Predictive Modeling of risk factors in slaughterhouses using Low-cost inertial sensors

Thesis Defense

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Outline

Section 1

Slaughterhouses, Wearable Technology and WRMSDs

Motivation

Challenges in the Meat Processing Industry

1. Labour represents a large percentage of the costs.
2. Global economic volatility induces pressure in manufacturing operations, specially when automatization is not yet possible.
3. Larger demographic processes will constrain labour markets in the future.
4. Individual health is often overlooked by decision makers.
5. Fatigue and bad practices in manual activities induce social and economic pressures.
6. Work-Related Muscukuloskeletal Disorders (WRMSDs) are the leading cause of work disability, sickness and absence from work [Bevan, 2015].

Motivation

State of the IoT Industry

1. IoT market has grown dramatically in the last five years.
2. Intelligent systems seem possible at the fusion between IoT and AI.
3. IoT market share by sector shows that wearable technology still represent a small proportion of the total (3%).

Motivation

Wearable Technology

1. Wearable devices have been used successfully in Human Activity Recognition (e.g.: Sport Recognition).
2. Occupational domains have been left behind.
3. Risk and lesion prevention of WRMSDs can lead to lower fatigue, increasing productivity and efficiency.

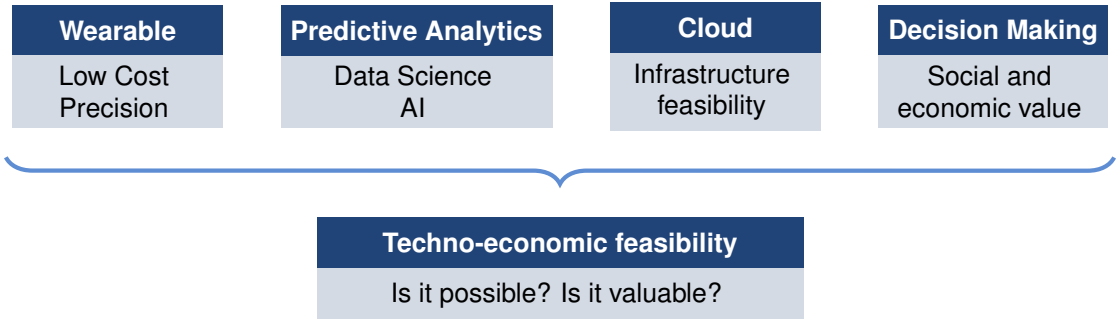
Perspective

Disciplines for addressing WRMSDs

Wearable	Predictive Analytics	Cloud	Decision Making
Low Cost Precision	Data Science AI	Infrastructure feasibility	Social and economic value

Perspective

Disciplines for addressing WRMSDs



Literature Review

Assessment of WRMSDs

1. WRMSDs of the wrist/hand are highly prevalent among meat cutters [Viikari Juntura, 1983].
2. RULA and OCRA Check List surveys are the standard assessment methodology [McAtamney and Nigel Corlett, 1993, Occhipinti, 1998].
3. Microsoft Kinect 3D cameras or intricate arrangements of IMUs, placed over the worker's body, have been used with good results [Vignais et al., 2013, Buisseret et al., 2018, Chen et al., 2018]
4. Deep Learning black-box models in work environments to detect bad postures [Barkallah et al., 2017, Abobakr et al., 2017, Hu et al., 2018].
5. Practitioners struggle to use IoT technologies to assess risk factors in real industry environments [Lim and D'Souza, 2020].

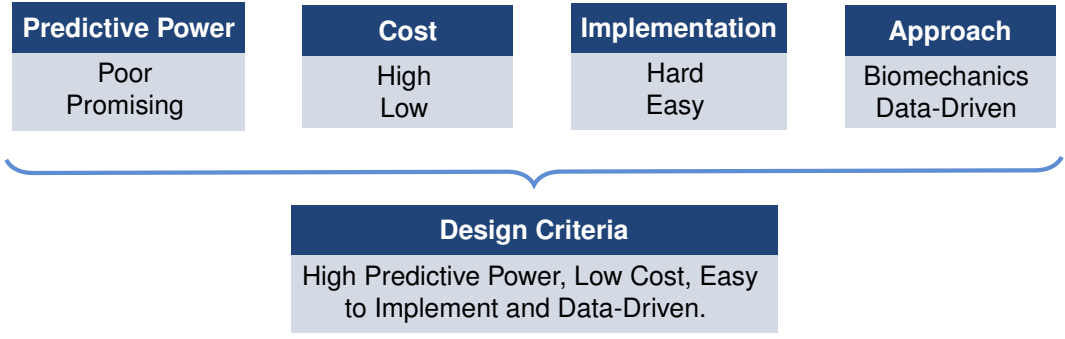
Perspective

Current Limitations

Predictive Power	Cost	Implementation	Approach
Poor Promising	High Low	Hard Easy	Biomechanics Data-Driven

Perspective

Current Limitations



Section 2

Thesis Hypothesis and Objectives

Objectives

Strategic Guidelines

1. System is innocuous to the worker and the product.
2. Generate an indicator that can be used to benchmark and evaluate workers.
3. Design a methodology that can be extrapolated to other cutting-tasks.
4. Avoid complex models if not needed.

Objectives

Objective 1

Model the presence of the risk factors, during a meat-cutting task, as a time series classification problem.

Objectives

Objective 2

Determine if the information obtained from low-cost sensors, placed in the wrists of the worker, and combined with expert supervision, are sufficient to accurately assess the presence of risk factors. For this, we focus on two risk factors

1. The prediction of the RULA score, related to ergonomic risk and improper technique [Viikari Juntura, 1983].
2. The presence of a knife with a compromised blade, since bluntness has been found to increase the likelihood of WRMSDs by increasing the necessary exertions [Marsot et al., 2007, Karltun et al., 2016, Savescu et al., 2018].

Objectives

Objective 3

Determine if the developed predictive modeling tools for the assessment of WRMSDs can be used to quantify the economic benefits of preventive decision making.

Objectives

Objective 4

Analyze if its possible to accurately predict whenever the worker begins and ends a cut.

Hypothesis

Research Questions

1. Is it possible to gather information from low-cost accelerometers, placed wrists of slaughterhouse workers and use it as input for machine learning algorithms that accurately predict the presence of risk factors in cutting activities.
2. Can we use the predictions of risk factors as a replacement for human ergonomic supervision and prevention.
3. Is it possible to assess risk factors with limited human supervision, and only relying on auxiliary predictions.
4. There exists a positive relationship between a reduction in ergonomic risk and improving productivity.

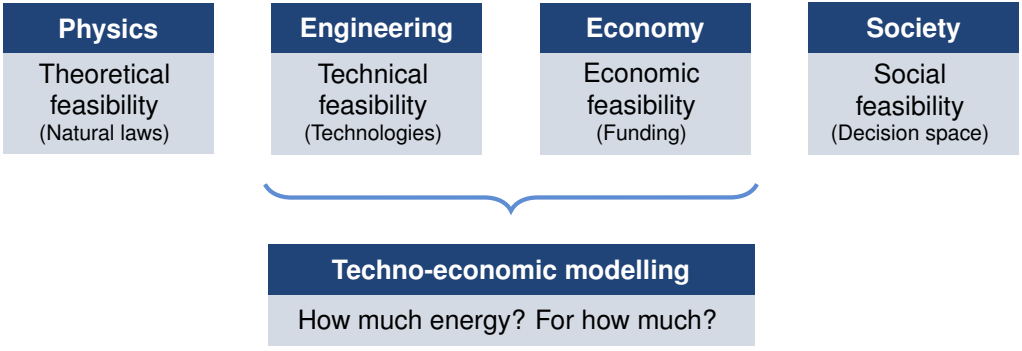
Hypothesis

Disciplines for investigating energy topics

Physics	Engineering	Economy	Society
Theoretical feasibility (Natural laws)	Technical feasibility (Technologies)	Economic feasibility (Funding)	Social feasibility (Decision space)

Hypothesis

Disciplines for investigating energy topics



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