GenieMo - State of Technologies Report

Current Version: 2.3 Beta

Introduction

The development genetics of GenieMo can be traced as far back as the works and initial research conducted Ravensbourne by the teams at DoubleMe and PlayLabz. One of the biggest differences in technological approaches is the move away from largely bespoke solutions reliant, based on narrative, on future deployment and adoption of 5G technologies, an approach espoused by DoubleMe. GenieMo is a unique software solution that is largely hardware and platform agnostic, favouring a largely COTS development approach.

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DoubleMe, incubated at Ravensbourne, attempted to push the technology heavily into the mainstream by partnering with 5G suppliers and vendors. As can be seen in their tech demonstration of 13th December 2016, a standard setup involved 8 VGA sensors and a large blue screen rig to generate moderately realistic 4D-video. When exhibited users would enter a darkened room with a single HoloLens in which they would don and use to view the fashion based exhibits. Models were meanwhile scanned in real-time in a room equipped with 8 sensors, a full lighting rig and blue screen. Impressive results however in terms of ease of deployment and practical usability.

As can be seen from their live demo at Ravensbourne on 7th December 2016, ([Portable Maria](#)) the results are largely mixed and early issues with camera 'latch-on' onto markers starting showing indications of issues with the mix of marker and tracker technologies being used.

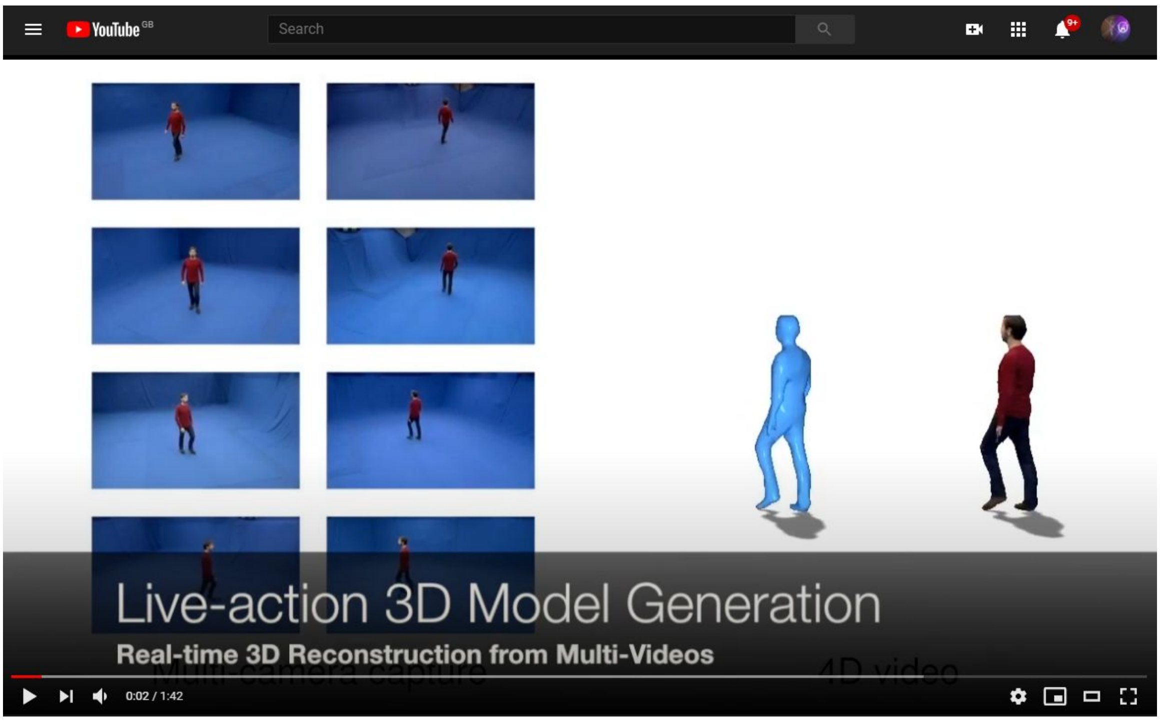

Figure 1: https://www.youtube.com/watch?v=8VeahzrcjAA

As can be seen from the demonstration (fig.1) the results are quite impressive, for the time. In terms of visual quality and fidelity the results are quite like what we see in Burn Cycle (fig.2), an early 1994 game released on Philips i-CD. Interesting however largely susceptible to the same problems as those early attempts at inserting a live-recorded human avatar into an artificial environment, for example edge artifacts, etc.

Figure 2: https://www.youtube.com/watch?v=7GOTfMDlLf8

An impressive start but given that that rig would cost the region of £40k and more, it is a system that is out of the reach of a lot of people who could otherwise benefit from it. That is a problem, particularly when we consider the far reaching applications for this technology particularly in the fields of education and healthcare, both of which are poorly funded in many countries, including the one of the author, the UK.

A demonstration a few months later proved to be far better. The first 'Rave HoloPortal', as [demonstrated at Ravensbourne]() on 31st July 2017 by one of the original creators of this technology, James Edwards Marks, aka JEM, really showed how quickly the technology had moved on in terms of accuracy, particularly around placement and tracking, and, as can be seen, no longer required a marker for effective placement in the surrounding environment. This was the effective break away solution that became....GenieMo. An amazing demonstration of this tech can be seen in the video recorded on 24th November 2019, in which we hear Marius Matesan, the coder and developer behind the GenieMo software, guiding a researcher in the use of the technology. Even on a 2D screen watching the demonstration on YouTube, watching it years later, you still get that initial sense of wonder as you see the researcher's head moving in 3D space and move *around and behind* the actual person in apparent real-time. Amazing.

The PlayLabz solution has been to remain as hardware agnostic as possible and to develop a usable, cost-effective, and above all, easy-to-use solution that is not reliant on 5G technologies for success or indeed even adoption. The solution is GenieMo, which, in its base form only needs one sensor to be effective and reliable for various applications.

GenieMo's Current Advanced Abilities

- Single-click installation.
- Built-in ability to stream content to anything requiring camera input support, for example stream content live via Zoom, Meets, Teams or Skype without any additional software.
- Can live stream content to any platform without any additional software.
- Variable sensor range clipping permitting the user to alter what appears in source (x, y, z axis).
- Real-time high-resolution surface and point-cloud modelling of objects and environment (see fig 3).
- Fine user control over content size, orientation, and position in virtual space.
- Import 3D objects and environments from any source, massive range of popular file formats including .3ds and .obj (see figs 4 and 5).
- Record live real-time stream incorporating all the above.
- Able to work sub-par lighting conditions to high efficiency (fig.3 shot with no light source other than the reflection from a monitor).
- Able to work without blue/green screens or other form of 'background blackout'.
- Minimal edge artifacts even in low light environments (fig.3).

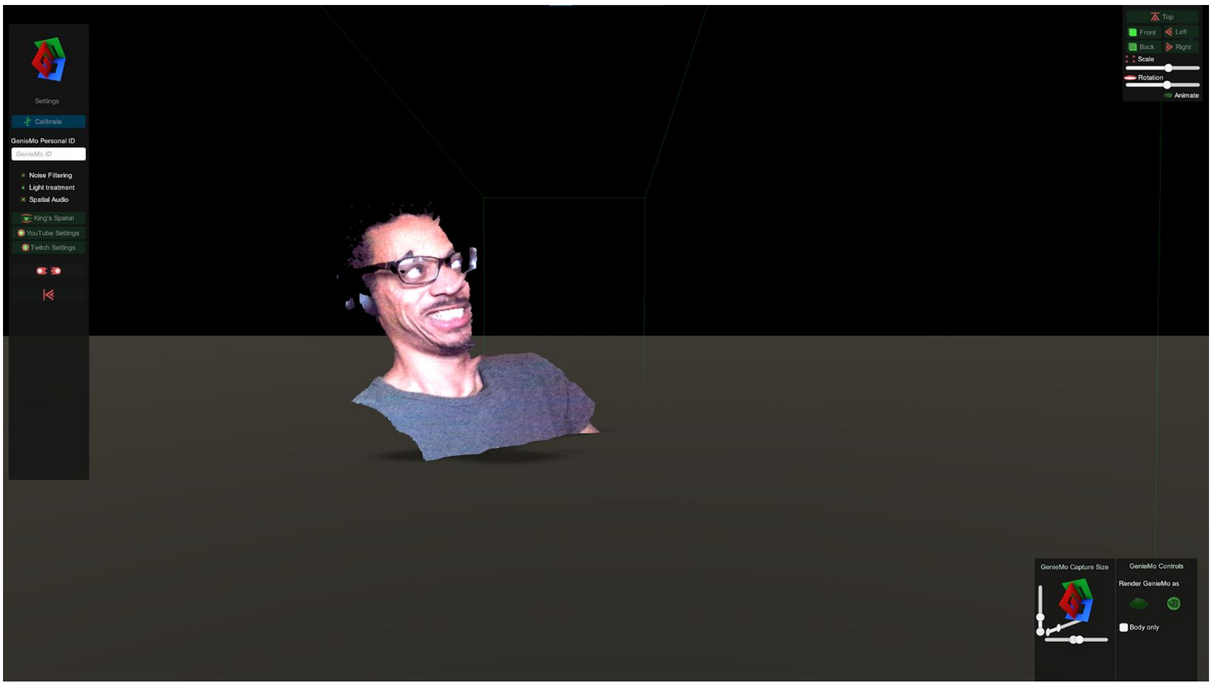

Figure 3: Single-click install - instant results.

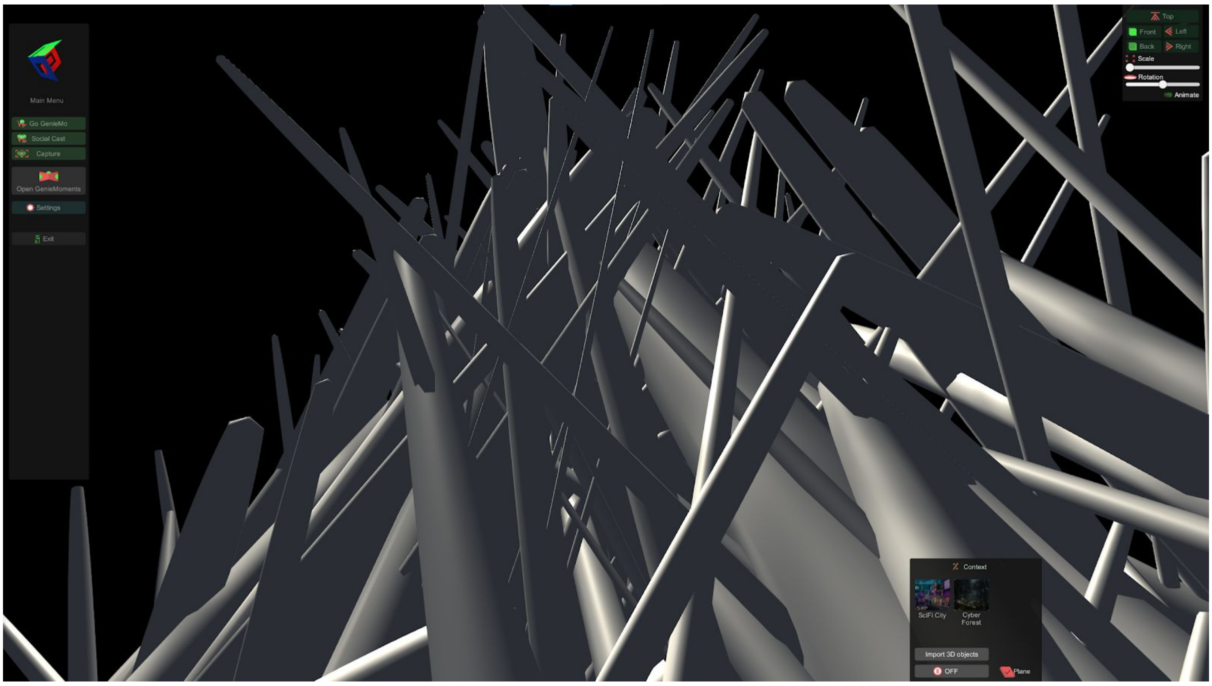

Figure 4: Custom imported 3D model from SketchFab.

Figure 5: Custom imported 3D model inserted into default environmental context.

In terms of ease of use it is possible to unpack a single sensor, install the software and start streaming high quality live content within 10 minutes or less. As can be seen in the [demo video] provided as part of this report it is easy to review how easy it is to generate superior results. This allows us to start demonstrating easy implementation into film, animation and visual effects real-time rendering and compositing.

On top of the considerable increase in features and capability in this version of GenieMo is the fact there is marked increase in resolution on display on my particular test rig (HP Z4 G4 i9/2080RTX Ti +

HP Z27n G2 27” HD monitors) with a smarter, cleaner UI clearly on display. And one cannot escape the incredible levels of detail captured in a live stream even in sub-optimal lighting conditions (fig.3).

SENSOR	LIGHTING	ENV*	COVERAGE (M)	COST (£)	SYSTEM
8X VGA	STUDIO RIG	BLUE SCREEN	5x5	£250,000	HoloPortal
8X KINECT2	STUDIO RIG	BLUE SCREEN	5x5	£20,000	3D Scan
1X KINECT3	ANY	ANY	2x2	£1,500	GenieMo

**ENV=Environment - indicative of optimum background environment to ensure clean cut out of foreground elements.*

Issues with Multi-Sensor Setups

1. *Multi-Sensor Marker Configuration*
    a. Ensuring that all sensors are synchronised requires recognition of a qr-code style marker being ‘viewed’ by each sensor in-situ.
    b. The margin of error increases in parallel with the increase in the number of sensors.
    c. Optimal lighting conditions are required for good sensor sync.
    d. Poor sensor sync results in excessive visual artifacts and break-down of geometry integrity.
2. *Wrap-Around Edge Artifacts*
    a. Wrap-around edge artifacts (WAEA) are present due to conflicting channel feeds which is a result of poor marker and sensor sync.
3. *Occluded-Edge Artifacts*
    a. Occluded-edge artifacts (OEA) are present due to conflicting channel feeds which is a result of poor marker and sensor sync.
4. *Sensor Cross-Shadow*
    a. Sensor cross-shadows (SCS) are present due to overlapping sensor fields causing occlusion shadows.
5. *Computing/Processing Power*
    a. Management of camera sensors, especially those including depth-sensors requires quite considerable processing power.
    b. If body-skeleton tracking is required, a setup will need a minimum of Nvidia 2080 (or equivalency) graphics cards per sensor, which drastically increases overhead cost of implementation.
6. *Streaming Bandwidth Impact*
    a. Multi-sensor setups considerably increase the requirement for increased bandwidth.
    b. For the increased data-streams to be streamed online at good quality access to reliable fibre-optic or 5G connections are required.
7. *Environmental Impact*
    a. Due to the increased requirement for high-powered graphics cards and processors in multi-sensor setups there are concerns over heat dissipation and its contribution to greenhouse gas emissions.

Potential Solutions for Issues with Multi-Sensor Setups

1. *Multi-Sensor Marker Configuration*
    a. Development of AI autonomous sensor field alignment combined with a servo-controlled ptz (pan-tilt-zoom) solution.

    b. Error correction utilising image analysis (GPT3).
2. *Wrap-Around Edge Artifacts*
    a. Development of implementation of Nvidia AI in order to solve waea issue manifestations in multi-sensor results.
3. *Occluded-Edge Artifacts*
    a. Development of implementation of Nvidia AI in order to solve oea issue manifestations in multi-sensor results.
4. *Sensor Cross-Shadow*
    a. Development of implementation of Nvidia AI in order to solve scs issue manifestations in multi-sensor results.
5. *Computing/Processing Power*
    a. Consider utilising cloud-based processing.
6. *Streaming Bandwidth Impact*
    a. No real solution.
7. *Environmental Impact*
    a. No real solution.
    b. CO2 offsetting implementation.

Potential Cost of Solutions for Issues with Multi-Sensor Setups

1. *Development of AI-Autonomous PTZ Sensor-Field Alignment Solution + Software*
    a. Dev + Hardware approx. £300,000
2. *Development of AI Solution for Resolution of WAEA/OEA/SCS Manifestations + Hosting*
    a. Licensing from $10,000 per CU (dependent on service scaling)
    b. Dev approx. £80,000 (based on stack and development)
3. *Development of Nvidi GPU/AWS Cloud Computing Platform*
    a. Licensings from $10,000 per CU (dependent on service scaling)
    b. Dev. approx. £120,000 (based on stack and development)

Issues with Single-Sensor Setups

1. *Wrap-Around Edge Artifacts*
    a. Wrap-around edge artifacts (WAEA) are present using a single sensor because there is a single point of occlusion for the sensor's vision area, which means edges, close to the 'wrap-around' of an object appear missing, or bitty.
2. *Occluded-Edge Artifacts*
    a. Occluded-edge artifacts (OEA) are present when a subject's extremity, for example their hand, arm, foot or leg, passes in front or around the subject. The 'shadow' cast on the subject is a result of the extremity acting in occlusion of the sensor's vision area.

Potential Solutions for Issues with Single-Sensor Setups

1. *Wrap-Around Edge Artifacts*
    a. Development of implementation of Nvidia AI in order to solve waea issue manifestations in single-sensor results.
2. *Occluded-Edge Artifacts*
    a. Development of implementation of Nvidia AI in order to solve oea issue manifestations in single-sensor results.

Potential Cost of Solutions for Issues with Single-Sensor Setups

1. *Development of AI Solution for Resolution of WAEA/OEA/SCS Manifestations + Hosting*
    a. Licensing from $10,000 per CU (dependent on service scaling)
    b. Dev approx. £60,000 (based on stack and development)

Future Advancement of GenieMo

With the advent of such devices as OpenCV's AI Kit it is becoming increasingly possible to bring the cost of entry to multi-dimensional motion arts creation down considerably to potentially the £200-£300 range including hardware. With this comes additional improvements to be had from expanded and integrated AI, for example the ability to utilise graphics-AI to solve 'wrap-around edge artifacts' and 'occluded-edge artifacts', which seem to be prevalent with single-sensor setups. Utilisation of AI to solve graphics issues without increasing sensors provides a far better infrastructure vs price point advantage of any other setup, especially when offset against achievable end-results with this technology.