Keyword Recognition using Tiny Machine Learning

Detecting Words: Silence, King, Noise, Clockwise, Drive

A Machine Learning Approach

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Introduction

Arduino TinyML enables on-device AI for keyword recognition.

Focus on detecting words like Silence, King, Noise, Clockwise, Drive.

Possible applications: Voice assistants, IoT devices, Smart home systems.

Methodology

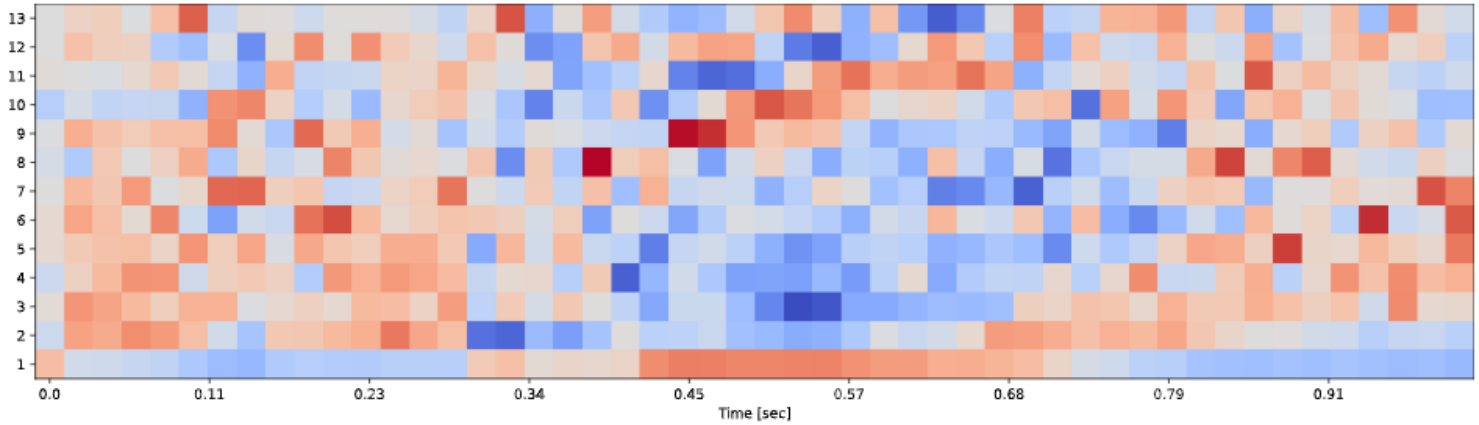
Dataset: Audio samples of selected keywords from Edge Impulse and recorded wia TinyMl.

Model: Lightweight neural network optimized for TinyML.

Hardware: Arduino TinyMl Microcontroller with low-power AI capabilities.

DSP result

Cepstral Coefficients



Processed features

```
0.7761, -0.3164, 0.0876, -0.3536, 0.1587, 0.1425, -0.0311, -0.1804, -0.0784, -0.7372, 0.0530,…
```

On-device performance

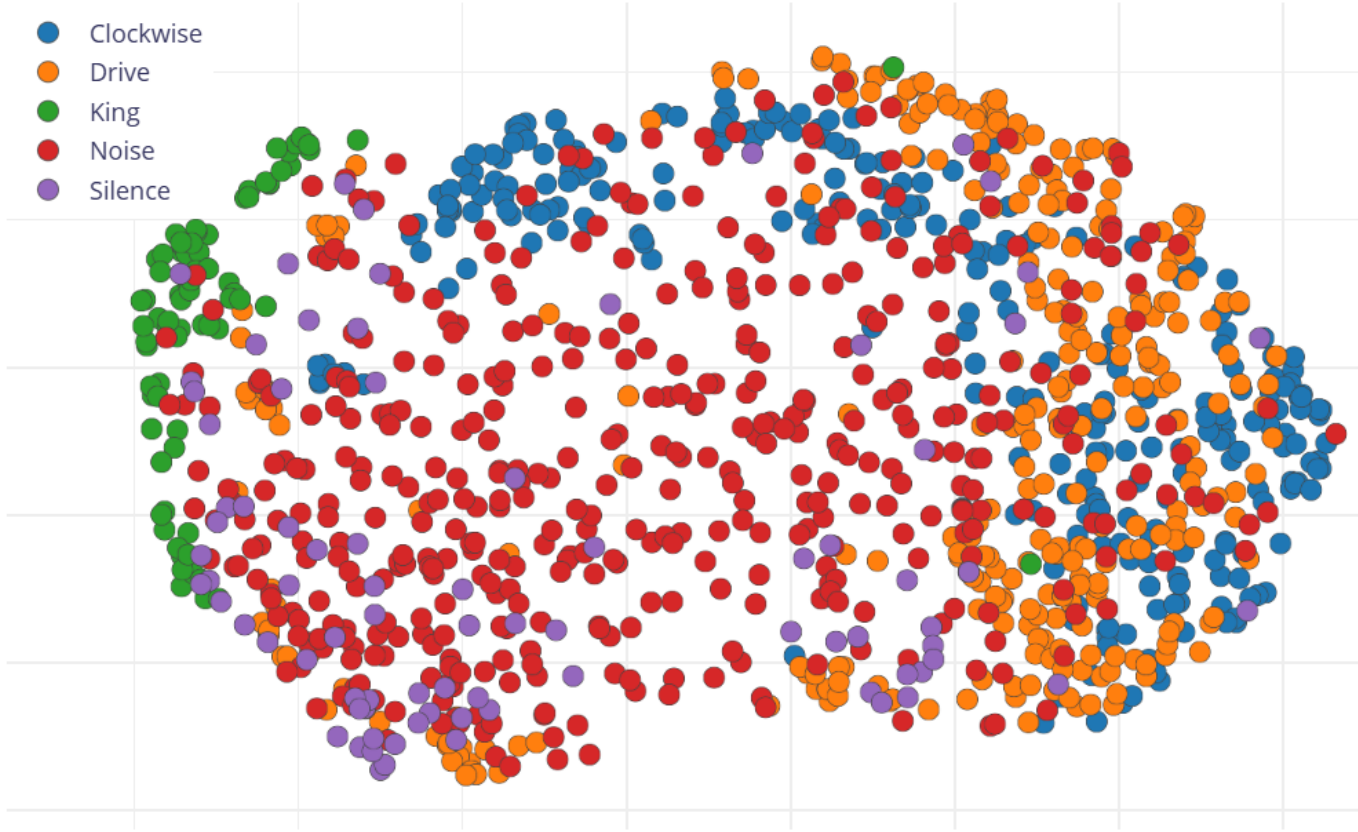
PROCESSING TIME

339 ms.

PEAK RAM USAGE

15 KB

Feature explorer



On-device performance

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Model

Model version: Quantized (int8)

Last training performance (validation set)

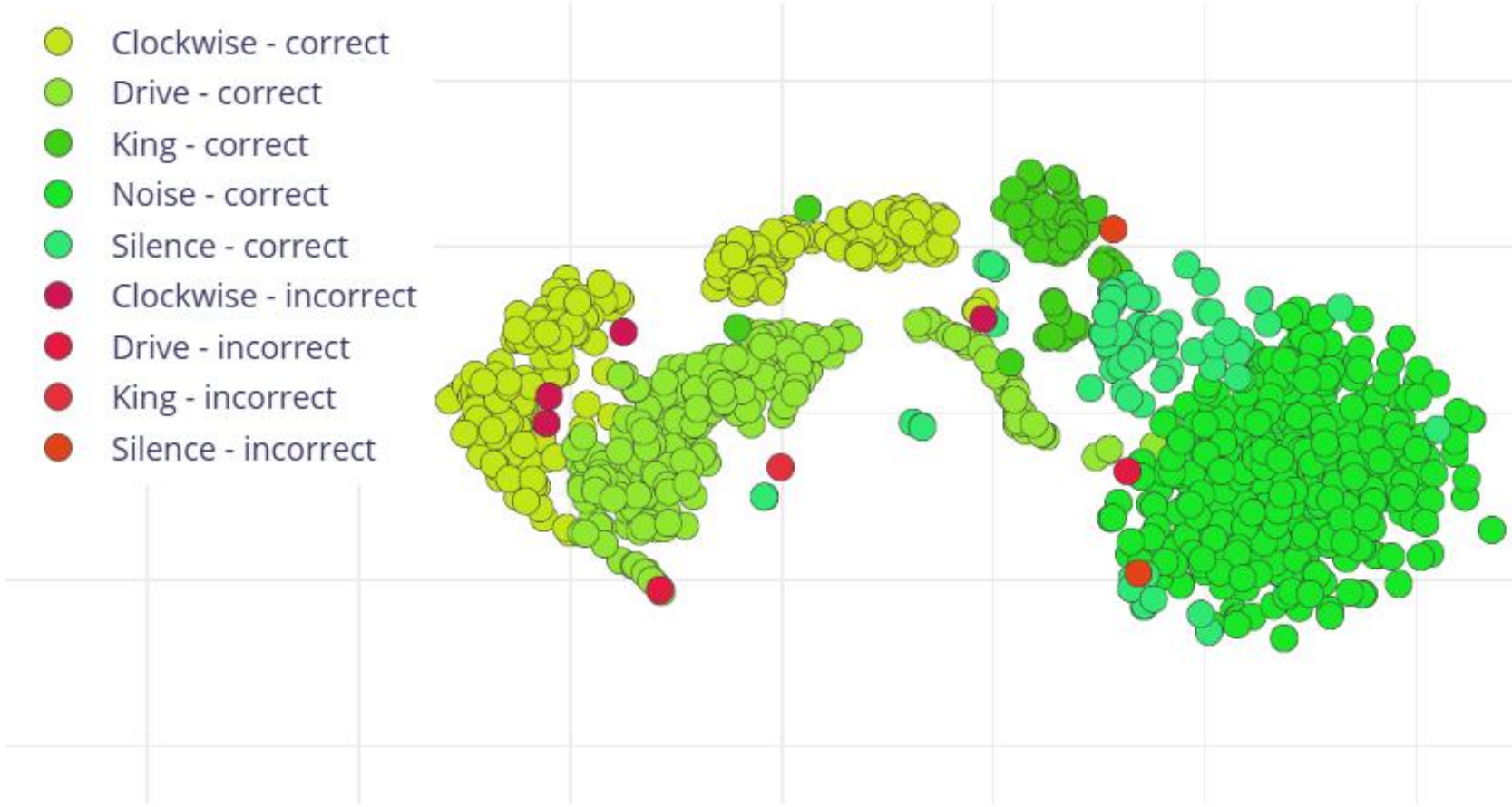
ACCURACY
96.6%

LOSS
0.23

Confusion matrix (validation set)

Error: 1.7% (1 / 58)
Actual label: Drive
Predicted label: Noise

	CLOCKWISE	DRIVE	KING		ENCE
CLOCKWISE	**93.1%**	6.9%	0%		0%
DRIVE	0%	**98.3%**	0%	1.7%	0%
KING	0%	0%	**94.7%**	0%	5.3%
NOISE	0%	0%	0%	**100%**	0%
SILENCE	0%	0%	0%	11.1%	**88.9%**
F1 SCORE	0.96	0.96	0.97	0.98	0.91


Clockwise - correct
Drive - correct
King - correct
Noise - correct
Silence - correct
Clockwise - incorrect
Drive - incorrect
King - incorrect
Silence - incorrect

Results

Accuracy: Achieved >90% keyword recognition accuracy.

Latency: Low inference time suitable for real-time applications.

Deployment: Successfully implemented on an Arduino Nano 33 BLE embedded system.

Conclusion

TinyML is capable of making real-time keyword recognition feasible on edge devices.

Future work: Expand vocabulary, improve noise resilience.

Potential applications: Smart assistants, security systems, hands-free control.