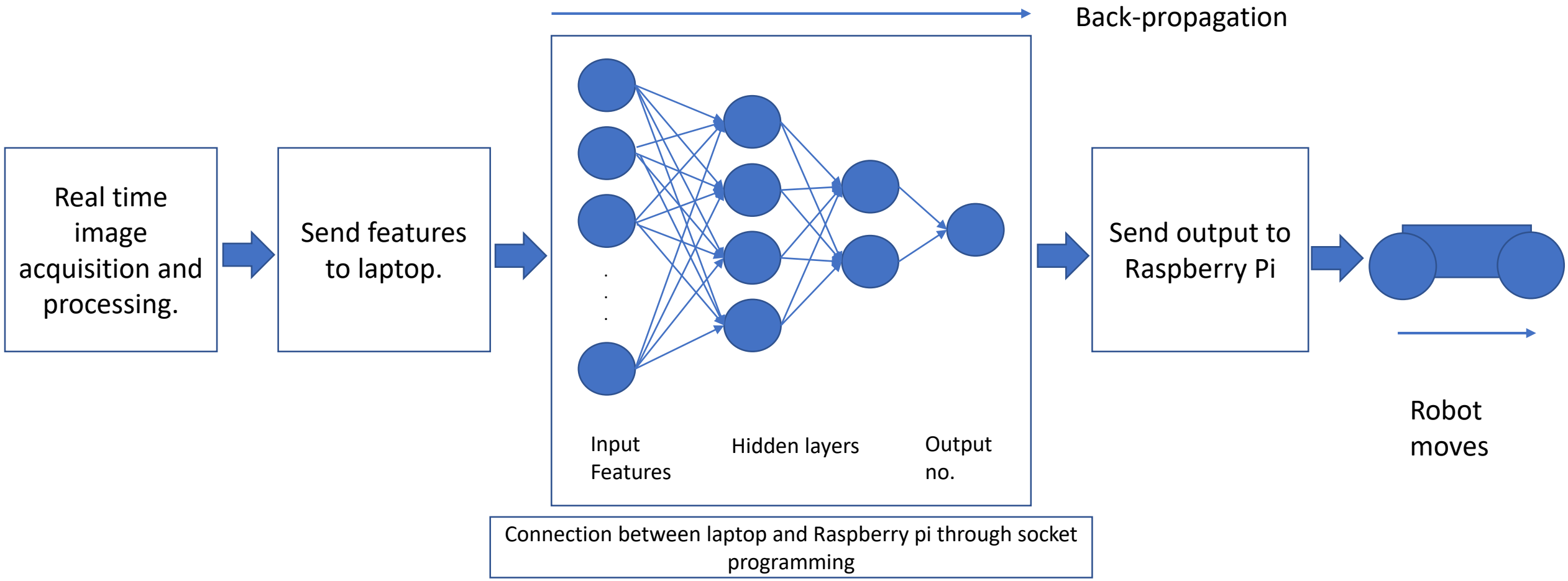
- Building the neural network with the right features to achieve satisfactory accuracy.
- Real time extraction of arrow sign from captured image.
- Communication between Raspberry Pi and laptop that will be running the algorithm.
- Controlling the motors based on output of the algorithm.

Objective

To build a robot with the following features

- Ability to recognize arrows. That is determine the direction in which it is pointing.
- Based on the determined direction it should move accordingly.
- It should be completely autonomous.

Methodology



Conclusion

This project is an opportunity for us to learn the following

- An introduction to computer vision.
- Robotics.
- Gives an insight to software projects.
- Time management.
- Teamwork.

Future Scope

- Improve the image processing techniques for better image extraction.
- Extend the neural network for object detection and not just for arrows.
- Replace the neural network with a convolutional neural network to skip the image processing step.
- Incorporate features from the past project to make the robot more versatile.
- Use image classification for path finding.

References

- Customizing kernel functions for SVM-based hyperspectral image classification – Baofeng Guo, Steve R. Gunn, R. I. Damper (2008)
- Hyperspectral image classification using two channel deep neural networks – Jingxiang Yang, Yongqiang Zhao, Chen Yi (2016)
- Robot navigation using camera by identifying arrow signs – Jongan Park (2008)
- An architecture combining convolutional neural network (CNN) and support vector machine (SVM) for image classification – Abien Fred Agarap (2017)
- Very deep convolutional neural network based image classification using small training sample size – Shuying Liu, Weihong Deng (2015)

Thank You