APPENDIX A – TERMS AND DEFINITIONS

Robotics and Systems Control

Articulated Figure – A set of rigid body segments connected by rotary joints.

Degrees of Freedom (DOFs) – The set of variables required to fully specify a creature's position and orientation in free space. A single rigid body in free space has six degrees of freedom, three for position and three for orientation.

Kinematics – Computation of the absolute position of all parts of a creature, given the relative joint angles. In animation, kinematics typically refers to the specification or manipulation of the joint angles and velocities without regard to physics.

Inverse Kinematics – Computation of the intermediate joint angles from absolute positions. For example, computing the angles of leg joints needed to place a foot in a particular position.

Dynamics – Computation of the accelerations of the links of an articulated figure using the laws of physics.

Inverse Dynamics – Computation of the torques and forces required to be applied to a body to achieve desired accelerations.

Centre of mass (COM) – The single point on a body through which a linear force can be considered to act, defined as:

$$\bar{x} = \frac{\int_{mass} x\,dm}{M}$$

where M is the total mass.

System state – The set of variables required to fully specify the position and velocity of every point on an object. The system state of an object consists of its degrees of freedom and their derivatives. Figure A–1 shows the two components of the state for a simple swinging pendulum plotted with respect to time. The two near-sinusoidal curves are out of phase since the peak joint velocity occurs when the joint angle is zero and the peak angle occurs when the velocity is zero.

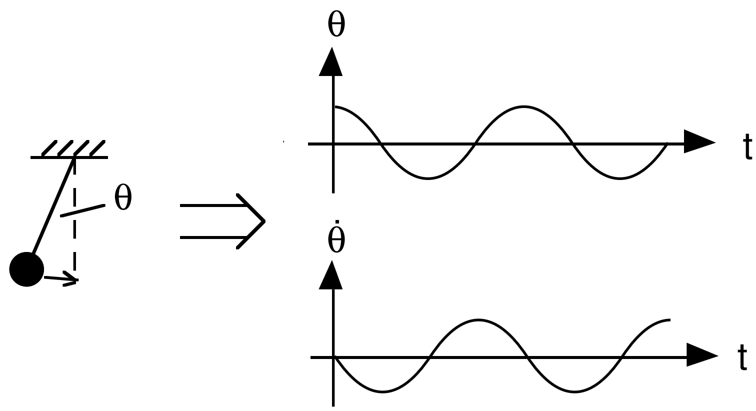

Figure A–1 - State vs time for a 1 degree-of-freedom swinging pendulum plotted vs time.

State space – The set of all possible values of the state of an object. A trajectory through the state space of an object describes its motion. Figure A-2 shows the state space representation of the trajectories of Figure A–1.

Limit cycle – A periodic, cyclic trajectory through state space. The trajectory in Figure A-2 is an example of a limit cycle which represents the periodic motion of a simple pendulum. Throughout this thesis, the term limit cycle is used to refer to cyclic, periodic motion in part of the state space rather than strictly applying to the full state space.

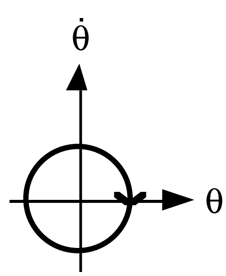

Figure A–2 - State-space trajectory of a simple swinging pendulum.

Biomechanics

Anthropomorphic – Human-like in structure.

Sagittal Plane – A reference plane on the human body. See Figure A-3.

Coronal or Frontal Plane – A reference plane on the human body. See Figure A-3.

Transverse Plane – A reference plane on the human body. See Figure A-3.

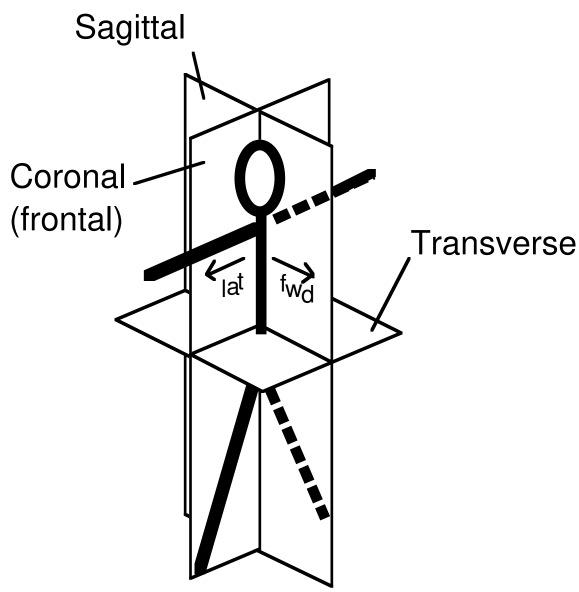

Figure A–3 - Reference planes of the human body.

Roll – Joint or body rotation in the coronal plane.

Pitch – Joint or body rotation in the sagittal plane.

Yaw – Joint or body rotation in the transverse plane.

Stride – One full gait cycle, for example, from the a foot touching the ground to the same foot touching the ground one full cycle later.

Step – The forward movement of a single leg. In a normal human walk, there are two steps in each stride.

Stance leg – A leg in contact with the ground at any point in a walk.

Swing leg – A non-supporting leg at any point in a walk.

Double-stance – The phase of a walk during which both feet are in contact with the ground. Figure A-4 shows the phases of a bipedal walk.

Single-stance – The phase of a walk or run during which only one foot is in contact with the ground. See Figure A-4.

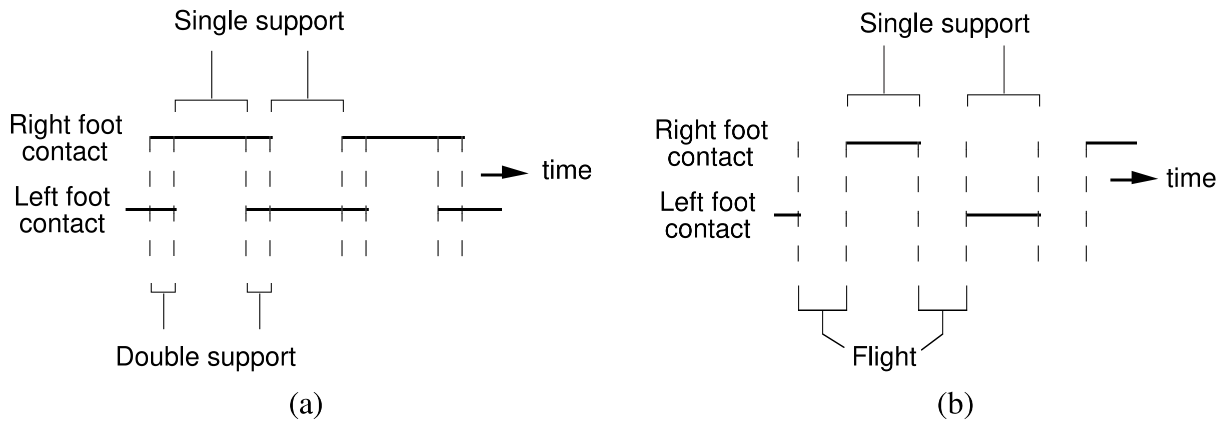

Figure A–4 - Phases of bipedal walking and running. Solid lines indicate the times that the associated foot is in contact with the ground.
(a) walking
(b) running

Computer Animation

Motion capture - A technique, used to animate computer generated characters, in which the motion of the animated character is taken from a real world source such as a person walking. Modern forms of motion capture typically use markers attached to the subject's body which are tracked by a sensing device (e.g. an IR camera).

Rotoscoping - A form of motion capture in which motion data is taken from pre-recorded live images such as film or video.

Thesis Related

Pose Control Graph (PCG) – A type of finite state machine which specifies a set of desired poses over time. Each desired pose specifies a set of desired joint angles for the articulated figure being animated.

Base Pose Control Graph – A pose control graph used to provide the basic cyclic control for a desired periodic motion.

Regulation Variable (RV) – A scalar function of system state chosen to represent a key feature in the overall motion of an articulated figure. A set of regulation variables essentially form a reduced order model of the system. Regulation variables are controlled in order to achieve some desired change in the overall motion for a figure. Q^d is used to denote the desired (or target) value of an RV. Q^* represents the final controlled value of the RV.

Linear Parametric Perturbation (LPP) – A fixed PCG multiplied by a scaling factor and added to a base PCG. LPPs are used to achieve desired changes in the regulation variables or variations in the overall motion of the base PCG.

Superposition (SP) sampling – A sampling strategy for constructing a model to balance one step of a walk. Using SP sampling, the biped is balanced in the sagittal and coronal planes independently and then the results are combined.

Forward-then-lateral (F-L) sampling – A strategy for constructing a model to balance one step of a walk. Using F-L sampling, the biped is first balanced in the sagittal plane and then the results of this operation are used to balance the biped in the coronal plane.

Lateral-then-forward (L-F) sampling – A strategy for constructing a model to balance one step of a walk. L-F sampling is similar to F-L sampling except that the biped is balanced first in the coronal plane and then in the sagittal plane.