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Enhancing Built-In AI of Universal Fighting Engine with Human-Like Behavior Patterns

Recommended for publication by associate professor Mozgovoy M.

Abstract

We aim to introduce human-like computer-controlled fighters into a popular fighting game engine UFE. This can be done with an emotional appraisal engine GAMYGDALA that assist creation of virtual characters, affected by emotions. While the goal of a fighting game is simple (to beat an opponent), fighters behavior is altered with a variety of emotions such as fear, anger or exuberance. The use of GAMYGDALA in UFE requires us to solve a number of technical issues, such as establishing interface between these engines, and designing a method to apply GAMYGDALA as an auxiliary technology for fine-tuning the UFE-provided Fuzzy A.I. system. This paper is dedicated to the practical implementation of emotional agents in UFE. We show how a relatively simple combinations of tools and technologies can be used to increase player enjoyment and immersion.

1. Introduction. Due to achievements in the development of game AI technology, non-player characters (NPCs) are already good enough to beat most human players. Therefore, we have to think in different direction if we want to improve AI-controlled characters further.

The primary goal of a game system is to entertain the player, thus "good AI" in this context is AI that facilitates *fun*. In turn, there is evidence that in games like one-vs-one fighting people enjoy playing against AI that behaves like a human [1]. There are different ways to implement

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believability (human-likeness) of AI behavior. One major trait of human-like behavior is affective (emotion-driven) decision making. If NPCs exhibit emotions during fights, the game should be more interesting for people.

In this paper we will describe how we designed human-like NPCs for Universal Fighting Engine environment (UFE) [2].

2. Gamygdala. We enrich NPC behavior with emotions using emotional appraisal engine Gamygdala [3]. NPCs are controlled with an AI system, and of course they can't feel or think. Within Gamygdala paradigm, we set character's goals and annotate game events with relation to these goals, then Gamygdala produces emotional state of the character according to the model of Ortony, Clore and Collins (OCC) [4]. Further details of our work are provided in [6].

3. Interoperability with UFE. Using Gamygdala poses additional challenges for us, since it is written entirely in JavaScript, while UFE is developed with Unity using C# language. We achieved interoperability by employing Jurassic, an open source implementation of JavaScript for the .NET platform [5]. Gamygdala is implemented in a single JavaScript file Gamygdala.js, and our own procedures interfacing Gamygdala (such as agent goals setup and event generation) are stored in an additional file GamygdalaUfe.js. Thanks to Jurassic, we can load, execute and communicate with these files directly from C# code:

```
// a fragment of BattleGUI.cs
public class BattleGUI : UFEScreen {
    protected ScriptEngine engine = new ScriptEngine();
    protected virtual void
        OnGameBegin(CharacterInfo player1,
                    CharacterInfo player2,
                    StageOptions stage) {
            BattlePrepare();
        }


    protected void BattlePrepare()
    {
        engine.SetGlobalValue("humanlife",
            (int)player1.totalLife);
```

```
        engine.SetGlobalValue("npclife",
            (int)player2.totalLife);
        engine.ExecuteFile("Gamygdala.js");
        engine.ExecuteFile("GamygdalaUfe.js");
    }
    ...
}
```

To make Gamygdala aware of changes in the fighting game world, we translate relevant Unity events into JavaScript code via global functions. For example, Gamygdala must be aware of damage caused or received by the players:

```
// GamygdalaUfe.js implements
// global functions OnHit() and getDamage()

// C# code
protected virtual void OnHit(HitBox strokeHitBox,
            MoveInfo move, CharacterInfo player) {
    if (player.playerNum == 2) {
        int life1 = (int)player1.Life;
        engine.CallGlobalFunction("OnHit", life1);
    }
    else if (player.playerNum == 1) {
        int life2 = (int)player2.Life;
        engine.CallGlobalFunction("getDamage", life2);
    }
}
```

By calling Gamygdala emotional appraisal functionality, we obtain emotional state of the NPC character and store it in a global variable as a stringified JSON object:

```
// GamygdalaUfe.js
emolen = emotionAgent.internalState.length;
for (var i=0;i<emolen; i++) {
    emo[i] =
        JSON.stringify(emotionAgent.internalState[i].name);
    intensity[i] = emotionAgent.internalState[i].intensity;
}
```

```
emoall = JSON.stringify(emo);
intensityall = JSON.stringify(intensity);
```

On the C# sharp side, we read the global variable and convert it from JSON to a conventional List object:

```
// C# code
int length = (int)engine.GetGlobalValue("emolen");
string emoall = (string)engine.GetGlobalValue("emoall");
string intensall =
    (string)engine.GetGlobalValue("intensityall");
List<string> emotion =
    JsonConvert.DeserializeObject<List<string>>(emoall);
List<float> intensity =
    JsonConvert.DeserializeObject<List<float>>(intensall);
```

4. Conclusion. In this paper, we show how to connect JavaScript-based emotion engine Gamygdala with a Unity-based Universal Fighting Engine environment. This approach was used to introduce affective behavior into UFE AI system, controlling NPCs. We believe emotions will improve user experience and will make playing against AI characters more fun. Our experience demonstrates that Gamygdala can be integrated quite easily into a Unity project. This result can be of interest to a wider community of game makers, given high popularity of Unity as a game development instrument.

References

1. Umarov I., Mozgovoy M., Rogers P. C. Believable and Effective AI Agents in Virtual Worlds: Current State and Future Perspectives // International Journal of Gaming and Computer-Mediated Simulations. 2012. Vol. 4, No. 2, P. 37–59.

2. Universal Fighting Engine [internet resource]: URL:http://www.ufe3d.com

3. Popescu A., Broekens J., Someren M. V. GAMYGDALA: An Emotion Engine for Games // IEEE Transactions on Affective Computing. 2014. Vol. 5. No. 1, P. 32–44.

4. Ortony A., Clore G. L., Collins A. The Cognitive Structure of Emotions. Cambridge University Press, 1990.

5. Jurassic [internet resource]:
URL:https://github.com/paulbartrum/jurassic.

6. Endo M., Yuda K., Mozgovoy M. Developing Emotional AI with Gamygdala for Universal Fighting Engine // Proceedings of the L International Scientific Conference on Control Processes and Stability. 2019. *To appear.*