TP557

ADVANCED TOPICS IN IoT AND ML

Institute National of Telecommunications

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WELCOME TO PRESENTATION

We are Diego and Felipe, and I'll be sharing with you our final project presentation.

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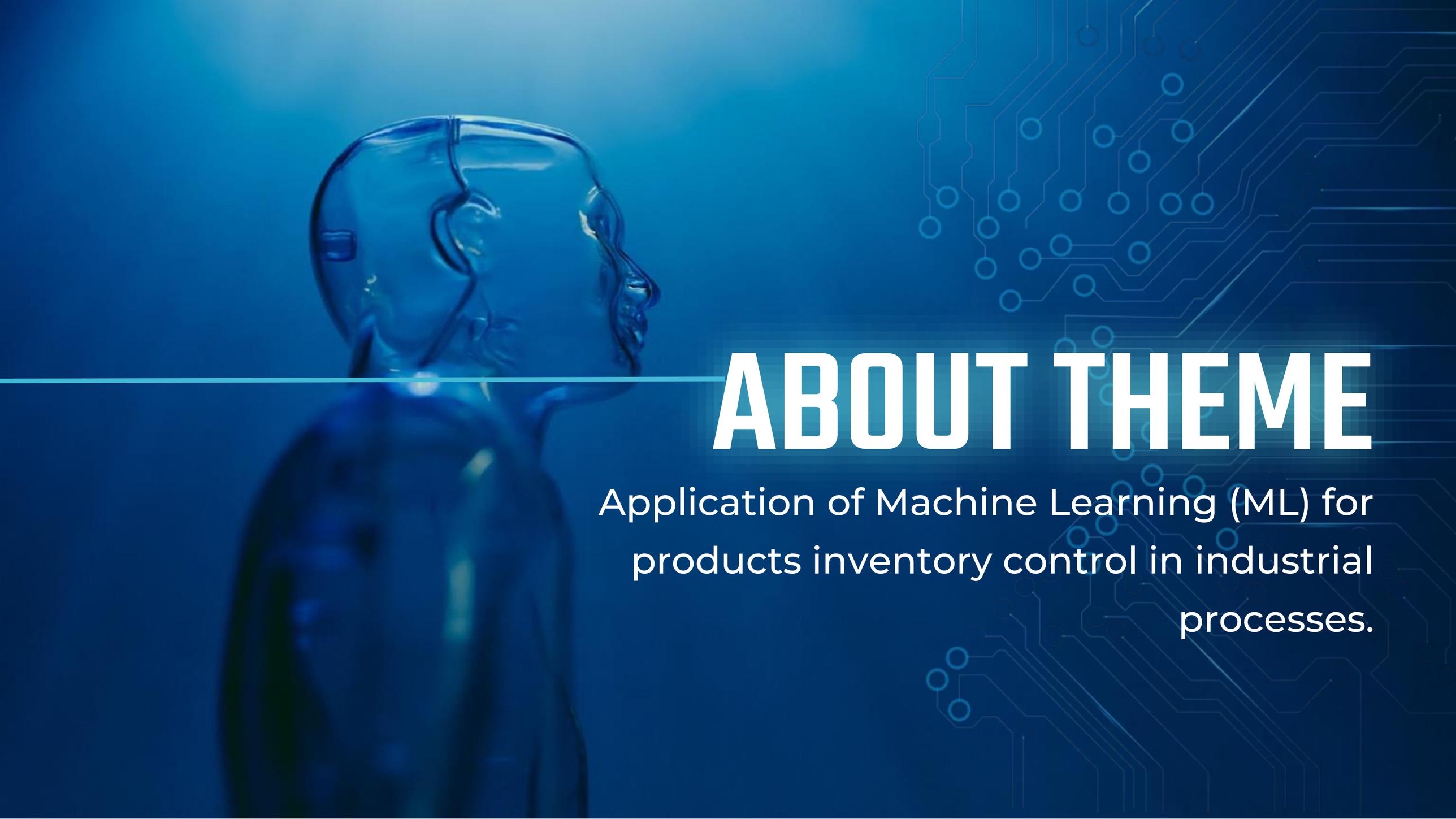
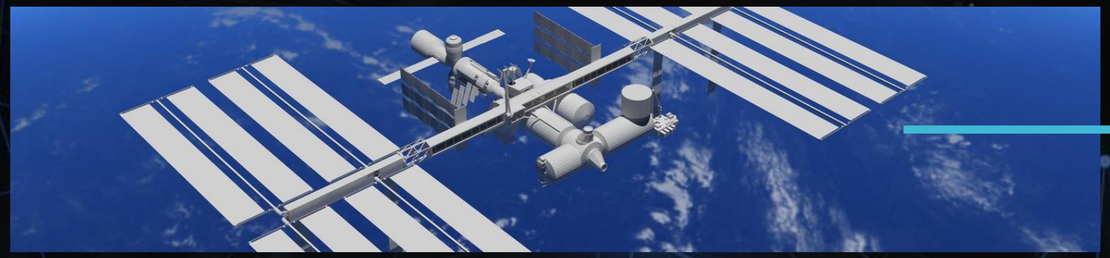


ABOUT THEME

Application of Machine Learning (ML) for products inventory control in industrial processes.

PRESENTATION OVERVIEW

Introduction



Related Works
and Methodology

Model Presentation
and Results

Conclusions

INTRODUCTION

EVOLUTION OF INDUSTRIAL PROCESSES

- **INITIAL INDUSTRIAL REVOLUTION:**
  Introduction of steam engines and mass production;
- **EMERGING AUTOMATION:**
  Evolution towards automated systems for efficiency production;
- **MANUAL INVENTORY CONTROL:**
  In early stages, inventory control relied heavily on manual records;
- **AUTOMATION OF INVENTORY CONTROL:**
  Advancement to automated inventory control processes;
- **INTEGRATION OF TECHNOLOGIES:**
  integration of technologies, including computational vision and Machine Learning (ML) to optimize inventory control in industrial processes.

RELATED WORKS

- **1 -** Product Quality Detection and Recognition based on Vision and Deep Learning;
- **2 -** Vision-based Object Classification using Deep Learning for Inventory Tracking in Automated Warehouse Environment;
- **3 -** Design and simulation robotic arm with computer vision for inspection process;
- **4 -** Real-time monitoring of Conveyor using Computer Vision and IoT;
- **5 -** Machine Monitoring for Industry using Computer Vision.

- Projects commonly focused on computation vision and ML techniques without considering support to low cost devices.

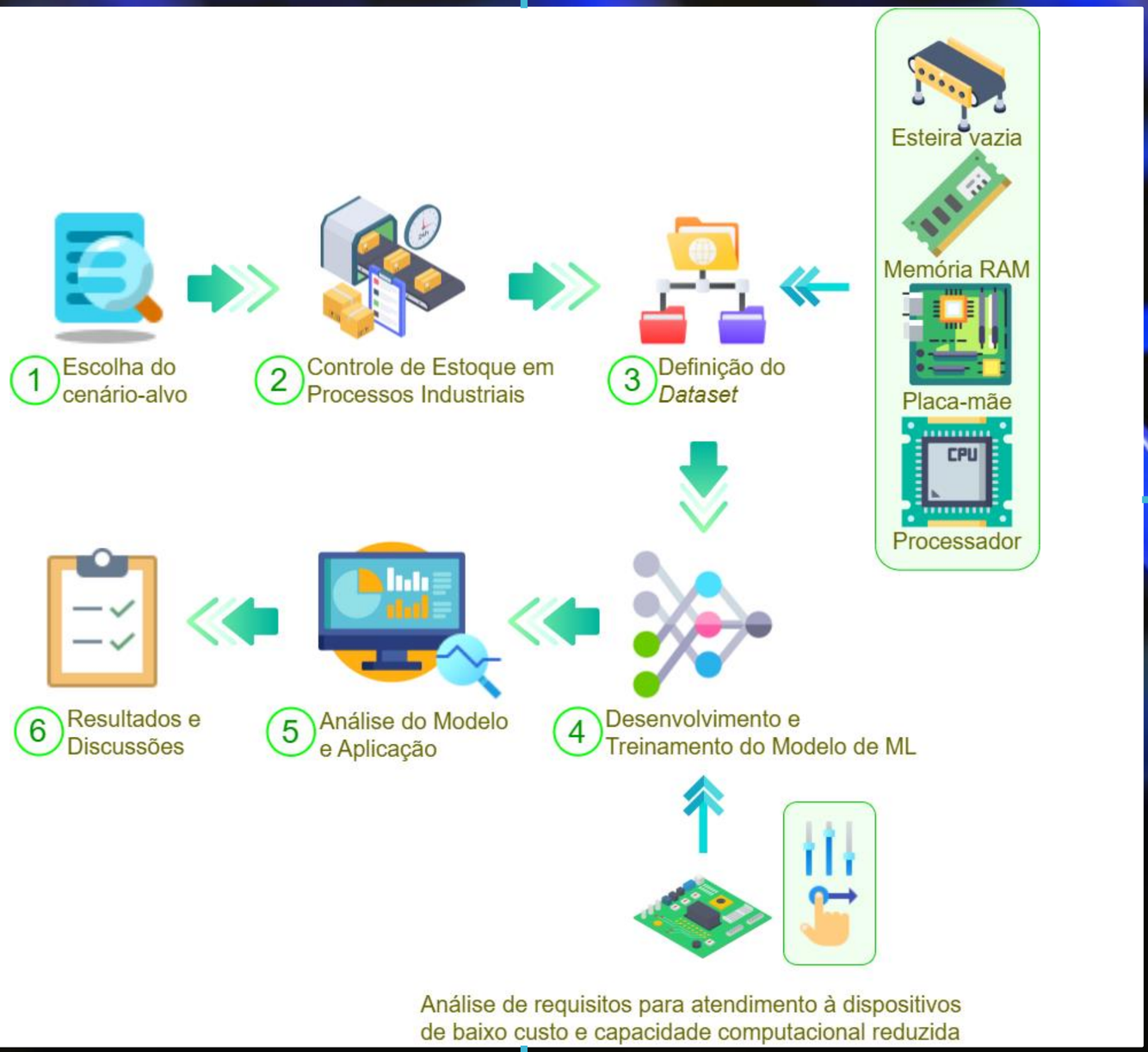
HOW TO IMPROVE INDUSTRIAL INVENTORY CONTROL?

— low complexity:
conventional strategies require mathematical and computing complexity to be developed;

— low cost devices:
Need to models supported by devices with low cost and low energy consumption.

METHODOLOGY

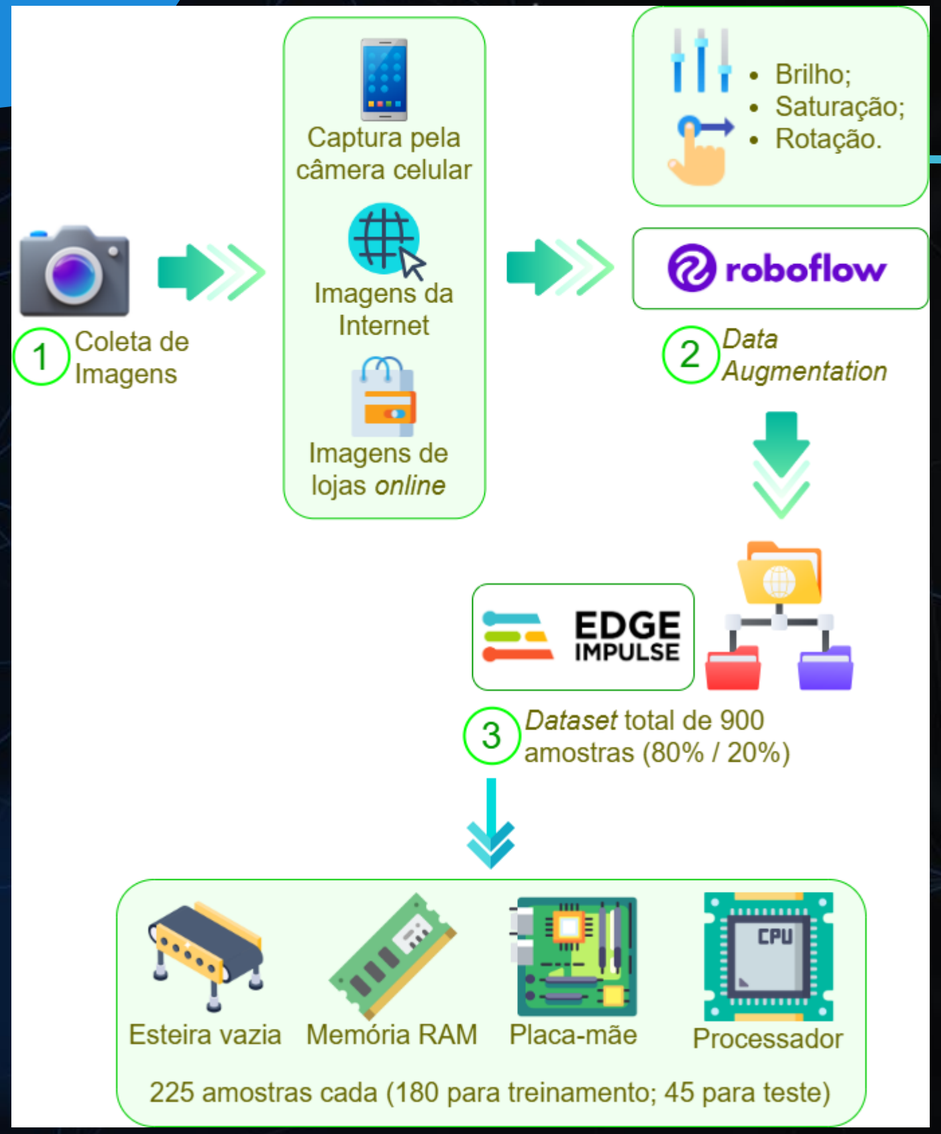
A PICTURE IS WORTH A THOUSAND WORDS


Esteira vazia
Memória RAM
Placa-mãe
CPU
Processador
1 Escolha do cenário-alvo
2 Controle de Estoque em Processos Industriais
3 Definição do *Dataset*
4 Desenvolvimento e Treinamento do Modelo de ML
5 Análise do Modelo e Aplicação
6 Resultados e Discussões
Análise de requisitos para atendimento à dispositivos de baixo custo e capacidade computacional reduzida

MODEL PRESENTATION

- Definition of dataset;
- Training and testing model using Edge Impulse tool;
- Deploy on devices with low computational capacity.

DEFINITION OF THE DATASET



FEATURES OF THE IMAGES

MODEL WITH HIGH INFERENCE TIME

Model

Model version: Quantized (int8)

Last training performance (validation set)

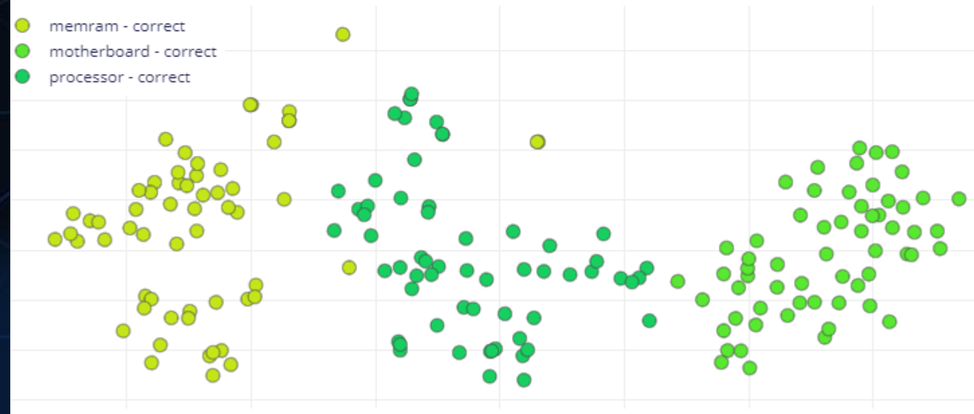
ACCURACY
100.0%

LOSS
0,03

Confusion matrix (validation set)

	MEMRAM	MOTHERBOARD	PROCESSOR
MEMRAM	100%	0%	0%
MOTHERBOARD	0%	100%	0%
PROCESSOR	0%	0%	100%
F1 SCORE	1.00	1.00	1.00

Data explorer (full training set)



On-device performance

INFERENCING TIME
1397 ms.

PEAK RAM USAGE
182,6K

FLASH USAGE
59,0K

MISSION

Automatize and optimize the inventory control in industrial proccess using ML.

VISION

Equilibrium between low cost devices requirements (RAM, flash) and inference time.

NEURAL NETWORK ARCHITECTURE

Características de Treinamento	Nº de épocas	14
	Taxa de Aprendizado	0,0005
	Conjunto de Validação	20%
	Tamanho do *Batch*	32
Arquitetura da Rede Neural	Camada de Entrada	27648 características
	Camada 2D Conv / *Pool*	32 filtros, 3 *Kernels*
	Camada 2D Conv / *Pool*	16 filtros, 3 *Kernels*
	Camada *Flatten*	-
	Dropout	Taxa de 0,25
	Camada de Saída	4 classes

STATS & NUMBERS

Results and discussions

TRAINING PERFORMANCE

Model

Model version: Quantized (int8)

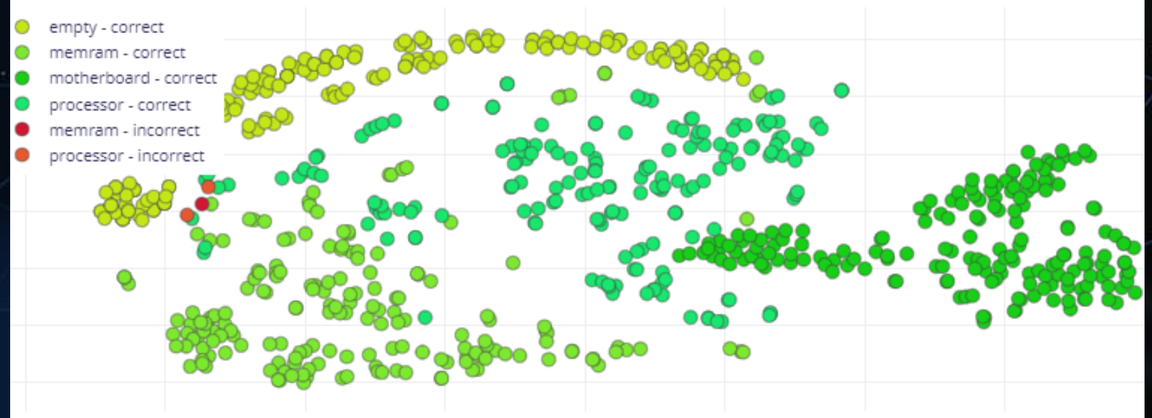
Last training performance (validation set)

ACCURACY	LOSS
100.0%	0,02

Confusion matrix (validation set)

	EMPTY	MEMRAM	MOTHERBOARD	PROCESSOR
EMPTY	100%	0%	0%	0%
MEMRAM	0%	100%	0%	0%
MOTHERBOARD	0%	0%	100%	0%
PROCESSOR	0%	0%	0%	100%
F1 SCORE	1.00	1.00	1.00	1.00

Data explorer (full training set)



On-device performance

INFERENCING TIME	PEAK RAM USAGE	FLASH USAGE
15 ms.	363,3K	70,9K

1.00

of F1-Score

100.00%

of accuracy

0,02

of loss (categorical cross-entropy)

15 ms

of inference time

363.3K

of peak RAM usage

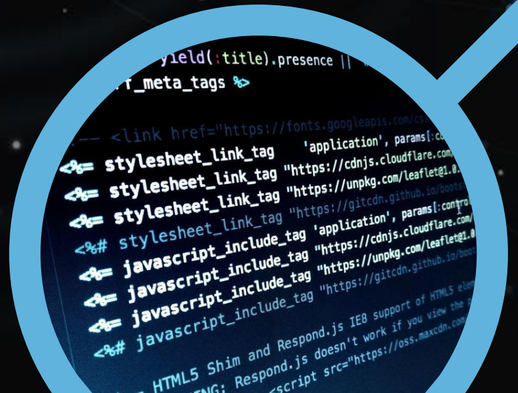
70.9K

of flash usage

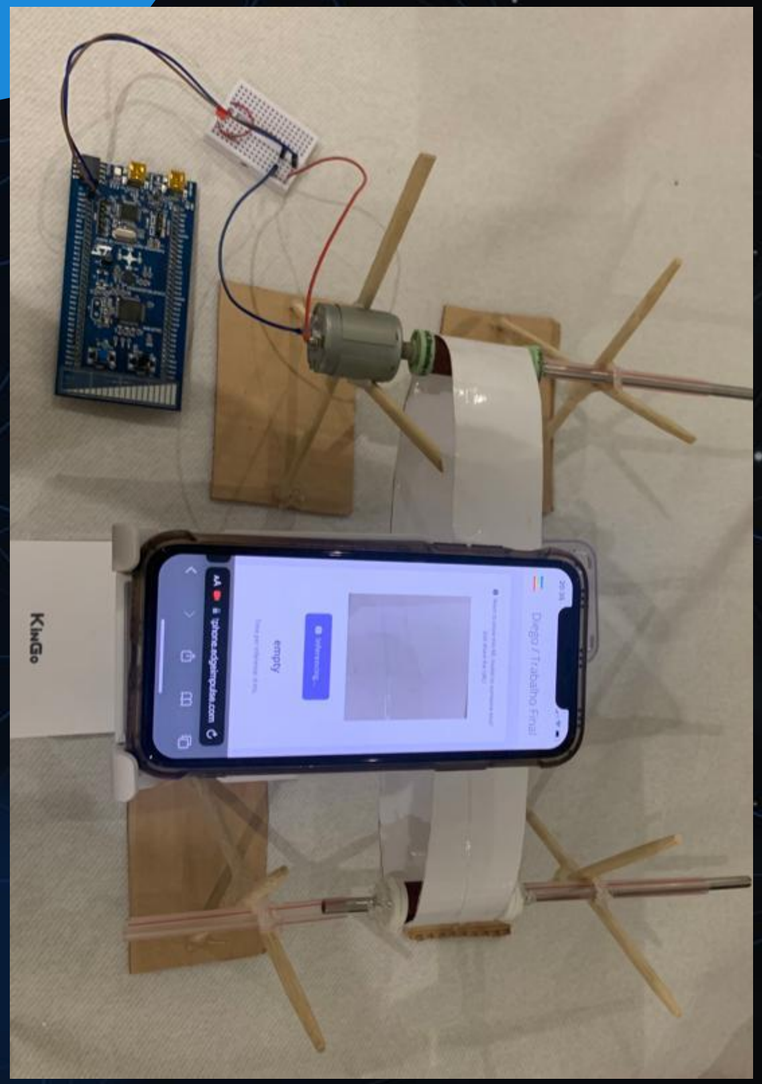
USE CASE

SETTINGS:

- Motor DC with power supply of 3V for moving conveyor;
- Inference through image capture made by cellphone câmera;
- Camera positioning for capture images on conveyor.



ML COMBINED TO
IoT ARE THE FUTURE!



TESTING MODEL ON USE CASE PROPOSAL

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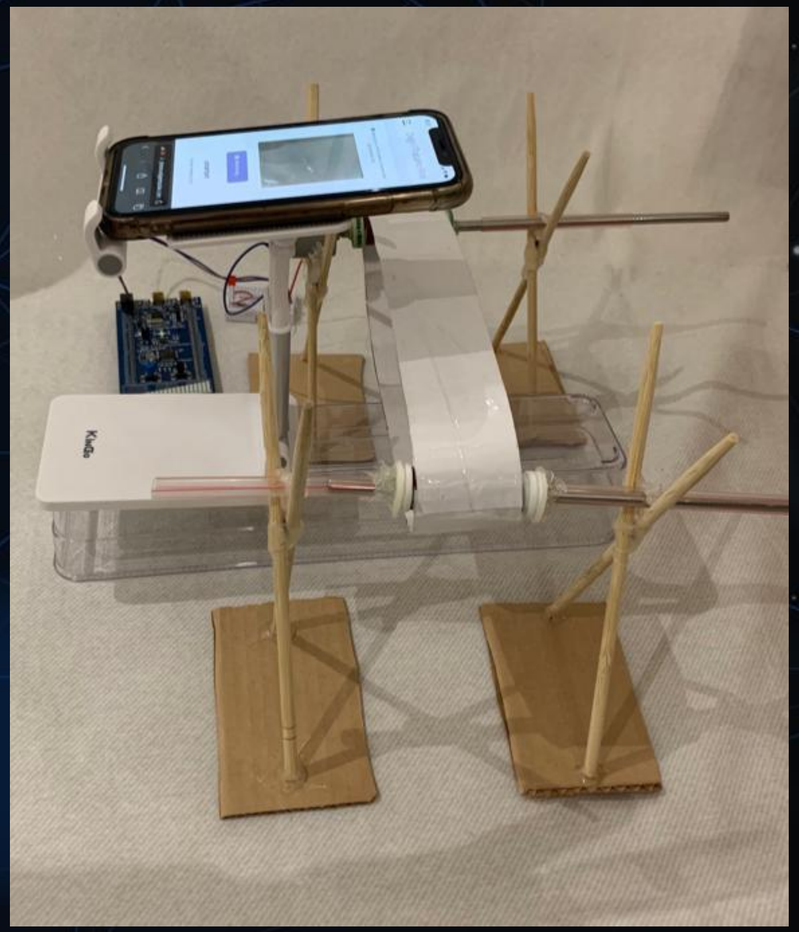

VIDEO DEMONSTRATION


clideo.com

CONCLUSIONS

S	W	O	T
STRENGTHS	**WEAKNESSES**	**OPPORTUNITIES**	**THREATS**
• Low inference time; • Reduction of complexity and processing time; • Support to low cost and low energy consumption devices.	• Support for devices with peak RAM usage above 363.KB; • Support for devices with flash usage above 70.9K; • Meet requirements for application whose inference time can be 15 ms or more.	• Improve neural network parameters; • Increase dataset; • Optimize model to achieve low RAM and, flash usages, and low inference time; • Application of model on real scenario;	• How does the developed framework performs as the number of classes and dataset size increase? • Is this neural network scalable? • What is the performance on different devices?

REFERENCES

(For more information about the final project)

GitHub Link of the Final Project:

- https://www.github.com/diegogspivoto/TP557

(*access link with powerpoint presentation, article, vídeo with tests, and Edge Impulse link with code*).

Public Link of Edge Impulse with code:

- https://studio.edgeimpulse.com/public/312119/latest

(*access link with step-by-step of the ML architecture building, such as dataset, model training and testing*).

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THANK YOU!

Do you have any question(s)?