The SWEATY Principle

Kinematics

- Reduction of the moments of inertia of the extremities
- Variable gear ratio of the joints: force and speed are angle dependent, the requirements were calculated on the basis of motion capture data

Image processing

- Algorithms for the identification of the soccer pitch, the opponent, lines and goals are mostly based on colors and contours
- Correction of the distortion from the lenses by calibration

Software

- Generic for humanoid robots, supports up to now Sweaty and Nao
- Layered architecture
- Numerous software development tools

Motion control

- Motion is based on MATLAB/Simulink/Stateflow, linkage to hardware via TCP/IP, CAN, RS485, SPI and I2C with a newly developed communication controller
- Newly developed motor controller, capable of overloading the motors up to 500% depending on the coil temperature

Evaporative cooling of the motors

- High currents in the motors result in strong heat release, newly developed evaporative cooling prevents failure of the motor due to overheating
- Extremely „light weight“, 2 g of water per motor are sufficient for a game (not necessary yet, as the actual motion algorithms do not allow yet human – like running).

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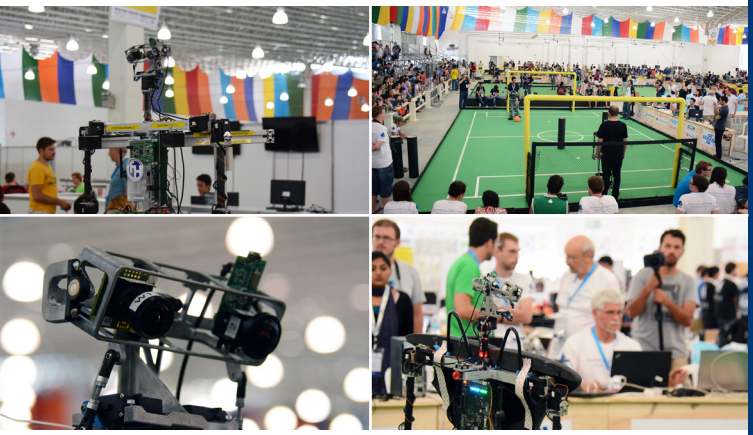
The SWEATY Project 2.0

A humanoid robot.

SWEATY 2.0 at a glance

- Height: 1.60 m, weight: appr. 24 kg
- Material: Aluminium, carbon fibre, steel
- Special components like feet, hands and the head were printed with 3D printer for metals
- Servo motors: 14 x EC 4 Pole 90W, 3x Volz DA, 6 x Robotis Dynamixel MX-64
- Cameras: UI3242LE-C (1280x1024, up to 60 fps) wide-angle lens
- "Brain": 2x GIGABYTE Brix i7-Core at 3.6 GHz
- Newly developed powerboard with two redundant batteries
- Newly developed communication controller board for the connection of the actuators and sensors to the high-level PCs. The software includes TCP-IP servers and the preprocessing of the sensor and actuator data
- Newly developed motor controller for short overloading of the motors with temperature control for high dynamic (140 mm/s) and maximum forces (up to 2100 N)
- Motion control with MATLAB Simulink/Stateflow



SWEATY 1.0 @ RoboCup Soccer 2014 in Brasil

The SWEATY Project 2.0

A multidisciplinary team of the University of Applied Sciences Offenburg developed the humanoid robot Sweaty and presented it 2014 in Brasil in the RoboCup soccer competition. The robot's name "Sweaty" epitomises the idea of overloading the motors and cooling them with evaporative cooling – similar to cooling by perspiration. Sweaty was the first robot using this approach. In addition to this novelty other innovative technologies were introduced in the context of the RoboCup soccer competition, such as innovations in the field of mechanics, kinematics, electronics and software. Not all of these technologies were successful, therefore we decided to rebuild the machine almost from scratch.

Two years later we are now presenting the new "Sweaty 2.0". The actuators are much stronger and the backlash in the joints has been dramatically reduced. The computational power has been substantially increased. Power, speed and the free angular range of the joints have been adapted to the necessary values calculated for the human gait from motion capture data –though we are not yet taking full advantage of the possibilities of the new machine. Sweaty was finalist in the world RoboCup soccer competition in Leipzig 2016 (AdultSize League). To be prepared for the World Championship 2017 in Japan, modification of the mechanical parts are under way, as well as modifications to the IT-structure, the electronics, algorithms and the vision. The aim is to keep pace with the world best robots in soccer and to reach again one of the first places.

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