Detecting camera preferences in a virtual savannah environment using statistical analysis

Master Thesis

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Title: Detecting camera preferences in a virtual savannah environment using statistical analysis

Theme: Master's Thesis

Project Period: 01.03.2011 – 29-06-2012

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Prints: 2
Pages: 12+cover & titlepage
Appendices: 1 CD

Abstract:
This report attempts to show correlation between user profiles and their choices when placing cameras as preferred in a 3D savannah environment with different tactical scenarios. The report show non-conclusively that a classifier can be made from the profile data and their choices to places cameras on agents as headcams or on the ground in specified areas.

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Introduction

Aquariums with fish and terrariums with insects or animals have so far been the means to experience the behavior of nature at home. At the zoo it is possible to experience larger mammals in larger arenas though still no match for the real deal. In the confined arena of the zoo pen the lions have no prey to stalk nor hyenas to wage war against. Prey is separate from predator with the result that the basic behaviors that are kill and flee never will be experienced live by the audience. Documentaries may show the events in the life of a zebra and the drama of the lions on the hunt but it is far from a live experience. The audience knows that it is recorded and that is has taken months or years to produce a wildlife documentary.

This project builds on the notion of a virtual wild life environment, a persistent virtual environment on display at the local zoo. The vision entail, that zoo visitors can insert their own animals into the dynamic environment. To create a feel of realism the animals in the virtual zoo should have their own artificial intelligence, but also a governing system that ensures dynamic events for the zoo visitors when lions meet zebras or when the weather changes and grass fields become ripe. Since the system is a system for a plural audience with limited or no controls the system should also be able to deliver exiting camera compositions.

Assuming the owner of an inserted animal is present when an event occurs with his animal in center, the system should tailor the camera experience to his preference. The focus of this project is how a system can guess the preferred camera setting of a user given profile data supplied when an animal is inserted into the environment.

Hypotheses

Considering that the profile data should affect camera preference the following series of hypothesis are put forth:

- A user prefers different a use of camera in different tactical scenarios.
- Users with a similar background in computer games and nature documentaries will prefer similar use of camera.
- The degree to which a user plays computer games directly correlates with the users preferred use of cameras.
- Users will disregard cinematography guidelines such as the 180 degree guideline.

Approach

Different methods can be used to gather data on user camera preference. The users could be presented with prerecorded videos with different camera perspectives. This approach limits the diversity of perspectives used. To allow freedom to disregard standards it is necessary for the user to be able to place the camera. Therefore data will be gathered by creating a program allows users to place cameras as they prefer in different scenarios. Data will then be recorded and analyzed using statistical tools.

To gather data on user background a survey will be created that users have to complete before completing the camera placement assignments.

Delimitation

Since the test of the hypotheses relies on statistical analysis it is important to gather as large a test group as possible. Therefore an online method will be chosen as it can reach more people faster than interviews and in house tests. It is assumed from common knowledge that long surveys and cumbersome tests online deter users from completing the surveys and tests. Therefore a short survey will be used and the test will be made as plain as possible.

The Survey

To test the hypotheses background information on the user needs to be gathered. The assumption is that camera styles that a user is used to experience, or camera styles from experiences that the user likes will carry through to the way a user will prefer cameras used in the virtual environment. To find correlations between how the user places cameras and their past experiences with camera settings, specifically in computer games and nature documentaries it is important to document the following features:

- Which notable games genres does the user play?
- How many encounters does the user have with the computer game experiences?
- Which movies did the user recently experience?
- Which tv channels featuring nature documentaries does the user have access to?
- How does the users feel about nature documentaries?

Survey questions were formulated based on the feature list above.

"Which of the following game genres do you play?"

To keep the survey short and quantifiable answers possibilities were limited. Genres were chosen for their tendency to display specific camera styles and include:

- First Person Shooter
- Third Person Shooter
- Massively Multiplayer Online Role Playing Games (MMORPGs)
- Simulations games (E.g. the sims, sim city)

Users were asked if they played games a few times a month, a few times a week, almost every day or every day. Instead of specifying hours a day or week, the question focus on game encounters.

Users were asked to mention the three last movies seen. This is a qualitative question because, it is assumed, camera perspective styles in movies are not as closely related to genres as computer games to their genres.

Specifying whether the user has access to nature channels is thought to make for better correlations than asking about experiences with nature documentaries because experiences with nature documentaries are thought to be more coincidental.

To assess whether the user actively engages in nature documentary experiences the user is asked about their feelings towards nature documentaries on a scale composed of the relations Love, like, neutral, dislike and despise.

Basic profile information was also included in the survey; gender and age. Since people may be sensitive about their age the participant where asked to type their year of birth. This should ensure the most accurate result when asking in an online survey. (Benjamin Healey, 2007)

The Camera Placement System

To gather data about user camera preference in a 3D environment a program was made where users can place cameras as they prefer. To investigate the implication of different tactical scenarios on camera placement three scenes were made each depicting a scenario picked from the National Geographic documentary The Pack Lions. (Geographic)

Animation

Each scenario was scripted using a waypoint system as seen in Figure 1. The waypoint system has been created such that each creature has a list of waypoints to follow step by step. Using the Unity editor classes a script was created to overwrite the normal graphical user interface of the unity inspector pane to create a button for creating waypoints, see Figure 2. (Unity)

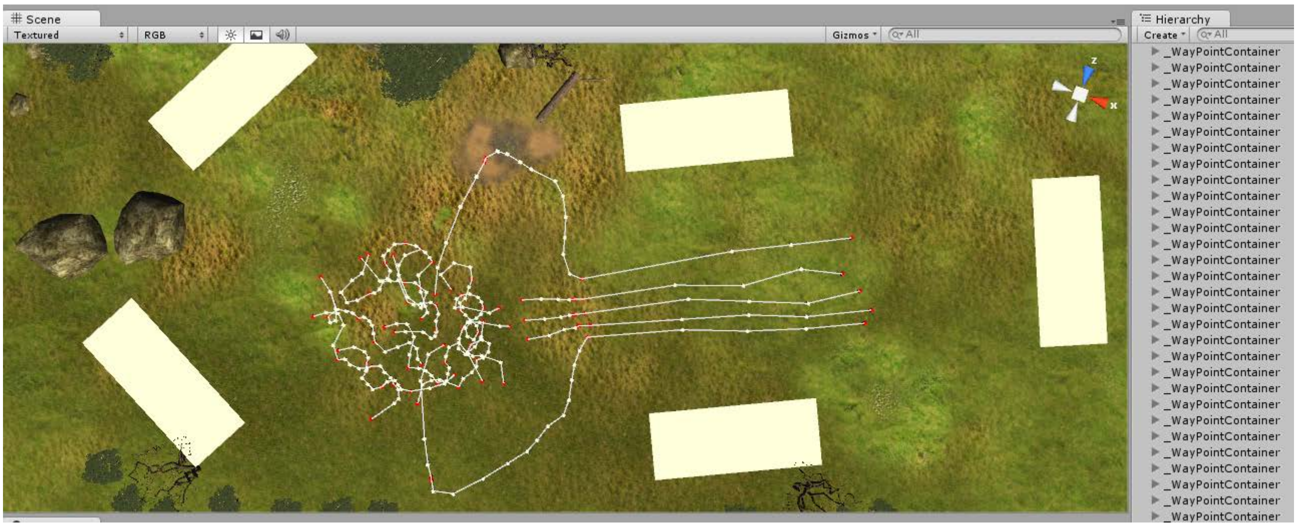

Figure 1 : The waypoints used for scenario two, The Blitz.

Each waypoint allows setting a speed towards the next waypoint and a delay in seconds to wait until proceeding to the next waypoint.

Using a waypoint system where agents walk arbitrary distances at arbitrary speeds and delays makes it difficult to go back and forth in time. Since there is no recorded temporal relationship, going back and forth in time involves bringing agents to previous or upcoming waypoints. Since there is no guarantee that agents will arrive at a waypoint at the same time bringing all agents back to a numbered waypoint has the risk of skewing an agent's position in time.

One solution that will allow using time as a variable is recording position and rotation over time for each agent when building the scene. This method has a discreet resolution and requires storage and recording of data. Another solution is generating a parameter equation from the waypoints of each agent. This method allows any position and rotation to be calculated from a time parameter.

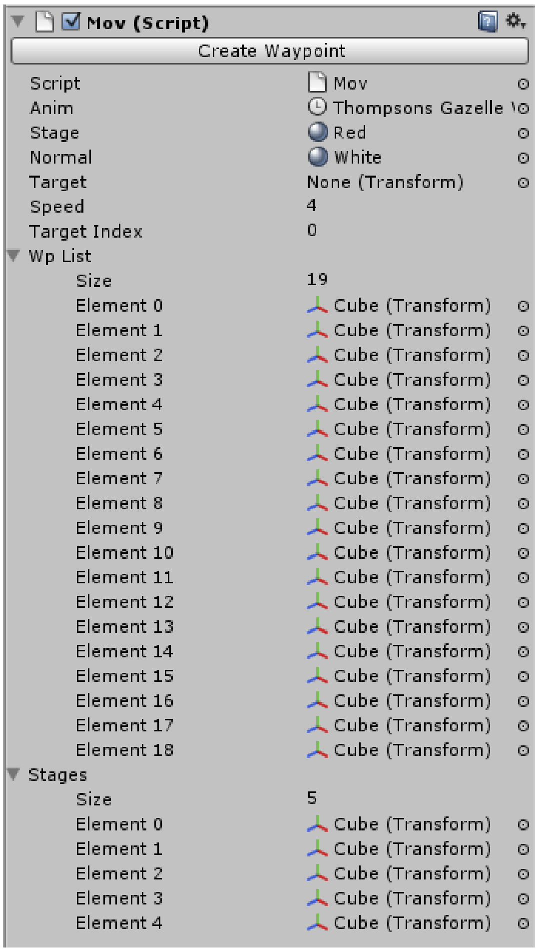

Figure 2 Unity Inspector pane, with custom button Create Waypoint

To simplify programming the method chosen was to define some waypoints as numbered stages. Each numbered stage defines a point of synchronization. If an agent reaches a stage before time it will wait until all other agents have reached the same stage. Stages can now be loaded with guarantee of synchronicity. The drawback is that fluid movement across a stage requires a perfect timing so agents that are supposed to move fluidly reach the stage waypoint without having to wait on other agents.

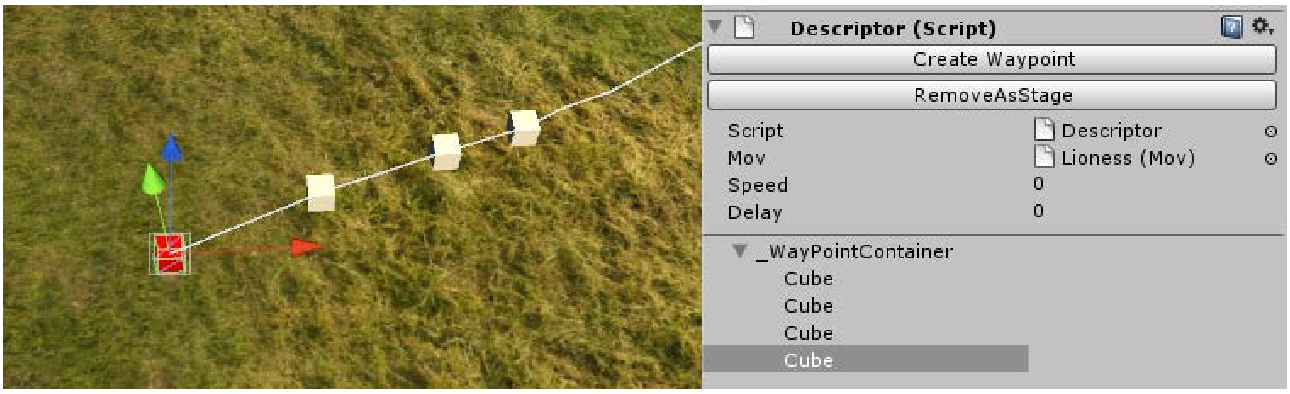

Figure 3 Waypoint inspector pane and scene hierarchy

Each agent has a list of stages as well as a list of waypoints. An editor script was created to allow easy creation of waypoints and conversion into stages with graphical buttons and hotkeys as seen in Figure 3. Since objects in the scene hierarchy are connected through the object transform any new waypoint is added to a waypoint container separate from the agent ensuring that the waypoints do not move with the agent.

Camera Placement

Two options were created for users to place cameras. One is the option for users to place a camera on agents as head cameras. Second is the option to place a camera on the savannah. Allowing the user to freely place a camera on the savannah will make it difficult to classify the placements of the cameras. To maintain some freedom of placement while enabling easy classification of the placement areas were created that cameras could be placed within. To show the user that a camera placement is possible areas were displayed as white rectangles. The possibility to place a camera on an agent is shown by displaying a white circle. See Figure 4.

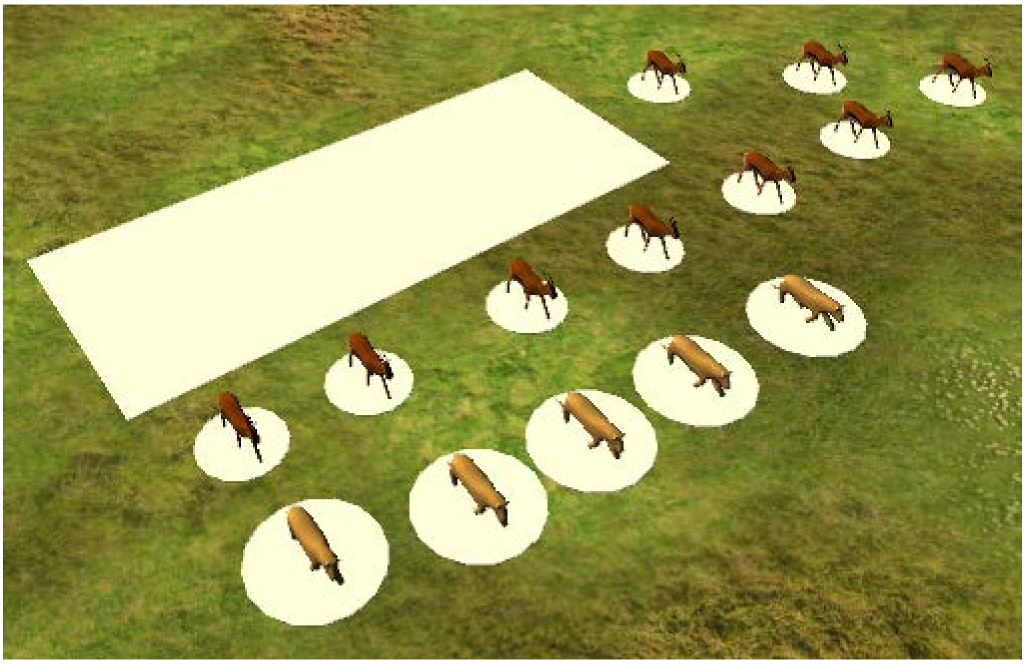

Figure 4 Areas where cameras can be placed.

Camera placement areas were placed so that the center of action can be filmed from opposite angles as seen in Figure 1. This will give users the opportunity to break the cinematography 180 degree guideline.

Graphical User Interface

To guide the user through the assignments a graphical user interface was designed. Buttons were created to allow the user to navigate to the different stages of the scenario. After initial testing of the assignments a red background was added to indicate the current stage. Preliminary test users had reported confusion as to what happened when buttons where clicked. To give the users an overview of their progress towards completing the assignment a check mark was placed next to the stage buttons to indicate in which of the stages camera had been placed.

Figure 5 User menu. Check marks represent cameras placed. The red Go to Stage button represents the current loaded stage.

The user interface was kept small and simple as not to draw attention from the assignments at hand.

Data Collection

Data is collected every time a user completes an assignment and continue to the next scene. This is achieved by sending an HTTP request with the information encoded to a .php script on a server. The script parses the information and stores it in a MySQL database. To keep track of the individual user and his data the system requests a unique ID from the server at the start of the program. This ID is sent along with each http request to identify the user.

The data collected in the assignments include:

- Area or type of agent where each camera was placed.
- Type of camera placement; area or agent.
- Time spent pr. assignment.
- Camera field of view.
- Camera position, rotation and camera target position.
- Time spent between constructive clicks.

The purpose of recording time spent between constructive clicks is to rule out irregular times in time spent pr. Assignment. A user who takes a break from the program for a will generate an irregularly high time spent pr. Assignment. If the users time between constructive clicks are all regular then it is likely that the user has spent a long time on the assignment, however if the user has a spike in the array of time between constructive clicks it is likely that the user left the program for a while.

Data Mining

The program was distributed by Facebook channels and on the Unity forums general topic board. 62 participants validly responded to the survey and continued to the first scenario assignment. Of those 62 participants 42 completed the first assignment, 36 completed the second assignment and 33 completed all three assignments.

To explore the extracted data the WEKA tool was used. (Group) The WEKA tool has a series of statistical analysis tools for mining data. Following are some of the results from the experiment.

```
kMeans
======

Number of iterations: 2
Within cluster sum of squared errors: 16.592592592592588

Cluster centroids:
                         Cluster#
Attribute    Full Data          0          1          2
                  (33)       (27)        (3)        (3)
=======================================================
L1S1_type       0.1515      0.037          1     0.3333
L1S2_type       0.1515      0.037          1     0.3333
L1S3_type       0.1212     0.0741     0.6667          0
L1S4_type       0.0909          0          1          0
L2S1_type       0.0909          0          1          0
L2S2_type       0.1212      0.037          1          0
L2S3_type       0.1212      0.037          1          0
L2S4_type       0.2727     0.1852          1     0.3333
L3S1_type       0.1515      0.037          1     0.3333
L3S2_type       0.1515     0.0741          1          0
L3S3_type       0.0909          0          1          0
L3S4_type       0.1515          0     0.6667          1
```

Figure 6 Clustering on variables denoting whether a camera was placed on an agent or an area. 0 is area 1 is agent.

Figure 6 above show whether users placed the camera on an agent (value of 1) or an area (value of 0) in each stage S1,S2,S3,S4 of each assignment L1,L2,L3. The data shows a large grouping of 27 users where any given user set few or no cameras on agents during the total of twelve stages. Another group of three users consistently placed cameras on agents throughout the stages. A third group has no apparent pattern and does not fit in the two other groupings. If considering camera style as a choice between camera on agent or on area this statistic could make an argument for rejecting the hypothesis;

- A user prefers different a use of camera in different tactical scenarios.

Since it seems that overall there is a consistent but low usage of agent cameras, and the large group alone shows a low agent camera usage in every scenario.

Assuming that the hypothesis above can be rejected, it is safe to assume that the choice between camera on agent and camera on area it independent of the tactical scenario. Therefore it is based on the immediate position of the agents at that stage, or based on the user's background. Averaging the values of user's choice pr. Stage, result in a value that indicates the likelihood of the user choosing a camera on an agent. Using a K nearest neighbor technique it is possible to create a classifier that based on the profile data collected can determine whether or not the camera shall be placed on an agent, see Figure 7.

```
=== Classifier model (full training set) ===

IB1 instance-based classifier
using 1 nearest neighbour(s) for classification


Time taken to build model: 0 seconds

=== Evaluation on training set ===
=== Summary ===

Correctly Classified Instances          41               97.619  %
Incorrectly Classified Instances         1                2.381  %
Kappa statistic                          0.8444
Mean absolute error                      0.0455
Root mean squared error                  0.1113
Relative absolute error                 24.2775 %
Root relative squared error             37.8555 %
Total Number of Instances               42

=== Detailed Accuracy By Class ===

               TP Rate   FP Rate   Precision   Recall  F-Measure   ROC Area  Class
                 1         0.25       0.974     1         0.987      0.997    '(-inf-0.5]'
                 0.75      0          1         0.75      0.857      0.997    '(0.5-inf)'
Weighted Avg.    0.976     0.226      0.977     0.976     0.975      0.997

=== Confusion Matrix ===

  a  b   <-- classified as
 38  0 |  a = '(-inf-0.5]'
  1  3 |  b = '(0.5-inf)'
```

Figure 7 K nearest neighbor classifier

The data shows that the classifier will accurately guess the users preferred camera type 97.6% of the time.

```
kMeans
======

Number of iterations: 2
Within cluster sum of squared errors: 23.180900621118013
Missing values globally replaced with mean/mode

Cluster centroids:
                          Cluster#
Attribute      Full Data         0         1         2
                    (33)       (7)       (3)      (23)
======================================================
GameTime          1.9091    1.5714         2         2
G_FPS=True        0.7273         0    0.3333         1
L1S1_type         0.1515         0         1     0.087
L1S2_type         0.1515         0         1     0.087
L1S3_type         0.1212    0.1429    0.6667    0.0435
L1S4_type         0.0909         0         1         0
L2S1_type         0.0909         0         1         0
L2S2_type         0.1212    0.1429         1         0
L2S3_type         0.1212    0.1429         1         0
L2S4_type         0.2727    0.1429         1    0.2174
L3S1_type         0.1515    0.1429         1    0.0435
L3S2_type         0.1515         0         1     0.087
L3S3_type         0.0909         0         1         0
L3S4_type         0.1515         0    0.6667    0.1304
```

Figure 8 Clustering result relating type of camera placed with frequency of computer game experiences and whether or not the user plays FPS games

Figure 8 shows an interesting relation between users who play first person shooter games and the preference for camera placement. It seems to say that users who play first person shooter games dislike agent cameras in the second scenario, but with a small likelihood prefers agent cameras in scenario one and three. Where the group of seven users seem to indicate that users who do not play first person shooters are with a small likelihood prefers agent cameras in scenario two but dislikes the agent cameras in scenario one and three. This seems to indicate that the hypothesis referenced below cannot entirely be rejected.

- Users with a similar background in computer games and nature documentaries will prefer similar use of camera.

Whereas the hypothesis further below referenced does not find any support on the basis of the data in Figure 8.

- The degree to which a user plays computer games directly correlates with the users preferred use of cameras.

Conclusion

By using statistical tools as those offered by WEKA profile data like the data gathered through this project can be translated into classifiers that can attempt to guess users preferred camera style. In this case further treatment of the data would probably show more convincing results. However, the data also shows a participant group which largely consists of males, so expanding the test group to include more females would give a more solid data foundation considering the use of the system would be in a public zoo.

The analysis in this report only covers a small portion of the intended work. A deeper insight in the position and targeting of cameras would be desirable as well as more work on the use of the field of view setting.

There are several points of critique which can be raised toward the data gathering system. For instance the fact that the dull animations can have deterred the users from using close ups, or that the jerky motions of the agents deterred users from placing cameras on agents.

Works Cited

Benjamin Healey, P. G. (2007). Asking the Age Question in Mail and Online Surveys. Massey University.

Geographic, N. (u.d.). *The Pack: Lions*. Hentet fra http://natgeotv.com/uk/the-pack/about

Group, M. L. (u.d.). *WEKA*. Hentet fra http://www.cs.waikato.ac.nz/ml/weka/

Unity. (u.d.). *Editor Class*. Hentet fra http://docs.unity3d.com/Documentation/ScriptReference/Editor.html