A Modular Paradigm for 3D Scanninng:
An overview of the Project Splinescan '4PASS' filter system

Abstract

This white-paper provides a brief introduction to the modular design methodology used within the Splinescan v4 prototype. The paper will discuss the advantages of the proposed modular filter system, and familiarise the reader with the basic filters that may be used during a typical scan.

Introduction

The Splinescan v4 prototype scanning system will consist of a series of discrete applications and scripts (known as 'filters') that are linked together using scripts to form a pathway. This 'pathway script' orchestrates the production of a 3D model from raw data. This modular approach has several distinct advantages over monolithic applications when dealing with fixed sensor, non-contact scanning applications.

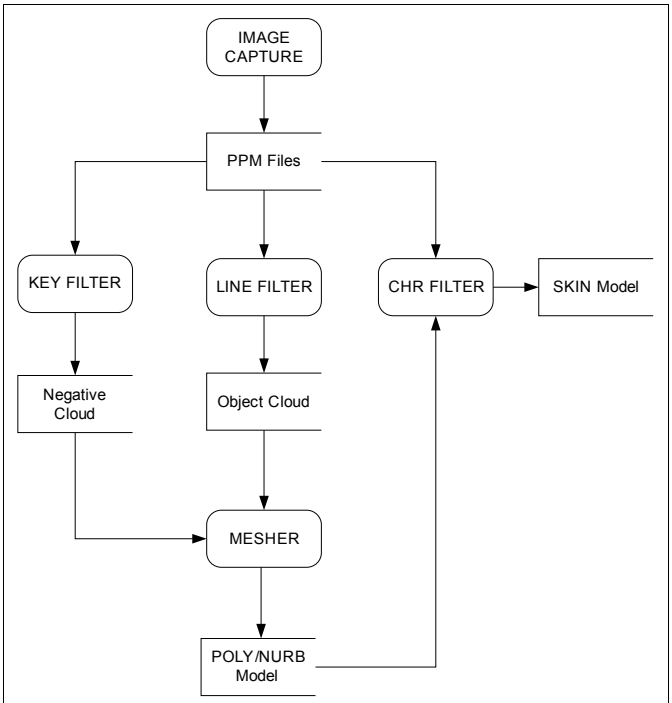

Figure 1: *The Ss.C prototype will use a multi-pass scanning system, where raw images are processed more than once to generate a coherent output model. The diagram above gives a sample layout for a typical scanning process.*

Firstly, the loosely interconnected nature of each application within the scanning pathway makes it simple to interface scripts and applications that have been produced in different languages. No recompilation or transcoding is necessary, which means that any developer can create filters or process modules for the scanning system in their preferred programming language.

General users will benefit from the flexibility afforded by the discrete applications. The open nature of the pathway facilitates user interactions on variable levels of user abstraction. For general users, scripts and applications can be piped together using a 4GL GUI, while more advanced users can generate their own pathway scripts from the terminal.

The modular approach has obvious benefits for distributed and parallel processing applications. With proper scripting, any processing can be carried out on any number of systems, independent of geography, operating system and processor architecture.

Filters

The Splinescan v4 system will have a number of default filters that can be added to or modified by general users. In the splinescan project, a filter can be described as any application or script which requires and/or produces a file in one of the formats recognised by the splinescan system. A script that links a series of filters together is called a 'batch filter'. The script that controls the entire scanning process is known as the 'scanning pathway' or 'control script'. A filter may call any other filter or external application when it is activated, but may not be called recursively.

Filter Hierarchy

Splinescan filters are divided into a number of hierarchical 'classes'. No filter can process data that has been output from a higher class, but some filters may access data from multiple subservient layers of the class hierarchy. It is possible to use multiple filters from each hierarchical level simultaneously, although the sequence of filters within each class must be piped correctly. As a minimum, each scan must have at least one input filter and one mesh filter to produce a coherent model. The hierarchical structure of the filter system is: PRE-FILTER<INPUT<ENHANCEMENT<MESH<SKIN.

A Brief description of the default filters is given on the next page.

PRE-FILTERS
The pre-filter subclass is the only filter class that does not require an input filename in order to function. Filters in this class are used to capture raw sensor data into the scanning pathway so that they can be further processed.

CNC Linear Scan	This filter is used to capture linear scan data from a computer controlled rig
CNC Rotary Scan	This filter is used to capture rotary scan data from a computer controlled rig
Timed Scan	This filter is used to capture linear scan data from a from a free moving rig

INPUT FILTERS
Filters within the input class are used to convert 2D PBM or BMP data to 3D point cloud (x,y,z) data.

Rotary Scan Filter	This filter is used to process data from rotary rigs
Linear Scan Filter	This filter is used to process data from linear rigs
Key Filter	This filter is used to process chroma-key data (the environment scan) from rotary rigs

ENHANCEMENT FILTERS
Enhancement filters modify 3D x,y,z data in some way.

Smooth Filter	Performs a vertical or horizontal smooth on a point cloud
2D Hole Filling	Fills holes in vertical scan lines using one of several methods
3D Hole Filling	Fills holes in vertical scan lines using 3D weighted methods
Sub-sample Filter	Reduces the number of points in a data cloud
Super-sample Filter	Increases the number of points in a data cloud.

MESH FILTERS
Mesh filters convert or translate x,y,z, POLY or NURBS models in some way.

Nurbs	Converts a Polygon model or point cloud into a NURBS model
Poly	Converts a NURBS model or point cloud into a Polygon model
Unmesh	Converts a NURBS or Polygon model into a regular point cloud
Raw	Converts a point cloud into a standard ASCII raw triangle file
Boolean	Performs boolean operations on point clouds, polygon models or NURBS models.

SKIN FILTERS

Skin filters are used to convert chrominance data captured from the surface of the model into a into SKIN file

Surface Filter	Generate a texture map from the surface of a model
Reflectance Filter	Generate a reflectance map from the surface of a model
UV Filter	Detect material differences based on UV reflectance and generate a UV mask.