

# Scalable Gunshot Detection Systems with Convolutional Neural Networks

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**Abstract**—Many cities with gunshot detection systems depend on expensive systems that rely on humans differentiating between gunshots and non-gunshots, such as ShotSpotter®. Thus, a scalable gunshot detection system that is low in cost and high in accuracy would be advantageous for a variety of cities across the globe, in that it would favorably promote the delegation of tasks typically worked by humans to machines. A convolutional neural network (CNN) was trained on a variety of sound data to recognize gunshots. This model was then deployed to a Raspberry Pi Model 3 B+ with an SMS modem attached. The findings generated by this research project have the potential to expand the current state of knowledge regarding sound-based applications of CNNs, and while simultaneously reducing the amount of jobs that require human input, the results of this project could very well increase the standards of safety for a city's residents.

**Index Terms**—machine learning, neural network, sound classifier, edge programming

## I. INTRODUCTION

Properly implementing a gunshot detection model to be used on a city-wide array of microcontrollers will enable automation of what previously required dedicated teams of human operators to perform. Further, it will demonstrate the capabilities of deep learning architectures in recognizing patterns from large amounts of sound data.

## II. EASE OF USE

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Number equations consecutively. To make your equations more compact, you may use the solidus ( / ), the exp function, or appropriate exponents. Italicize Roman symbols for quantities and variables, but not Greek symbols. Use a long dash rather than a hyphen for a minus sign. Punctuate equations with commas or periods when they are part of a sentence, as in:

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### E. Some Common Mistakes

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- In American English, commas, semicolons, periods, question and exclamation marks are located within quotation marks only when a complete thought or name is cited,

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- There is no period after the “et” in the Latin abbreviation “et al.”.
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An excellent style manual for science writers is [7].

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TABLE I  
TABLE TYPE STYLES

Table Head	Table Column Head		
	Table column subhead	Subhead	Subhead
copy	More table copy <sup>a</sup>		

<sup>a</sup>Sample of a Table footnote.

Fig. 1. Example of a figure caption.

Figure Labels: Use 8 point Times New Roman for Figure labels. Use words rather than symbols or abbreviations when writing Figure axis labels to avoid confusing the reader. As an example, write the quantity “Magnetization”, or “Magnetization, M”, not just “M”. If including units in the label, present them within parentheses. Do not label axes only with units. In the example, write “Magnetization (A/m)” or “Magnetization {A[m(1)]}”, not just “A/m”. Do not label axes with a ratio of quantities and units. For example, write “Temperature (K)”, not “Temperature/K”.

#### ACKNOWLEDGMENT

The preferred spelling of the word “acknowledgment” in America is without an “e” after the “g”. Avoid the stilted expression “one of us (R. B. G.) thanks ...”. Instead, try “R. B. G. thanks...”. Put sponsor acknowledgments in the unnumbered footnote on the first page.

#### REFERENCES

Please number citations consecutively within brackets [1]. The sentence punctuation follows the bracket [2]. Refer simply to the reference number, as in [3]—do not use “Ref. [3]” or “reference [3]” except at the beginning of a sentence: “Reference [3] was the first ...”

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