OBTAINING 3D INFORMATION FROM 2D IMAGES EFFICIENTLY USING FEATURE EXTRACTION AND LASER DOT PROJECTION

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Abstract. A system to extract 3D information about a space was created that could be trained simply in a matter of minutes. The system, nicknamed "Constellation", was designed to be implemented in situations requiring rapidly updating computations and environmental awareness, to run on relatively inexpensive hardware, and to perform its tasks with limited human intervention. To achieve this, Constellation uses a combination of hardware and software components, focused around a set of artificial neural networks to extract features and a physical grid of points refracted from a single laser. A Python 3.6 implementation of the system was tested on two machines in a variety of environments, and produced an average of x times faster environment generation as other comparable algorithms or approaches to similar problems.

1. Introduction

2. Background

2.1. Neural Networks

A human brain is composed of billions of neurons, connected and excitable cells which allow humans to be intelligent. Each neuron's dendrites receive signals from other neurons. If the these electrical signals exceed a threshold, the neuron fires, thereby propagating a voltage out of its synapses and on to other neurons. Together, these neurons form an extensive network, where an immense set of sensory input it processed alongside expected outputs. The purpose of artificial neural networks is to simulate this same network of interconnected neurons using mathematical properties to emulate electrical signals and approximate complex functions

2.1.1. Artificial Neurons

An artificial neuron is an approximate mathematical model of a biological neuron, and is intended to fulfill similar purposes. Each artificial neuron has multiple inputs from other neurons. Along with the inputs, each neuron has a weight for each input, a bias term, and activation function, and only one output. The output of one neuron travels to other neurons and becomes of their inputs. The output of a neuron is expresses mathematically for n inputs x and weights w, a bias term b, and activation function $f(x)$ as follows:

$$activation = \sum_{i=0}^{n} x_i w_i + b$$
$$output = f(activation)$$

Mentioned above, weights are positive or negative numbers which scale the effect or relevance of their accompanying inputs on a neuron's single output. Besides the weights, an important component of a neuron is the activation function.