Movement analysis of a worker in the forest cleaning activities

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Introduction

• Forest cleaning – a pre-harvesting procedure with no direct financial benefits
• Outdated tools and methods – manual work using billhook, machete and sickle
• Repetitive movement, hard working conditions, sharp tools → physical and musculoskeletal injuries
• New tool → battery shears → improvement in the humanisation of forest cleaning activities
Motion capture measurements in forestry

• Aside from measuring physical workload, postural load and recording number and type of injuries, motion capture measurements in forestry are not common

• Technical limitations → until present day motion capture technology was reserved for indoor application

• New technologies → possibility of outdoor measurements

• Motion capture suit → frequently used in medicine, sports and film industry

• Comparison of two working methods from motion capture point of view
Research area

• 10 years old state forest
• Main tree species: sessile oak (*Quercus petraea* (Matt.) Liebl.), common hornbeam (*Carpinus betulus* L.) and common beech (*Fagus sylvatica* L.)
• All measurements were conducted on the edge part of the stand
Materials and methods - worker

• 50 years old male
• Body mass: 105 kg
• Height: 186 cm
• At the time of research the worker had 20 years of working experience in forestry
• The worker was dressed in Xsens lycra suit with integrated IMU sensors and standard issued protective clothes
Materials and methods - tools

Manual method: standard issued billhook
Mass: 1.5 kg
Length: 1.15 m

Motor-manual method: Stihl ASA 85 battery shears and AP 300 battery
Mass: 0.98 kg – shears, 1.7 kg battery
Cutting diameter: 45 mm
Materials and methods – motion capture

• Full-body motion capture suit with 17 IMU sensors

• Human measurement system based on inertial sensors, biomechanical models and sensor fusion algorithms

• Each IMU sensor consists of a 3D accelerometer, a 3D magnetometer and 3D gyroscope

• MVN Analyze software capable of real-time 3D animations, graphs and data streaming
Materials and methods – on site

• A 1 kW gasoline generator was used to power the laptop (trunk) and receiver (roof) – a 12 V battery with power inverter would be better solution

• Before measuring procedure, an obligatory calibration was conducted to „pair” the suit to the worker
Measuring procedure

• The worker was instructed to perform forest cleaning using manual (billhook) and motor-manual (battery shears) method – around 15 minutes of each

• Due to dense vegetation which was interfering communication between receiver and suit, the measurement was limited to the edge part of the stand
The potential of the new technology

• Collected data still in processing phase

• Big potential of the motion capture technology in analysis and evaluation of whole body or body segment movement

• Repetitive movements as the core of the problem

• General lack of physical data to describe repetitive movements and its effect on the human body

• Motion capture → joint angles, segment kinematics, segment global positions, the body center of mass etc.
Observed repetitive movements - billhook
Observed repetitive movements – battery shears
Thank you for your attention!

Questions?