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UNIVERSITÀ DEGLI STUDI DI VERONA

UNIVERSITÀ di VERONA

TECNOLOGIE DI BIOFEEDBACK INTELLIGENTE AMBIENTALE E INDOSSABILE PER LA CORREZIONE POSTURALE - TECNICHE DI MACHINE LEARNING PER LA CUSTOMIZZAZIONE DI STRUMENTI DI BIOFEEDBACK MOTORIO

COD. ENTE 1695 UNIVERSITA’ DEGLI STUDI DI VERONA

ASSE OCCUPABILITA’ - DGR NR. 1463 DEL 08/10/2019

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University of Verona

Dipartimento di Neuroscienze, Biomedicina e Movimento

Dipartimento di Informatica

Wellness for Every age

Postural Analysis e of the Walk

Ergonomics

quality of life

Our areas of research

Neurological Pathologies

sport Performance improvement

Functional Rehabilitation

Health

The University of Verona for Veneto and the United Nations

Our research areas follow the development paths of RIS3 Veneto in terms of Sustainable Living, human well-being and sustainability of the living environment. They are also in line with Goal 3 of the Agenda United Nations 2030: to ensure health and well-being for all people and for all ages. Our projects promote the quality of life of older people and people with illnesses. The idea of the Fund is to strengthen the capacity of all countries to report, reduce and manage health risks in advance

Introduction

- Postural system is one of the fundamental neurophysiological mechanisms of the human body in ensuring balance against gravity and fixing body orientation, and function as a reference frame for perception-action coupling while efficiently dealing with the external world.

- ❑ Choose the best rehabilitation exercises
- ❑ Effective recovery after surgery
- ❑ Walk correction
- ❑ Correction of posture
- ❑ Avoid possible relapses

Objective of the study

- Identify the parameters that define the current state of health.
- Quantify the level of recovery achieved and its maximum limit.
- Suggest specific rehabilitation exercises based on the results obtained

Purpose of the study

- Intended to verify “|how wearable devices can be assembled and employed to provide feedback to human subjects for gait and posture improvement applied to sports performance, or motor impairment performances due to accidents or aging”

Continued …

- The project is organized in three sequences:

✓The first sequence provides experimental protocols for studying action anticipation and related processes involved in the control of posture and gait.

✓The second sequence draws a biofeedback strategy.

✓The third sequence provides algorithmic processing of the biofeedback.

Project goals

- Project goals, reporting the most suitable application scenarios of the technology.

✓(a) Basic application-scenarios;

✓(b) Envisioned technology;

✓ (c) System architecture workflow.

Architecture workflow(logic model)

- User Interface: allows the user to input “environments” and provides visualization of all data/results returned by Machine Learning module;
- Configurator: takes as input a set of environments and gives as output a set of feasible “exercises” to be used by the Trainer, according with user input and machine learning algorithms indications;
- Trainer: uses the exercises and determines the “should be” Paths, meaning which exercises shall be executed and with which environment;
- Evaluator: is responsible for the evaluation of data and automatic comparison with benchmarks;
- Sensor: deals with wearable sensors, collecting and normalizing data.
- Machine Learning: gathers data and induces Models

Methodology design workflow

- To achieve the system's architectural requirements, we have designed a four-step method,

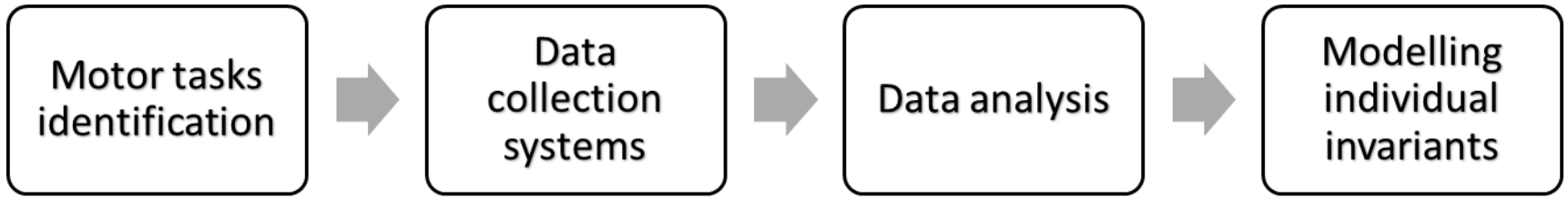
❑- The first step consists of the identification of the most suitable motor tasks;

❑ The second step consists of the description and design of the used data collection 302 systems composing the GPSEnv/GPSJack;

❑ The third step exploits the collected data analysis workflow; 304 –

❑ The fourth step exploits the modeling of gait and posture individual variants by machine learning

Methodology design workflow



Motor task identification

- Three challenging motor tasks were identified ,
- Train fundamental motor skills as action adaptation, compensation, and anticipation while on the other side to measure the performances developed of such skills

Data collection system

- Instruments involved in the design of the GPSEnv and GPSJack systems.

❖The GPSEnv is defined on state-of-the-art apparatus.

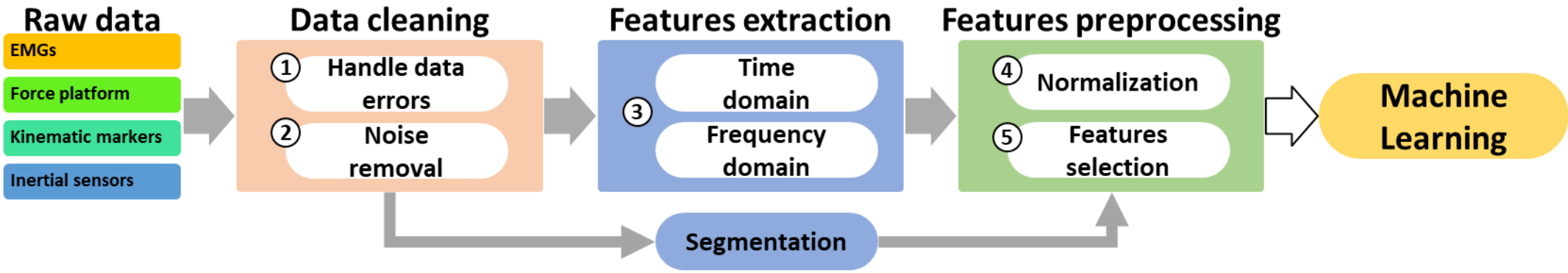
❑force platform;

❑ Surface EMGs;

❑Motion capture cameras

❖The GPSJack is designed over a low-cost and long-battery life System on Chip (SoC).

Data processing workflow



Modeling individual variants by machine learning

- Specific functionalities of the envisioned technology:

❑customization

❑personalization.

Conclusions

- Devised investigating how to build the parameters that allow the physiatric medical staff to evaluate the patient.

- To measure the quality of the performed motor tasks, we designed a low-cost, extended battery life, body area network (aka., GPSJack).

- Moreover, designed an android mobile application that works as a data aggregator and controller for the GPSJack system over which the user can observe the collected data and the posture and gait quality indicators.