Riflessioni sugli esiti di una ricerca multidisciplinare
Collaborazione
Studying Autonomic and Central Nervous System Dynamics through Signal Processing and Wearable System

Respiration Activity

EEG

PPG

EDR

EMG

ECG

Heart rate Variability

Commercial hardware

Research on new Sensors and Wearable Systems for physiological monitoring
Monitoring Systems: An overview

- Wearable systems
- Machine learning (modeling, classification)
- Biomedical signal processing

![Biomedical Image](image-url)
Emotions

Mental

Emotional

Spiritual

Physical

Social

Wellbeing
Where do they come from?
The Autonomic Nervous System

Controls involuntary and visceral bodily functions

- Heartbeat
- Breathing
- Digestion
- Energy levels
- Fluid levels

AUTONOMIC NERVOUS SYSTEM RESPONSE - SUBJECT’S INNER STATE ASSESSMENT
Animal Welfare

Welfare: the state of doing well; well-being

Well-being

- Freedom from hunger and thirst
- Freedom from fear and distress
- Freedom to express normal behavior
- Freedom from discomfort
- Freedom from pain, injury or disease
Come tutto ha avuto origine
WHY INTERACTION BETWEEN HUMANS AND ANIMALS?
WHY INTERACTION BETWEEN HUMAN AND ANIMALS?

1 - HOW MUCH ARE HORSES SIMILAR TO HUMANS?

2 — AUTONOMIC NERVOUS SYSTEM INTERACTION
HOW MUCH ARE HORSES SIMILAR TO HUMANS?

Horses have feelings
The way emotions are processed in the human brain is different from the horse due to the compartmentalization of the horse's brain.

Horses simply feel emotion (without reasoning) because they don’t have the ability to rationalize the feeling.

Horses can express feeling

...and Horses can recognise human emotions
2 — AUTONOMIC NERVOUS SYSTEM INTERACTION

HORSE PRODUCES SWEAT: THE ELECTRICAL IMPEDANCE OF THE HORSE’S SKIN CHANGES DUE TO LIQUID PRODUCTION

• AUTONIMIC MODIFICATIONS - SIMPATHOVAGAL MODIFICATION
• HEART — HEART COUPLING

IT MEANS THAT MANY OF THE SYSTEMS DEVELOPED FOR HUMANS CAN BE RE-USED FOR HORSES
Heart Rate Variability is:

A measure of neurocardiac function that reflects heart-brain interactions and Autonomic Nervous System dynamics.

✓ Rapid fluctuations in HR usually reflect PNS control.

✓ Slower fluctuations in HR reflect combined SNS and PNS + other psychological and emotional influences.
Human – Horse

- Human-Horse = Dynamic Time Variant System
  → Complex Oscillation

- Cardiac Activity → Heart Rate Variability – HRV
  - Involuntary Response Autonomic Nervous System
  - “Fight / Flight” Reaction
  - Emotion
Textile electrodes use sweat to improve electrochemical coupling at the electrode-skin interface → Improving performances improve along time
Elastic Belt

Textile Electrodes

Ag/AgCl Electrodes

Embedded Electronics

Elastic Belt

Image of a horse with embedded electronics and textile electrodes. A tablet displaying a monitoring application with ECG data.
Final wearable system for Horses
Working phase
Experimental protocol

• Neutral Phase (P1)
• Visual and Olfactor Contact (P2)
• Physical Contact (P3)
Experimental protocol

Example of P2 phase
Results

• Statistics

<table>
<thead>
<tr>
<th>feat</th>
<th>$P_1$ vs. $P_2$</th>
<th>$P_1$ vs. $P_3$</th>
<th>$P_2$ vs. $P_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$M S C$</td>
<td>0.032 (&quot;)</td>
<td>0.0029 (#)</td>
<td>0.0029 (#)</td>
</tr>
<tr>
<td>$M P C$</td>
<td>0.83 (-)</td>
<td>0.014 (#)</td>
<td>0.0029 (#)</td>
</tr>
<tr>
<td>$D T W$</td>
<td>0.57 (-)</td>
<td>0.036 (&quot;)</td>
<td>0.036 (&quot;)</td>
</tr>
</tbody>
</table>

Classification ➔ Confusion Matrix

---

SVM confusion matrix (mean ± standard deviation) resulted by the LOSO cross-validation technique.

<table>
<thead>
<tr>
<th></th>
<th>$P_1$</th>
<th>$P_2$</th>
<th>$P_3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$P_1$</td>
<td>90.90</td>
<td>0.00</td>
<td>9.10</td>
</tr>
<tr>
<td>$P_2$</td>
<td>0.00</td>
<td>100.00</td>
<td>0.00</td>
</tr>
<tr>
<td>$P_3$</td>
<td>9.10</td>
<td>9.10</td>
<td>81.80</td>
</tr>
</tbody>
</table>

$P_1$: resting state, $P_2$: visual and olfactory interaction, $P_3$: brushing
Applications

- Equine assisted therapy and psycho-therapy

Equine-Assisted Therapy Treats:
- Substance Abuse
- ADHD
- Eating Disorders
- Depression
- Anxiety
- PTSD

Human horse sensing

Horse Training
Publications


IEEE.


A Smart Future for Saddlery

by Cristina Wilkins, Editor

Imagine buying a rug that predicts when your mare will foal, a saddlecloth that records and stores heart rate and respiration rate changes during your exercise sessions, or can tell you if your horse is stressed. What about a grith that beeps if it is too loose or a noseband that changes color when it is done up too tight?

We are talking about a future where a horse gear will be made with built-in smart electronics, but is made to look like regular gear (no wires or bulky battery packs). Gear that can light up, flash or sound readings of your horse’s body temperature and other vital signs. It can even take an electrocardiogram (ECG) and send the readings to your mobile device.

Textiles made with conductive fibres woven into the fabric may sound futuristic, but they are nothing new. Royal gowns have been embroidered with gold and silver threads for many centuries. However, this innovation has been integrating these textiles with wearable electronic devices.

Although Europeans can already buy jackets that monitor body temperature and have a built-in mp3 player, most of these products are still “first generation” and very expensive, so don’t go looking in the saddling catalogues just yet... The horse world is not quite there. Nevertheless, a team from the University of Pisa, Italy, have already tested textile platforms in horses, which have shown promising results.

Nevertheless, an Italian research team composed of veterinarians from the Department of Veterinary Sciences (www.unipi.it) and bioengineers from the Bioengineering and Robotic Research Center “E. Piaggio” from the University of Pisa, Italy, have already developed and tested textile platforms in horses, with promising results...

Veterinarian and researcher Paolo Baragli presented, on behalf of the research team, the preliminary results at the 10th International Equitation Science Conference in Denmark. The Italian team has tested smart fabrics as a replacement for the standard electrodes used for electrocardiogram (ECG) - a test that checks for problems with the electrical activity of the heart, translating that activity into line drawings on paper or screen.

For this project, patches of smart fabrics made with stainless steel yarn combined with elastane were sewn to the underside of a regular saddlecloth and connected to a very small transmitter that sent readings wirelessly to a tablet. The equipment could be used with a saddle and a rider. The project was focused on comparing textile electrodes with standard electrodes to evaluate the performance and artifacts (reading errors that normally occur as a result of body movement) of both platforms.

"Our results showed that as well as the well-known advantages of comfort and simplicity in using, the smart textiles also offer better technical performance than the standard electrodes," Baragli says. "Although preliminary, these good results indicate that smart textiles can be profitably employed to collect short-term ECG in horses, both during rest and light physical activity."

There is still plenty of work to do because detection of each parameter requires an appropriate validation process. "After proper 'gold standard' validation, textile platforms could be easily adopted in horses to collect parameters related to the Autonomic Nervous System activity," he explains. "For example, heart rate variability (one of the important measures for stress), respiratory rate, peripheral measures of cardiovascular and respiratory functioning, electrodermal response and skin secretion of stress-related hormones."

It seems that the sky is the limit when it comes to the future of smart textiles. The race is on in all corners of the world for (equitation) scientists and the textile industry to explore their full potential, and make that potential a reality to help us do the best for our horses.
Partecipazione a Fieracavalli a Verona
PHOTOGALLERY

FESTIVAL INTERNAZIONALE DELLA ROBOTICA 2018

Foto gentilmente concesse da Sidebloom / Rudy Pessina
Progetti di ricerca

PROGETTI DI RICERCA CORRENTE 2017

N. identificativo progetto: IZS VE 15/17 RC

Progetto presentato da:

ISTITUTO ZOOPROFILATTICO SPERIMENTALE DELLE VENEZIE

Area tematica: Benessere animale

Titolo del progetto:
Interazione emotiva tra cavallo e uomo negli IAA: componenti fisiologiche e comportamentali
Odori umani e feromoni

I cani sentono l'odore della felicità e della paura

LabEC
Laboratorio di Etologia Canina
Prof. Biagio D’Aniello
## Consortium

<table>
<thead>
<tr>
<th>Participant Number</th>
<th>Participant organisation name</th>
<th>Country</th>
</tr>
</thead>
<tbody>
<tr>
<td>1-University (coordinator)</td>
<td>Università di Pisa (UNIPI)</td>
<td>Italy</td>
</tr>
<tr>
<td>2-University</td>
<td>ISPA - Instituto Universitário (ISPA)</td>
<td>Portugal</td>
</tr>
<tr>
<td>3-University</td>
<td>Karolinska Institutet (KI)</td>
<td>Sweden</td>
</tr>
<tr>
<td>4-SME</td>
<td>SRA Instrumentation (SRA)</td>
<td>France</td>
</tr>
<tr>
<td>5-University</td>
<td>Polytechnic University of Valencia (UPV)</td>
<td>Spain</td>
</tr>
<tr>
<td>6-University</td>
<td>University of Essex (UESSEX)</td>
<td>UK</td>
</tr>
<tr>
<td>7-University</td>
<td>Università di Padova (UNIPD)</td>
<td>Italy</td>
</tr>
<tr>
<td>8-SME</td>
<td>Inventya Ventures (EU) Ltd. (INV)</td>
<td>Ireland</td>
</tr>
<tr>
<td>9-University</td>
<td>KU LEUVEN Centre for IT and IP law (KUL)</td>
<td>Belgium</td>
</tr>
<tr>
<td>10-SME</td>
<td>Feel-Ing S.r.l. (F-ING)</td>
<td>Italy</td>
</tr>
<tr>
<td>11-University*</td>
<td>Massachusetts Institute of Technology (MIT)</td>
<td>USA</td>
</tr>
<tr>
<td>12-University*</td>
<td>University College London (UCL)</td>
<td>UK</td>
</tr>
<tr>
<td>13-LE*</td>
<td>Agilent Technologies (AGI)</td>
<td>Italy</td>
</tr>
<tr>
<td>14-University*</td>
<td>Uppsala University (UPP)</td>
<td>Sweden</td>
</tr>
<tr>
<td>15- University*</td>
<td>Nencki Institute of Experimental Biology (NIEB)</td>
<td>Poland</td>
</tr>
<tr>
<td>16- University*</td>
<td>Scuola Internazionale Superiore di Studi Avanzati (SISSA)</td>
<td>Italy</td>
</tr>
</tbody>
</table>

* Advisory board institutions
Main objectives

POTION aims to study the human capacity to transmit emotions and influence social behaviour through body odour: chemosignals.

When we feel emotions such as happiness and fear, the human body produces chemosignals which are released through sweat and which could be emotionally contagious the moment they are perceived by others.
Thank you for your attention!

Enzo Pasquale Scilingo, PhD
Enzo.scilingo@unipi.it