

Energetsko učinkovit sistem za detekcijo slonov s pomočjo strojnega učenja

Ključne besede: strojno učenje, mikrokrmilnik, sklepanje na napravi, termalna kamera, sistem z majhno porabo, **UKD:** XXXXX

Povzetek

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Energy efficient system for detection of elephants with Machine Learning

Key words: machine learning, microcontroller, on-device inference, thermal camera, low-power system

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Abstract

Human-Elephant Conflict is a major environmental and animal conservative problem, according to WILDLABS, an average of 400 people and 100 elephants are killed every year in India alone because of it. Early warning systems replace the role of human watchers and warn local communities of nearby, potentially life threatening, elephants, thus minimising the Human-Elephant Conflicts.

In this Master's thesis we present the structure of an early warning system, which consists of several deployed embedded systems equipped with thermal cameras and a single gateway; the main focus of the thesis was the design and implementation of the former. To detect presence of elephants, we designed and trained several accurate image classification models, capable of classifying thermal images. We optimised said models for on-device performance and compared them in terms of accuracy, execution speed and size. While writing firmware we ported a part of TensorFlow library and created our own build system, suitable for the platform of our choice. We also implemented reporting of inference results over LoRaWAN network and described possible server-size setup. We finally constructed fully functional embedded system from various development and evaluation boards, and evaluated its performance in terms of inference speed and power consumption. We show that embedded systems with Machine Learning capabilities are a viable solution to many real life problems.

List of Abbreviations

WWF	World Wide Fund for Nature
HEC	Human-Elephant Conflicts
ML	Machine Learning
NN	Neural Networks
CNN	Convolutional Neural Networks
DNN	Deep Neural Networks
IoT	Internet of Things
RMS	Root Mean Square
ReLu	Rectified Linear Activation Unit
ISM	Industrial, Scientific and Medical
3GPP	The 3rd Generation Partnership Project
LoRa	Long Range
IR	Infrared
EM	Electromagnetic
LWIR	Long Wave Infrared Region
ROIC	Readout Integrated Circuit
VOx	Vanadium-Oxide
NETD	Noise Equivalent Temperature Difference
CPU	Central processing unit
FPA	Focal Point Array
TWI	Two Wire Interface

SPI	Serial Peripheral Interface Bus
PIR	Passive Infrared Sensor
I2C	Inter-Integrated Circuit
MOSI	Master Out Slave Input
MISO	Master Input Slave Out
FPA	Focal Point Array
AGC	Automatic Gain Control
SYS	System Information
VID	Video Processing Control
OEM	Original Equipment Manufacturer
RAD	Radiometry
GCC	the Gnu Compiler Collection
TTN	The Things Network
DK	Development Kit
EVK	Evaluation Kit
GNSS	Global Navigation Satellite System
DWT	Data Watchpoint Trigger
TTN	The Things Network

Bibliography