



Modelbased Methods In Motion Capture Uppsala Dibertations From The Faculty Of Science Technology 4

Sajeev C. Puthenveetil



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Forthcoming Books Rose Army,2003 *Whitaker's Books in Print* ,1998 **Model-Based Methods in Motion Capture** Kjartan Alf Halvorsen,2002 **Model-based Methos in Motion Capture** Alf Kjartan Halvorsen,2002 **Motion Capture System for 3D Human Motion Estimation** ,2008 **Capturing Motion** David Putrino,Brandon

Larson,2021-04-15 Capturing Motion Studying Human Movement in the Digital Age provides an update on the available technologies and techniques used in a variety of applications The book discusses the basic functionality of the major forms of motion capture technology used in industry common issues experienced by users different motion capture approaches existing design challenges and the future of motion capture The book provides data insights and case studies from a leading laboratory offering a comprehensive guide to new frontiers in motion capture technology Covers available motion capture technologies including evidence based analysis Considers the various applications of motion capture technology across disciplines Gives the strengths and weaknesses of different techniques and use cases Includes exclusive data insights and case studies from a leading laboratory Offers practical guidance on motion capture technologies applications and techniques

Practical Color-based Motion Capture Robert Yuanbo Wang,Massachusetts Institute of Technology. Department of Electrical Engineering and Computer Science,2011 Motion capture systems track the 3 D pose of the human body and are widely used for high quality content creation gestural user input and virtual reality However these systems are rarely deployed in consumer applications due to their price and complexity In this thesis we propose a motion capture system built from commodity components that can be deployed in a matter of minutes Our approach uses one or more webcams and a color garment to track either the user s upper body or hands for motion capture and user input We demonstrate that custom designed color garments can simplify difficult computer vision problems and lead to efficient and robust algorithms for hand and upper body tracking Specifically our highly descriptive color patterns alleviate ambiguities that are commonly encountered when tracking only silhouettes or edges allowing us to employ a nearest neighbor approach to track either the hands or the upper body at interactive rates We also describe a robust color calibration system that enables our color based tracking to work against cluttered backgrounds and under multiple illuminants We demonstrate our system in several real world indoor and outdoor settings and describe proof of concept applications enabled by our system that we hope will provide a foundation for new interactions in computer aided design animation control and augmented reality A Model-based, Generative and Stochastic Method for Human Motion Capture Using Hierarchical Particle Filters Yuanqiang Dong,2011 Searching in probability spaces can prove to be an impractical task due to the high dimensionality of the state vector In the context of tracking human pose through image features in video sequences the number of degree of freedom DOFs of the human body forces the search to be done using an exponentially large number of possible configuration states In this dissertation we stated that the computational complexity of this search can be greatly reduced by the introduction of a

hierarchical model for the propagation of the state variable and by the efficient selection and synthesis of configuration states through this hierarchy We demonstrated this claim by developing a new hierarchical framework for tracking human pose Extensive experiments on a public benchmark dataset demonstrate comparable tracking errors to the state of the art and up to 60% computational reduction *Machine Learning for Image Based Motion Capture* Ankur Agarwal, 2006 Image based motion capture is a problem that has recently gained a lot of attention in the domain of understanding human motion in computer vision The problem involves estimating the 3D configurations of a human body from a set of images and has applications that include human computer interaction smart surveillance video analysis and animation This thesis takes a machine learning based approach to reconstructing 3D pose and motion from monocular images or video It makes use of a collection of images and motion capture data to derive mathematical models that allow the recovery of full body configurations directly from image features The approach is completely data driven and avoids the use of a human body mode This makes the inference extremely fast We formulate a class of regression based methods to distill a large training database of motion capture and image data into a compact model that generalizes to predicting pose from new images The methods rely on using appropriately developed robust image descriptors learning dynamical models of human motion and kernelizing the input within a sparse regression framework Firstly it is shown how pose can effectively and efficiently be recovered from image silhouettes that are extracted using background subtraction We exploit sparseness properties of the relevance vector machine for improved generalization and efficiency and make use of a mixture of regressors for probabilistically handling ambiguities that are present in monocular silhouette based 3D reconstruction The methods developed enable pose reconstruction from single images as well as tracking motion in video sequences Secondly the framework is extended to recover 3D pose from cluttered images by introducing a suitable image encoding that is resistant to changes in background We show that non negative matrix factorization can be used to suppress background features and allow the regression to selectively cue on features from the foreground human body Finally we study image encoding methods in a broader context and present a novel multi level image encoding framework called hyperfeatures that proves to be effective for object recognition and image classification tasks *Computer Vision-based Motion Capture of Body Language* Thomas Baltzer Moeslund, 2003 *MoCap for Artists* Midori Kitagawa, 2020-10-14 Make motion capture part of your graphics and effects arsenal This introduction to motion capture principles and techniques delivers a working understanding of today's state of the art systems and workflows without the arcane pseudocodes and equations Learn about the alternative systems how they have evolved and how they are typically used as well as tried and true workflows that you can put to work for optimal effect Demo files and tutorials provided on the downloadable resources deliver first hand experience with some of the core processes **Development of Marker-based Human Motion Capture Systems for Assembly Simulation and Ergonomic Analysis** Sajeev C. Puthenveetil, 2013 In aerospace industry the assembly operator

is often exposed to potential ergonomic injuries due to awkward postures while working in confined spaces. Manually generating worker postures in simulation software for ergonomic analysis is cumbersome. This research focuses on the use of marker based optical motion capture technology to generate human motion simulations in real time for ergonomic analysis. To address the challenges involved in capturing human motions in a real work environment, an assembly operation was simulated in a four walled Computer Automated Virtual Environment (CAVE) which provides an immersive 3D environment to the worker performing the assembly operation. Multiple cameras were set up to capture motion data during fastening operation on a physical fuselage mock up model as well as during virtual fastening developed using the CAVE. To facilitate the setting up of a portable turn key motion capture system, a methodology for placing multiple cameras was developed. The process of transforming body joint coordinates of the human skeleton model in the motion capture system to the digital human model used for ergonomic analysis is explained. Anomalies in human motion simulation during motion capture were identified and corrected in real time using anatomical body joint limits and a Kalman filter based predictive filtering algorithm without the need for post processing of motion data. The developed system has been demonstrated for human motion capture, graphic simulation and ergonomic analysis of fastening operation on a physical mock up model and also virtual model of the belly section of an aircraft fuselage.

Abstract leaf iii Application and Evaluation of Lighthouse Technology for Precision Motion Capture

Soumitra Sitole, 2018. This thesis presents the development towards a system that can capture and quantify motion for applications in biomechanical and medical fields demanding precision motion tracking using the lighthouse technology. Commercially known as SteamVR tracking, the lighthouse technology is a motion tracking system developed for virtual reality applications that makes use of patterned infrared light sources to highlight trackers. Objects embedded with photodiodes obtain their pose or spatial position and orientation. Current motion capture systems such as the camera based motion capture are expensive and not readily available outside of research labs. This thesis provides a case for low cost motion capture systems. The technology is applied to quantify motion to draw inferences about biomechanics capture and analysis, quantification of gait and prosthetic alignment. Possible shortcomings for data acquisition using this system for the stated applications have been addressed. The repeatability of the system has been established by determining the standard deviation error for multiple trials based on a motion trajectory using a seven degree of freedom robot arm. The accuracy testing for the system is based on cross validation between the lighthouse technology data and transformations derived using joint angles by developing a forward kinematics model for the robot's end effector pose. The underlying principle for motion capture using this system is that multiple trackers placed on limb segments allow to record the position and orientation of the segments in relation to a set global frame. Joint angles between the segments can then be calculated from the recorded positions and orientations of each tracker using inverse kinematics. In this work, inverse kinematics for rigid bodies was based on calculating homogeneous transforms to the individual trackers in the model.

reference frame to find the respective Euler angles as well as using the analytical approach to solve for joint variables in terms of known geometric parameters This work was carried out on a phantom prosthetic limb A custom application specific motion tracker was also developed using a hardware development kit which would be further optimized for subsequent studies involving biomechanics motion capture

Query-by-example for Motion Capture Data Bennett Lee Rogers,2007

Motion capture datasets are employed widely in animation research and industry however there currently exists no efficient way to index and search this data for diversified use Motion clips are generally searched by filename or keywords neither of which incorporates knowledge of actions in the clip aside from those listed in the descriptions We present a method for indexing and searching a large database of motion capture clips that allows for fast insertion and query by example Over time more motions can be added to the index incrementally increasing its value The result is a tool that reduces the amount of time spent gathering new data for motion applications and increases the utility of existing motion clips

Second Skin Dennis R. Miaw,2010

Second Skin aims to combine three dimensional 3D motion tracking with tactile feedback for the purpose of improving users motor learning ability Such a system would track a user s body and limb movements as he or she performs an action and then give the user automatic real time tactile feedback to aid in the correction of movement and position errors This thesis details the development of a robust and low cost optical 3D motion capture system along with versatile and flexible tactile feedback hardware The vision is that these technologies will facilitate further research and the future development of motor learning platforms that fully integrate 3D motion tracking and tactile feedback

Toward motion-capture-based digital human modelling ,2012

Human Motion Capture in Images and Videos Using Discriminative and Hybrid Methods Suman Sedai,University of Western Australia,2012

Truncated abstract Vision based human pose estimation and tracking is a popular research area that has generated a great deal of interest in the last decade This is motivated by the fact that this research area has many applications including video surveillance clinical rehabilitation and the analysis of athlete performance It is also non intrusive and does not require markers to be attached to the body parts as opposed to the marker based motion capture systems In this thesis two machine learning and one feature representation techniques have been developed to automatically capture human motion from images and videos This thesis is organized as a set of papers published to and or under review by journals or international conferences During the last two decades there has been much work in markerless human motion capture This thesis contributes to the existing body of work by providing three new algorithms First an appearance descriptor is proposed for human pose estimation from monocular images Second a discriminative learning based fusion algorithm is proposed to combine shape and appearance features for human pose estimation from monocular images Third a hybrid discriminative and generative method that takes into account prediction uncertainty of the discriminative model is proposed for 3D human pose tracking from both single and multiple cameras Shape based features such as silhouettes and appearance features are commonly used for pose estimation from monocular

images using regression based techniques Silhouette features require a segmentation step to obtain only information pertinent to the shape of the occluding body parts and discards appearance information that can potentially be useful for pose estimation In order to utilize appearance information we present an appearance descriptor that involves dimensionality reduction and vector quantization and that is suitable for regression based human pose estimation To objectively compare the state of art shape and appearance descriptors with our appearance descriptor we conducted a quantitative evaluation using the HumanEva I dataset Shape based features such as silhouettes are insensitive to background variations but they can be associated with more than one pose resulting in ambiguities Appearance features on the other hand can be more distinctive than shape features but they may be affected by background clutter and variations in the clothing of the human subject which can make appearance features unstable While neither shape nor appearance features are self sufficient for a robust estimation of human poses they have the potential to complement each other because one may not be sensitive to conditions that affect the other This thesis presents a novel fusion method based on discriminative learning to combine the proposed appearance descriptor with a shape descriptor to exploit their complementary properties for human pose estimation from monocular images The proposed method which is named localized decision level fusion technique is based on clustering the output pose space into several partitions and learning a decision level fusion of the regression models for the shape and appearance descriptor in each region

Constructing a Reference Standard for Sports Science and Clinical

Movement Sets Using IMU-based Motion Capture Technology Thomas Jamin Gilbert,2021 **Classification of Motion Capture Sequences** Dharin Haresh Maniar,2009 Motion capture data is a digital representation of the complex temporal structure of human motion Motion capture is widely used for data driven animation in sports medicine and entertainment because of its ability to capture complex and realistic motions Due to its efficiency and cost methods for reusing collections of motion capture data are becoming important in the field of computer animation These motions can then be used for motion blending and morphing which in turn requires identification and retrieval of the motion from the large collection of motions Currently motion data is manually labeled and segmented through a labor intensive process This thesis investigates algorithms for the classification of motion capture sequences This classification task is challenging due to the data being high dimensional continuous and time variant The main contribution of this thesis is an empirical comparison of a variety of classification algorithms for motion capture sequences We investigate three different aspects of these classification algorithms 1 the use of discrete versus continuous models of the data 2 generative versus discriminative models and 3 dimensionality reduction through Principal Component Analysis a linear technique versus the Gaussian Process Latent Variable Model a non linear technique Whole-body Motion Capture and Beyond Yinghao Huang,2022 Though effective and successful traditional marker less Motion Capture MoCap methods suffer from several limitations 1 they presume a character specific body model thus they do not permit a fully automatic pipeline and generalization over diverse body shapes

2 no objects humans interact with are tracked while in reality interaction between humans and objects is ubiquitous 3 they heavily rely on a sophisticated optimization process which needs a good initialization and strong priors This process can be slow We address all the aforementioned issues in this thesis as described below Firstly we propose a fully automatic method to accurately reconstruct a 3D human body from multi view RGB videos the typical setup for MoCap systems We pre process all RGB videos to obtain 2D keypoints and silhouettes Then we fit the SMPL body model into the 2D measurements in two successive stages In the first stage the shape and pose parameters of SMPL are estimated frame wise sequentially In the second stage a batch of frames are refined jointly with an extra DCT prior Our method can naturally handle different body shapes and challenging poses without human intervention Then we extend this system to support tracking of rigid objects the subjects interact with Our setup consists of 6 Azure Kinect cameras Firstly we pre process all the videos by segmenting humans and objects and detecting 2D body joints We adopt the SMPL X model here to capture body and hand pose The model is fitted to 2D keypoints and point clouds Then the body poses and object poses are jointly updated with contact and interpenetration constraints With this approach we capture a novel human object interaction dataset with natural RGB images and plausible body and object motion information Lastly we present the first practical and lightweight MoCap system that needs only 6 IMUs Our approach is based on Bi directional RNNs The network can make use of temporal information by jointly reasoning about past and future IMU measurements To handle the data scarcity issue we create synthetic data from archival MoCap data Overall our system runs ten times faster than traditional optimization based methods and is numerically more accurate We also show it is feasible to estimate which activity the subject is doing by only observing the IMU measurement from a smartwatch worn by the subject This not only can be useful for a high level semantic understanding of the human behavior but also alarms the public of potential privacy concerns In summary we advance marker less MoCap by contributing the first automatic yet accurate system extending the MoCap methods to support rigid object tracking and proposing a practical and lightweight algorithm via 6 IMUs We believe our work makes marker less and IMUs based MoCap cheaper and more practical thus closer to end users for daily usage

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Introduction

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