OCR SYSTEM FOR BILLET IDENTIFICATION

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EXECUTIVE SUMMARY

Introduction

SMS Concast: a steel manufacturing leader, is undertaking a crucial digital transformation.

Digital Focus

Implementing advanced technologies to improve steel billet identification, enhance quality control and market expansion

Data-Driven&innovation

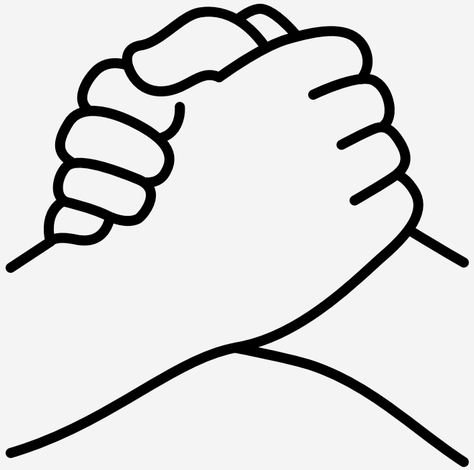
Build a foundation for machine learning models through extensive data collection and labeling, use Raspberry Pi for operating a high-resolution camera system

Transformation Goal

Enhance steel billet identification accuracy with at least 99.8%, increase productivity, reduce costs

TEAM COLLABORATION

- Project Manager
- Research Partner Representative
- Technical Team
- Risk Management Consultant
- Data Analysis Expert



- Technical Team
- Head of Supply Chain
- Market and Business Strategy Consultant

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SMS CONCAST

SMS group

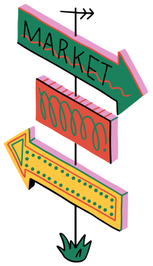
VALUE PROPOSITION

Efficiency

Enhance the accuracy of steel billet identification from 98% to 99.933%

Economic Impact

Net profit 30K CHF per project and significant cost savings per year up to 928.86K CHF



Market Expansion

Leveraging a B2B model to connect with steel companies

Social & Ecological Stance

Commitment to sustainable production, reduce up to 128.86 ton CO2 aligning with global ecological goals.

***We assure that the remelting rate from 2% decreases to 0.067%, the cost of electricity is 131 MWH, 33g CO2/kWH electricity intensity in CH**

STATE OF THE ART IN STEEL MANUFACTURING

Digital Technology Integration

Merging traditional steel manufacturing practices with next-generation digital technologies to enhance productivity and quality.

Industry Challenges

- Complex logistics
- Reduce carbon footprint through innovative digital solutions.

Advancements

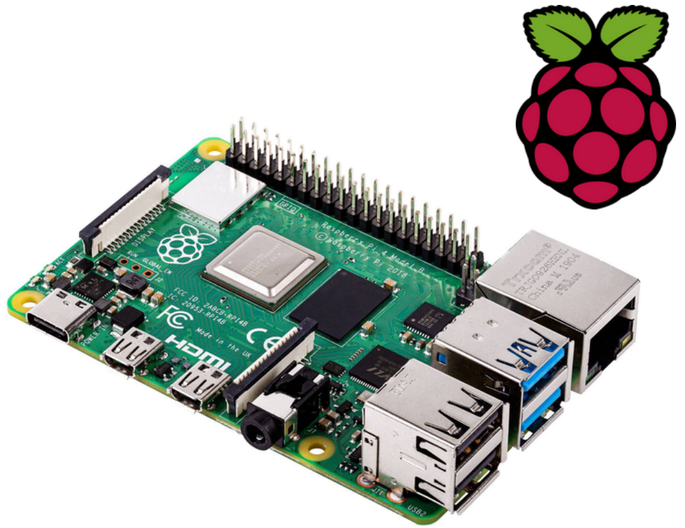
- Continuous casting technology
  - reduced operational costs
  - improved the quality and diversity of steel products.
- OCR/OPR

AI for Future Growth

SMS Concast is proactively exploring the integration of AI and machine learning for more precise and efficient steel manufacturing processes.

INNOVATIVE DIGITAL TRANSFORMATION

- **Raspberry Pi:**
  - A small, affordable, and versatile single-board computer with powerful processing capabilities.
  - Controls an integrated **camera system with software-controlled RGB LED flashes**



- **High-resolution imaging** for accurate billet identification and efficient **machine learning algorithms**.
- **OCR** using open-source tools like **Tesseract** for enhanced identification accuracy.

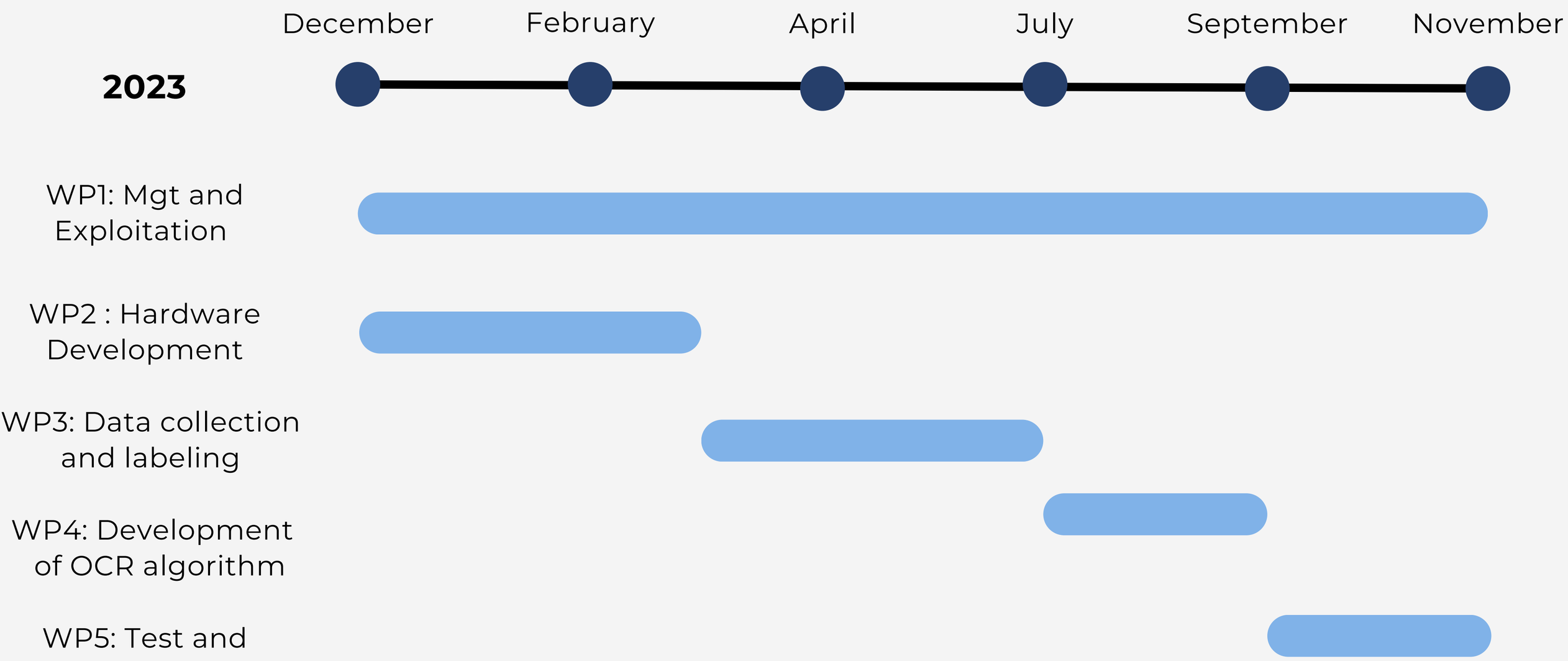
SETTING QUANTIFIABLE GOALS & FOUNDATIONAL WORK

- **Scientific Goals:** ml model accuracy > 99.8%
- **Economic Impact:**
  - 50% reduction in billet identification time
  - ++ productivity by at least 30%
  - reducing operational costs.
- **Societal Contributions:**
  - Reduce CO2 emissions by 25%
  - Improve workplace safety by automating processes
- **Technological Advancements:**
  - Real-time processing < 3 secs
  - System compatibility with existing production lines
- **Preliminary Work:** R&D focus on OCR, Data Collection and Analysis, Strategic Partnerships, Pilot Studies and Staff Training

RISK IDENTIFICATION

Title	Category	Risk expectation (1 to 10)	Impact of the risk (1 to 10)	Preventive Measure	Corrective Measure
Inadequate harware specifications	Research	4	8	Regular design reviews with stakeholdesr	Modify specifications based on feedback
Camera malfunction in data collection	Technical	4	6	Implement redundant camera systems/ Check regularly camera output	Use backup from redundant systems
Incorrect or not precise labeling	Implementation	4	9	Develop labeling guidelines and provide training for labelers	Implement a review process for labeled data
Overfitting in OCR algorithm training	Technical	7	8	Implement cross-validation techniques during model training	Retrain the model on a more diverse dataset
Delays in project timeline	Management	7	3	Regular monitoring	Implement fast-tracking or resource reallocation

PROJECT TIMELINE



PROJECT COST ESTIMATE

Working Package	#Units/Hour	Cost/Unit/Hour	Subtotal	% of Total
Project Management	**150**		**11'100**	**9.5%**
Project Manager	150	74	11'100	
Technical Team			**87'000**	**73.7%**
Hardware Design & Dvp Team	300	60	18'000	
Data Analysis Experts	500	70	35'000	
Market and Business Strategy Consultant	850	40	34'000	
Material Costs			**192**	**0.02%**
Hardware Costs		192	192	
Reserves (20% of estimate)			**19'620**	**16.6%**
Total Project Cost Estimate			118'000	

MACHINE LEARNING ALGORITHM METHODOLOGY

- **Set the data pre-processing :**
  - Store the images in a huge Tensor (# of images, height, width, # colors)
  - Normalize the data and convert it to the approriate type
  - Label the data by hand to prepare the supervised training

- **Define the model architecture:**
  - We use a Convolutional Neural Network Architecture (CNN)
  - The loss used is the crossentropy, the most appropriate for classification tasks
  - Adam is the optimizer we selected to train our model

- **The training procedure:**
  - We train our model on 15 epochs, using a batch size of 128
  - We performed data augmentation to improve our model robustness

- **Model results:** Our best model achieved a **99.93% test accuracy**

THE RESULTS OF OUR RESEARCH PROCESS

What worked

- **Increasing the number of kernels** on each layer by a multiple of 2
- Make the learning procedure on **15 epochs**

What didn’t worked

- Make the **kernel size bigger** like for example (4,4) or (5,5)
- **Increasing too much the number of kernels** at each convolutional layer

This induces a **96,5% reduction of the error** from 2% to 0.07%.

Based on this, we can estimate a potential **net cost saving of 515'237 - 118'000 = 397'237 per year**


THANK YOU!

FUTURE WORK FOR FURTHER IMPROVEMENTS

Make the Convolutional NN deeper

It is well known in Neural Networks that increase the depth of the model can lead in an improvement of its performance

Learning rate scheduling

Learning rate scheduliong is a process of decreasing the lr during the learning procedure. It allows to avaoid overfitting

Try Vision Transformer architecture (ViT)

Vision transformer (ViT) have emerged recently and achieves excellent results on visions tasks. It has 98%+ accuracy on MNIST

Hyperparameters optimization

The hyperparameters can always be optimised. With more time we can try more different values for them, as the dropout rate, etc.