# A game as a tool for empirical research on the shamanic interface concept


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**Abstract**

*A Shamanic Interface is a recent concept that posits that the acknowledgment of culture in gestural commands may contribute to richer and more powerful user interaction with abstract concepts and complexity, but has a lack of empirical validation. Hence, this paper presents a game developed as an empirical research tool for data collection and testing on shamanic interfaces. The game is a small maze where users use gestures to control a character to reach the end of each level. The control gestures performed by each user are captured with a Leap Motion controller and recognized through Hidden Markov Models. Three command sets were implemented: Portuguese cultural gestures, Dutch cultural gestures, and a generic set. This paper evaluates the game with different users to check its playability. We conclude that the game can be used as a research data-collection tool as is, but also acknowledge several playability-related improvement recommendations.*



**Keywords**

*Human-Computer Interaction, Natural Interaction, Culture, Shamanic Interface, Gesture Recognition, Hidden Markov Models, Leap Motion*


## 1 Introduction

The shamanic interface (SI) was proposed in 2014 [Morgado 14] with the intent of creating a gestural interface paradigm that goes beyond imposing the mimicry of a few ad hoc gestures. Rather, users would employ the rich meaning of gestural emblems available in their own culture. Since then, there has been some initial work in the area [Carvalho 14, dC14], including the development of a proof of concept architecture, but there is no research tool to support researchers wishing to perform empirical evaluations and validations of using cultural-aware gestural commands.

Gestural interfaces have been dubbed "natural" interfaces by many, assuming they provide an intuitive and unambiguous interaction, but this assumption is far from reality. Both critical and empirical analyses have exposed the artificiality of common gestural interfaces [Malizia 12]. Different gestures (emblems in semiotics terms) are used for the same meaning in different cultures, or the same gesture having different meanings across cultures, as well as distinct connotations. Some examples are the "Thumbs Up" and "Ring" gestures, which can share the meaning of "OK" or be insults, depending on the individual's culture. Similarly, the "Palm-back V-sign" gesture, that is generally associated as a "V of victory", is considered a sexual insult in Britain [McNeill 92].

Besides the actual differences in meaning, the use of the shallow meanings such as "OK" or "victory" is wasting the rich semantics associated with gestures in everyday life. For instance, the assertiveness of raising a finger in North America culture to say "Number 1" or "I wish to talk" is all but ignored if an application simply uses it to express the numeral 1. The shamanic interface paradigm stands by culture awareness in gestures as more than mere customization, but indeed as a call for leveraging the various layers of meaning towards an enhanced and empowered interaction with computerized systems.

Testing this concept is, however, a complex task. By creating a game that is playable using different sets of gestures, we propose a standard context for interaction analysis, where users need to learn interaction methods, express intent, and have ulterior goals. Thus, a tool for researchers

Figure 1: Usage of the Leap Motion controller [Motion 15a]

to collect data on various aspects of the shamanic interface concept and test its validity empirically.

The remainder paper is organized in 5 other sections: Section 2 outlines how the tool was planned; Section 3 describes the game and the gestures used; Section 4 specifies the interface implementation in the final application; Section 5 presents a playability test with some users; and the last section, Section 6, draws conclusions and future work paths for the project.

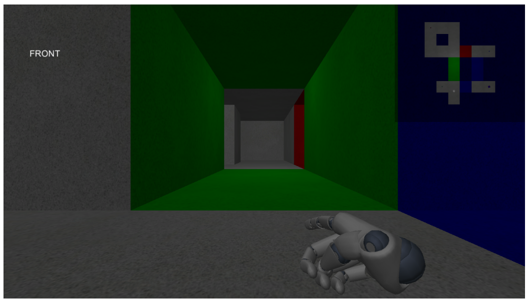
## 2 Tool

In order to create the empirical research tool, we planned a small game fully controlled by gestures. Users with different cultures can control it with hand gestures associated to their own cultural background. Culture-agnostic gesture sets (i.e., default gestures used in common devices) can also be used as placebo or Hawthorne control groups.

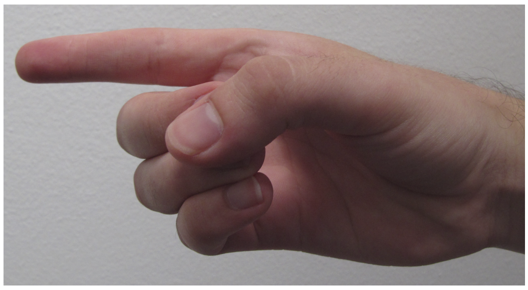
The final application seeks to use gestures with a wider spectrum of possible cultural and meaningful gestures and, therefore, achieve a higher probability of finding different gestures in the two different cultures selected, Dutch and Portuguese. It also has a set of generic gestures, based on the default gestures available in the capture device's API, resulting on an extra set of gestures that is available to users but not connected to a specific culture.

The game plans to use a Leap Motion controller, Leap Motion Inc. to capture the users' hands, as in Figure 1. This capture device was developed by Leap Motion Inc. [Motion 15b], and it is capable of tracking objects like fingers, hands, and forearms available within a field of view of 150°, a capture range between 2.5 cm and 1 meter, a frame rate of 50-200 fps and an accuracy of less than 2.5 mm [Weichert 13], situated in the upper side of the device. The precision on detecting and capturing the user's hands and its recent nature make this device a good option to recognize hand gestures in a research tool.

To model and recognize the patterns performed by the user, the application adopted a statistic method, Hidden Markov Models, and a classifier (through the Accord.NET Framework [dS15]), because of their previous successful use in the field of pattern recognition, such as in speech recognition and other applications. Hence, the gestures after being recognized are used in the game as normal input signals.




(a) During the game



(b) Side view

Figure 2: Gesture to *Move Forward* associated with the Portuguese culture

## 3 Game Description

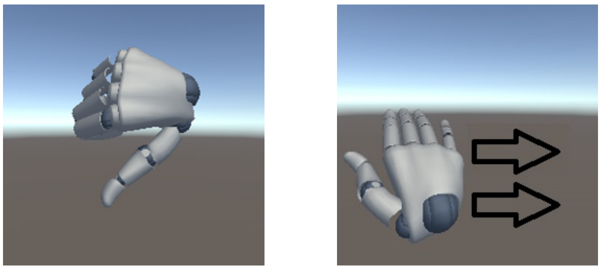
The game is a simple maze game where the player must perform certain actions, such as drink colored potions, allowing walking over tiles of the same color, and grab a magical cube in the labyrinth's end to finish the game.

Previous to the game start proper, there is a main menu, where it is possible to start the game, open a settings menu or quit the game. In the settings menu, the player can change the game's culture (for gestures) and its difficulty (number of colors for tiles).

In the settings menu, to pick the game's difficult, the player must perform a cultural gesture to define the number of colors (1, 2 or 3) available in the game. In the main menu, after electing to start the game, the user must confirm or cancel the setting with which the game will start through an yes or no (Figure 3) gesture in the user's defined culture. The selection of options in these menus is made through mimicking the motion of touching a screen or tapping a button in mid-air. This is an ad hoc option, because culture for gestures can only be set after the user accesses the settings section.

During the game, all action commands are issued through hand gestures. To reach the maze's end the user can move and rotate the character, drink a potion, and grab the end cube. The player can also pause the game. While paused, it is possible to to mute or unmute the game environment sounds, as well as resume the game. In the end, after reaching and grabbing the magical cube, the player can elect to continue towards the main menu or terminate the application. In Figure 2 it is possible to see the user moving forward at the beginning of the game (Figure 2a), as well the side view of a gesture being used (Figure 2b).

There are 17 distinct commands in total during the game. If all cultural gestures were different, this would require 34 gestures to support two cultures. However, after selecting cultural gestures for Portuguese and Dutch cultures, only 24 different gestures were required, since some commands (e.g. selecting, grabbing, moving backwards) have a common gesture in both cultures. All gestures performed by the user are captured through a Leap Motion controller, that provides several informations from the capture hand, such as forearm, hand, and finger positions, directions, translations, rotation, and even the radius of a imaginary sphere that fits the curvature of the hand. However only 6 features, three-dimensional vectors representing the five fingers and the hand's palm's direction, are extracted from the captured frame in order to characterize a hand sign/gesture, with a total of 18 values per hand.



(a) Portuguese culture (b) Dutch culture

Figure 3: Gesture *No* in both cultures

## 4 Implementation

Our shamanic interface implementation relies on a cultural layer that is responsible to store all the associations between commands, cultures, and gestures' names, as well as returning the correct gesture given a command and culture.

The mapping between these three components is made through a look-up table (1) between a pair composed by a *Command* and a *Culture*, and the correspondent *Gesture Name*.

$$(Command, Culture) \rightarrow Gesture\ Name \quad (1)$$

Based on this, given a list of commands (*C*) and the user's culture (*Culture*), it is possible to obtain a list with all gestures' names (*GN*) that the interface must recognize.

$$([C_1 \dots C_i], Culture) \rightarrow [GN_1 \dots GN_i] \quad (2)$$

These gesture names are later converted into Hidden Markov Models (3), created previously to represent each gesture, and loaded with the respective commands into a classifier of HMMs (4) created to evaluate the likelihood of each model given a sequence of signs.

$$GN \rightarrow HMM \quad (3)$$

$$Classifier([HMM_1 \dots HMM_i], [C_1 \dots C_i]) \quad (4)$$

Due the intrinsic error associated to statistical methods, where a vast range of solutions increases the error, in a system based on the classification of patterns through Hidden Markov Models, by incrementing the number of patterns available to be recognized it will increase the possibility of a misclassification. Accordingly, the application, instead of trying to recognize a pattern between all available gestures, selects only a small group of gestures needed to be analysed. This selection is based on the commands used in the game's current state as well as the user's culture. The game is, therefore, divided into states, where each state has a set of commands used in the respective game's part. Based on this division, in the cultural layer where the classifier is created, only the needed commands in the game's current state are computed into a set of gestures in the user's culture that are expected to be performed in the current phase of the application.

During the application's run time, the user's hands are detected, featured into a set of values, and stored. Since the gestures made by a user have a dynamic and fluid nature, they are stored in a buffer created to contain a list with the last sets of values (selected features of a captured hand).

To recognize the gesture, the sequence of sets of values is given to the classifier, where is selected the most likely model. After the given motion pattern being recognized, the classifier returns a command associated to the selected model, being processed later by the application.

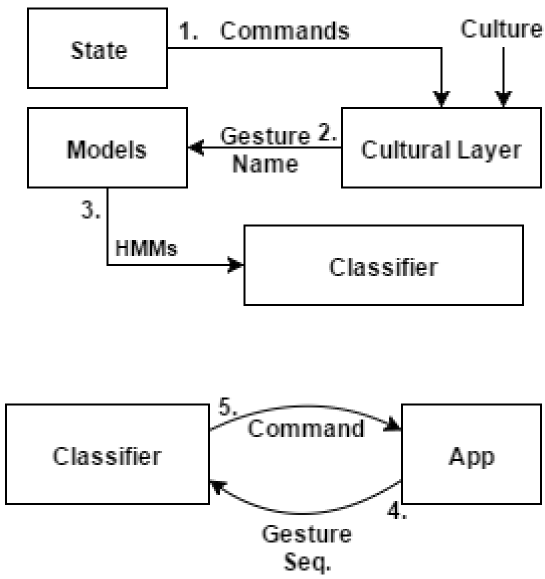



Figure 4: Gesture recognition flow

The flow described previously, responsible for the classifier creation and the gesture recognition cycle can be found in figure 4. In the game state, given a list of commands (1) and the user's culture, a list of gesture names (2) is obtained. Those are converted into HMMs (3), used later by the classifier to recognize a command (5) based on a sequence of gestures (4).

## 5 Tests with Users

A test with a small number of users was carried out with the main purpose of evaluating the game playability with users of different cultures. The reaction of each player during the evaluation was also observed and in the end he/she was asked for general feedback about the application.

The tests followed the following sequence: in the beginning, it was explained to each user the game's description and commands (gestures) and some hints to operate with the device. After starting the application and selecting the option menu, each user was asked to choose the culture and the difficulty (number of colors), in this sequence since the gestures used in the difficulty selection menu are dependent from the culture selected. Afterwards, back to the main menu, each user started a new game and confirmed the configurations selected before. In the game level, the user had to travel through a simple maze, reach the end cube and quit the application. During the game level he/she was asked to pause, mute and resume the game. The game level presented is linear (figure 5), since in each part it's only possible to do one thing in order to proceed until the game cube is reached. Since the beginning of the game, the end cube is showed to the user, and thereafter the color he/she must achieve in the end to reach it, exposing from the start the game goal. In the end the users were invited to give general feedback about the application, the interface and their recent experience with them.

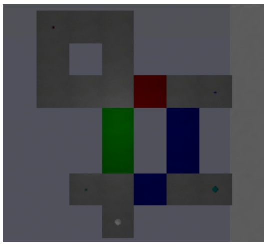
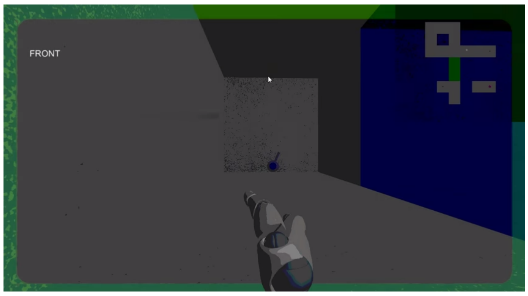


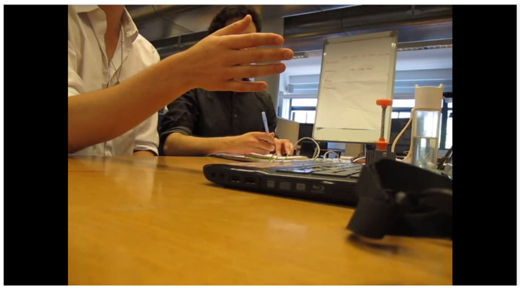
Figure 5: Game map

The test was executed in 3 groups of 4 people each, and each group used a different set of gestures. While the groups that used a set of cultural gestures were composed by users of the matching cultural background (Portuguese and Dutch), the group that used a set of default gestures was composed of users with a miscellaneous of cultural backgrounds, more specifically, a Dutch, a Belgian, an Indian and a Brazilian. Both the screen and the user were recorded separately.

As expected, all users were able to start and complete the game, although at first almost all experienced some difficulties associating their own hands with the displayed ones, mainly due to lack of awareness of the device's operational range, as well as the recognition of some gestures (mainly in the Dutch set of gestures). During the game, an evolution in the proficiency of performing the correct gesture was noticed, being mentioned in the end by some users that they got more familiar with the gestural interface during the essay.




(a) Screen



(b) Camera

Figure 6: Dutch user moving forward

While the main goal with these tests was to obtain qualitative data (e.g. reactions, feedback), it was possible to analyse the time used for the few users that experience this test. The 12 users took an average time of 7 minutes to complete the test, which 20% of the time is related to the initial menus and the other 80% are related to the time spent in the game level. Since no quantitative testing was conducted, we recommend a more extensive and detailed testing with a quantitative nature as further work.

## 6 Conclusion

With the developed application, where users are able to use their own cultural set of gestures to interact with the game, and the successful results in the tests with different users in a small scale, it can be concluded that this research tool can be used by empirical researchers to test and develop the concept further.

Since the shamanic interface is a promising but recent and untested concept, and based on some problems detected during the tests, it is still possible to conclude that the system, while usable, can be enhanced in different aspects, such as the gesture's featuring, modelling, and classification, by studying, testing, and applying different approaches available for each problem. We also recommend quantitative testing as subsequent work, to strengthen and guide the project for further work.

The use of this tool it is not limited to empirical research, such as finding possible relationships between the use of cultural gestures vs. default mimicking motions and learnability or recall. It can also be used to test new paths forward for the shamanic interface concept, as for example identifying the cultural background of a user through the gestures perform by him/her in a given context, or extrapolating extra meaning (e.g., emphasis, conviction) from gesture metadata.

This game tool for empirical research on the shamanic interface concept, can be downloaded from the following repository:

https://github.com/Wolfox/SIGame.git

We invite all interested researchers to download it, contribute to its development, and use it to study the shamanic interface concept.

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