
Digital human designers

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Abstract: This study creates digital human designers. Digital human designers are models of designers. Therefore, digital human designers use design methods to create designs. Digital human designers also use digital human users to create designs. Digital human users are models of users. Therefore, digital human designers use digital human users to determine the effects of designs on users. The digital human designers in this study created designs that matched user choices with 91.4% accuracies. As a result, the digital human designers in this study used design methods to fully automate the design process. The digital human designers in this study also used the digital human users in this study to determine the effects of designs on user structures. As a result, the digital human designers in this study also used the digital human users in this study to fully automate the design process.

Keywords: digital human designers; digital human models; design methods.

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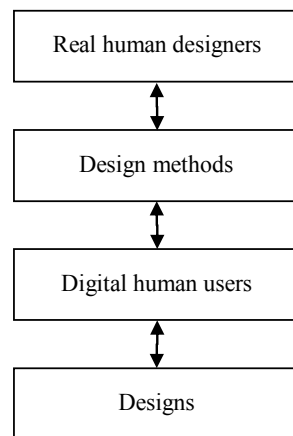
1 Introduction

Real human designers use design methods to create designs. The design process consists of three steps: identify user needs, select design concepts and create designs. Therefore, real human designers use design methods to identify user needs, select design concepts and create designs. As a result, real human designers use design methods to partially automate the design process.

Real human designers also use digital human users to create designs. Digital human users are models of users. Therefore, digital human users are digital human models. Digital human users duplicate user behaviours, functions, or structures. Therefore, real human designers use digital human users to determine the effects of designs on users. As a result, real human designers also use digital human users to partially automate the design process.

Figure 1 shows that real human designers use design methods to create designs. Figure 1 shows that real human designers also use digital human users to create designs.

Figure 1 Real human designers

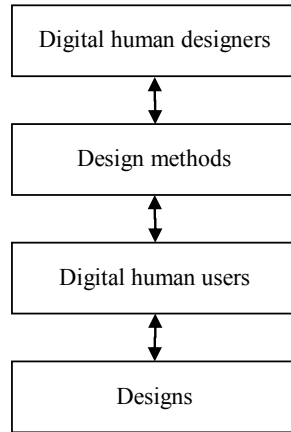


This study creates digital human designers. Digital human designers are models of designers. Therefore, digital human designers are digital human models. Digital human designers duplicate designer behaviours. Therefore, digital human designers use design methods to create designs. The design process consists of three steps: identify user needs, select design concepts and create designs. Therefore, digital human designers use design methods to identify user needs, select design concepts and create designs. As a result, digital human designers use design methods to fully automate the design process.

Digital human designers also use digital human users to create designs. Digital human users are models of users. Therefore, digital human users are digital human models. Digital human users duplicate user behaviours. Therefore, digital human designers use digital human users to determine the effects of designs on users. As a result, digital human designers also use digital human users to fully automate the design process.

Figure 2 shows that digital human designers use design methods to create designs. Figure 2 shows that digital human designers also use digital human users to create designs.

Figure 2 Digital human designers



Digital human designers are new. Therefore, there are no previous studies on digital human designers. As a result, Section 2 uses concepts from previous studies on humans to create digital human designers, Section 3 uses concepts from previous studies on design methods to create designs, Section 4 uses concepts from previous studies on digital human users to determine the effects of designs on users and Section 5 presents results and conclusions.

The results and conclusions show that digital human designers are new. The results and conclusions show that digital human designers use design methods to fully automate the design process. The results and conclusions show that digital human designers also use digital human users to fully automate the design process.

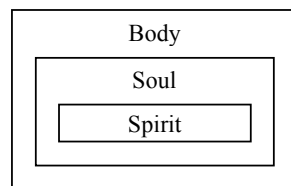
2 Digital human designers

2.1 Humans

Humans use body, soul, and spirit components to sense, speak, and act, think, feel, and initiate, and consider, approve, and select. Body components use eye, ear, nose, mouth, and hand components to sense, speak, and act. Soul components use mind, emotion, and will components to think, feel, and initiate. Spirit components use fellowship, conscience, and intuition components to consider, approve, and select.

Figure 3 shows that humans use body, soul, and spirit components to sense, speak, and act, think, feel, and initiate, and consider, approve, and select.

Figure 3 Humans

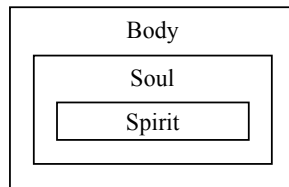


2.2 Digital human designers

Digital human designers are digital human models. Therefore, digital human designers use body, soul, and spirit modules to sense, speak, and act, think, feel, and initiate, and consider, approve, and select to create designs. Body modules use eye, ear, nose, mouth, and hand modules to sense, speak, and act to create designs. Soul modules use mind, emotion, and will modules to think, feel, and initiate to create designs. Spirit modules use fellowship, conscience, and intuition modules to consider, approve, and select to create designs.

Figure 4 shows that digital human designers use body, soul, and spirit modules to sense, speak, and act, think, feel, and initiate, and consider, approve, and select to create designs.

Figure 4 Digital human designers



2.3 The digital human designers in this study

The digital human designers in this study were digital human models. Therefore, the digital human designers in this study used body, soul, and spirit modules to sense, speak, and act, think, feel, and initiate, and consider, approve, and select to create designs. The body modules used eye modules to sense to create designs. The soul modules used mind, emotion, and will modules to think, feel, and initiate to create designs. The spirit modules used fellowship, conscience, and intuition modules to consider, approve, and select to create designs.

The eye modules used document readers to process documents and extract text. The mind, emotion, and will modules used mind, emotion, and will rules to process text and extract aspirational, emotional, functional, and physical keywords. The fellowship, conscience, and intuition modules used fellowship, conscience, and intuition rules to process keywords and extract selected aspirational, emotional, functional, and physical keywords.

Figure 5 The digital human designers in this study

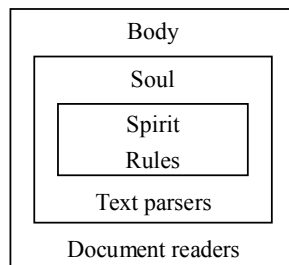


Figure 5 shows that the digital human designers in this study used document readers, mind, emotion, and will rules, and fellowship, conscience, and intuition rules to process documents and extract text, process text and extract aspirational, emotional, functional, and physical keywords, and process keywords and extract selected aspirational, emotional, functional, and physical keywords.

3 Designs

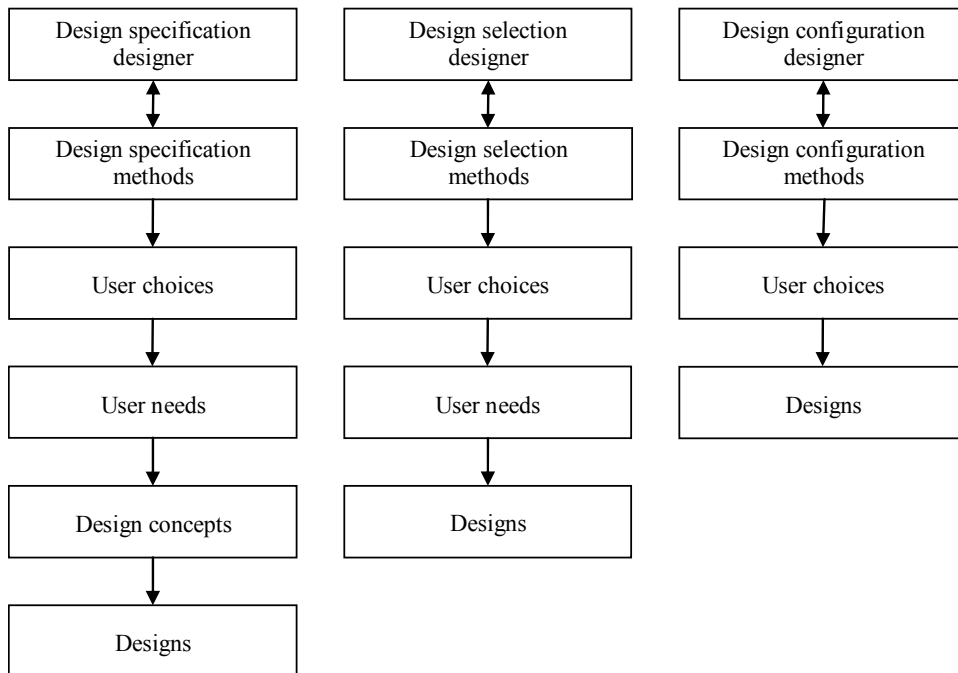
3.1 The design methods in this study

The digital human designers in this study were a design specification designer, a design selection designer, and a design configuration designer. Therefore, the digital human designers in this study used the latent semantic engineering design specification, design selection, and design configuration methods to identify user needs, select design concepts, and create designs.

The design specification designer used the latent semantic engineering design specification methods to match user choices to designs, match user needs to design concepts, and match design concepts to designs. The design selection designer used the latent semantic engineering design selection methods to match user choices to designs, and match user needs to designs. The design configuration designer used the latent semantic engineering design configuration methods to match user choices to designs.

Figure 6 shows that the digital human designers in this study used the latent semantic engineering design specification, design selection, and design configuration methods to create designs.

Figure 6 The design methods in this study



3.2 The designs in this study

The digital human designers in this study used the latent semantic engineering design specification, design selection, and design configuration methods to create 15 individually customised car designs for 15 users (one individually customised car design for each user). Fifteen of the users were from Taiwan, 15 of the users were 20–24 years old, 12 of the users were male, three of the users were female, and 15 of the users were graduate-level mechanical engineering students at a university.

The user choices were extracted from 15 design concept documents, which were chosen by users. The user needs were extracted from 15 user need documents, which were written by users. The design concepts were extracted from 100 design concept documents for Acura, Audi, BMW, Buick, Cadillac, Chevrolet, Chrysler, Dodge, Fiat, Ford, GMC, Honda, Hyundai, Infiniti, Jaguar, Jeep, Kia, Land Rover, Lexus, Lincoln, Mazda, Mercedes Benz, Mini, Mitsubishi, Nissan, Porsche, Scion, Smart, Subaru, Suzuki, Toyota, Volkswagen, and Volvo cars, trucks, suvs, and vans, which were written by reviewers from major newspapers, magazines, automotive websites, the US National Highway Traffic Safety Administration, and the US Insurance Institute for Highway Safety (U.S. News Best Cars). The designs were created from design elements, which were extracted from the 100 design concept documents. Therefore, the user choices, user needs, design concepts, and designs were represented by selected aspirational, emotional, functional, and physical keywords.

Table 1 The design concept document which was chosen by User 10

Mazda MX-5 Miata
{572 words}

The 2013 Mazda MX-5 Miata ranks 2 out of 10 affordable sports cars. This ranking is based on our analysis of published reviews and test drives of the Mazda MX-5 Miata, and our analysis of reliability and safety data.

The 2013 Mazda MX-5 Miata has a four-cylinder engine, which isn't as powerful as the engines of many sports cars in the class. However, test drivers agree that, combined with the Miata's light weight, the responsive engine delivers enough power to keep up with newer competitors like the Subaru BRZ. A five-speed manual transmission is standard, and test drivers love its short throws. Most also note that the transmission offers precise shifts that reinforce the Mazda Miata's fun driving dynamics. According to the EPA, the 2013 Miata gets up to 22/28 mpg city/highway, which is better than competitors like the Ford Mustang, but not quite as good as the Mini Cooper Roadster. In general, the automotive press loves the Miata's quick, accurate steering and athletic handling. In a comparison test, one reviewer also notes that the Miata soaks up bumps and road imperfections better than the BRZ. From a practical standpoint, the Miata also earns a better reliability rating than most cars in the class.

Inside, the Miata earns reviewer praise for its attractively-designed interior, which features a functional, driver-focused control layout. Most interior materials are hard plastic, but auto writers say that they're attractive and seem appropriate for the Miata's price. Some test drivers comment that the two-seat Miata's small size means that taller occupants may want more space. The Miata's trunk is also one of the smallest in the class, but some critics say that if you pack carefully, there's room for a weekend's worth of luggage. A few reviewers write that wind and road noise are common on the highway, even with the available hardtop. A six-speaker stereo with an auxiliary input jack is standard in the 2013 MX-5 Miata. Options and features available on higher trims include automatic climate control, leather seats, heated seats, Bluetooth, push-button start, satellite radio and a Bose stereo.

Table 1 The design concept document which was chosen by User 10 (continued)

“This is the point at which I input the standard laudatory comments about the MX-5’s excellent handling, outstanding fun-to-drive factor, and fantastic value. And it’s all true; very, very true. I’m still convinced this is one of the best driver’s cars on today’s market.” Consumer guide

“The Miata isn’t flashy or fast. It’s just a fun, affordable and reliable roadster that is guaranteed to bring a smile to the face of anyone with a beating heart and a valid driver’s license.” Kelley Blue Book

“This compact convertible offers everything a driver needs – style, convenience and ample fun.” AutoWeek (2011)

The 2013 Mazda MX-5 Miata is a rear-wheel drive, two-seat convertible that’s available with a soft top or a retractable hardtop. A 2.0-liter four-cylinder engine and a five-speed manual transmission come standard, and a six-speed automatic transmission is optional. The Miata comes in three trims: sport, club and grand touring. Club and grand touring trims add to the Miata’s list of interior features, and come with a six-speed manual transmission as standard equipment. For 2013, the Miata gets an updated front fascia and standard fog lights, and the Club trim replaces the outgoing Touring model. Aside from that, the Miata is basically unchanged. As a result, this overview uses applicable research and reviews from 2007 through 2012, as well as the current model year.

Table 2 The user need document which was written by User 10

User 10

{95 words}

I would like the car which has scissors doors. Automatic transmission is a trend, it can let more people drive this car. And if car makes available in the convertible category, I can enjoy going for a spin. Car’s drive train would better be rear-wheel drive for a good drive control. The cabriolet makes people feel more luxury about the car. It would be better to be a hybrid car, which make less carbon dioxide and use electricity instead of fuel, for being green. The price of car must be low, that people can afford it.

Table 3 The design concept document for the Mazda MX-5 Miata

Mazda MX-5 Miata

{572 words}

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Table 3 The design concept document for the Mazda MX-5 Miata (continued)

Inside, the Miata earns reviewer praise for its attractively-designed interior, which features a functional, driver-focused control layout. Most interior materials are hard plastic, but auto writers say that they're attractive and seem appropriate for the Miata's price. Some test drivers comment that the two-seat Miata's small size means that taller occupants may want more space. The Miata's trunk is also one of the smallest in the class, but some critics say that if you pack carefully, there's room for a weekend's worth of luggage. A few reviewers write that wind and road noise are common on the highway, even with the available hardtop. A six-speaker stereo with an auxiliary input jack is standard in the 2013 MX-5 Miata. Options and features available on higher trims include automatic climate control, leather seats, heated seats, Bluetooth, push-button start, satellite radio and a Bose stereo.

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Table 4 The user choice keywords for User 10

Mazda MX-5 Miata
{94 keywords}

type-Mazda-MX-5, type-affordable-sports-car, type-convertible, type-sports-car, rank-affordable-sports-car-2, rank-affordable-sports-car-high, rank-affordable-convertible-1, rank-affordable-convertible-high, price-23720-30350, price-affordable, mpg-city-22, mpg-hwy-28, mpg-city-high-not, mpg-hwy-high-not, fuel-efficient-not, performance-9.0, performance-high, interior-6.0, interior-high-not, safety-na, safety-high-not, lights-fog, front-updated, handling-high, handling-superb, top-hard, top-retractable, reliability-high, interior-space-not, trunk-large-not, performance-spirited, engine-4c, engine-powerful-not, weight-light, engine-responsive, power-competitive, speeds-5, transmission-manual, transmission-precise, transmission-high, type-fun, fuel-competitive, steering-responsive, steering-accurate, steering-high, handling-high, handling-athletic, ride-smooth, reliability-high, reliability-competitive, interior-attractive, interface-high, interface-easy, interior-materials, interior-plastic, persons-2, size-small, interior-space-not, trunk-large-not, ride-quiet-not, top-noise-not, stereo-has, stereo-6-speaker, audio-input, climate-control, seats-leather, seats-heated, bluetooth-has, start-automatic, radio-has, radio-satellite, stereo-Bose, handling-high, type-fun, price-value, speed-high-not, reliability-high, type-unchanged-not, type-stylish, type-convenient, type-rwd, persons-2, top-soft, top-hard, top-retractable, engine-2.0-liter, engine-4c, speeds-5, transmission-manual, speeds-6, transmission-auto, front-updated, lights-fog, type-unchanged

Table 5 The user need keywords for User 10

Subject 10
{17 keywords}
doors-high, doors-scissor, transmission-high, transmission-auto, type-convertible, ride-high, ride-enjoyable, type-rwd, handling-high, handling-control, type-luxury, type-hybrid, earth-protect, emissions-low, type-electric, fuel-efficient, price-affordable

Table 6 The design concept keywords for the Mazda MX-5 Miata

Mazda MX-5 Miata
{94 keywords}
type-Mazda-MX-5, type-affordable-sports-car, type-convertible, type-sports-car, rank-affordable-sports-car-2, rank-affordable-sports-car-high, rank-affordable-convertible-1, rank-affordable-convertible-high, price-23720-30350, price-affordable, mpg-city-22, mpg-hwy-28, mpg-city-high-not, mpg-hwy-high-not, fuel-efficient-not, performance-9.0, performance-high, interior-6.0, interior-high-not, safety-na, safety-high-not, lights-fog, front-updated, handling-high, handling-superb, top-hard, top-retractable, reliability-high, interior-space-not, trunk-large-not, performance-spirited, engine-4c, engine-powerful-not, weight-light, engine-responsive, power-competitive, speeds-5, transmission-manual, transmission-precise, transmission-high, type-fun, fuel-competitive, steering-responsive, steering-accurate, steering-high, handling-high, handling-athletic, ride-smooth, reliability-high, reliability-competitive, interior-attractive, interface-high, interface-easy, interior-materials, interior-plastic, persons-2, size-small, interior-space-not, trunk-large-not, ride-quiet-not, top-noise-not, stereo-has, stereo-6-speaker, audio-input, climate-control, seats-leather, seats-heated, bluetooth-has, start-automatic, radio-has, radio-satellite, stereo-Bose, handling-high, type-fun, price-value, speed-high-not, reliability-high, type-unchanged-not, type-stylish, type-convenient, type-rwd, persons-2, top-soft, top-hard, top-retractable, engine-2.0-liter, engine-4c, speeds-5, transmission-manual, speeds-6, transmission-auto, front-updated, lights-fog, type-unchanged

Table 1 shows the design concept document which was chosen by User 10. Table 2 shows the user need document which was written by User 10. Table 3 shows the design concept document for the Mazda MX-5 Miata. Table 4 shows the 94 user choice keywords which were extracted for User 10. Table 5 shows the 17 user need keywords which were extracted for User 10. Table 6 shows the 94 design concept keywords which were extracted for the Mazda MX-5 Miata. For all of the user choices, user needs, and design concepts, there were 553 user choice, user need, and design concept keywords.

The 553 user choice, user need, and design concept keywords were used to create 553-element user choice, user need, and design concept vectors. The 94 user choice keywords for User 10 were used to create a 553-element user choice vector with 459 zeros and 94 ones, the 17 user need keywords for User 10 were used to create a 553-element user need vector with 536 zeros and 17 ones, and the 94 design concept keywords for the Mazda MX-5 Miata were used to create a 553-element design concept vector with 459 zeros and 94 ones.

The user choice, user need, and design concept vectors were projected into a latent semantic engineering semantic space. The projected vectors were matched by calculating latent semantic engineering semantic space cosines. The projected vectors with the lowest latent semantic engineering semantic space cosines were the closest matches (Smith and Smith, 2012).

For the design specification designer, the projected vectors were matched to match user choices to designs, match user needs to design concepts, and match design concepts

to designs. For the design selection designer, the projected vectors were matched to match user choices to designs, and match user needs to designs. For the design configuration designer, the projected vectors were matched to match user choices to designs, and match (user-selected) design concepts to designs.

3.3 The design accuracies in this study

The design accuracies in this study were the number of vector elements that matched divided by 553 (the total number of vector elements). The design accuracies for the latent semantic engineering design specification method were |UCDA| (user choice to design accuracy), UNDA (user need to design accuracy), UNCA (user need to design concept accuracy), and DCDA (design concept to design accuracy). The design accuracies for the latent semantic engineering design selection method were |UCDA| (user choice to design accuracy), and UNDA (user need to design accuracy). The design accuracies for the latent semantic engineering design configuration method were |UCDA| (user choice to design accuracy), and DCDA (design concept to design accuracy).

Table 7 The design accuracies in this study

<i>Results</i>	<i>Designer</i>	<i> UCDA </i>	<i>UNDA</i>	<i>UNCA</i>	<i>DCDA</i>
(1)	Specification	91.4	90.7	90.7	100.0
(2)	Selection	97.2	95.8		
(3)	Configuration	100.0			100.0

Table 7 shows the design accuracies for the three digital human designers and the 15 individually customised car designs in this study. The design accuracies show that the design specification designer created designs from user need documents, the design selection designer created designs from user need documents, and the design configuration designer created designs from (user-selected) design concept documents. The design accuracies show that the design specification designer created individually customised car designs that matched user choices and user needs with 91.4 and 90.7% accuracies, the design selection designer created individually customised car designs that matched user choices and user needs with 97.2 and 95.8% accuracies, and the design configuration designer created individually customised car designs that matched user choices and (user-selected) design concepts with 100.0 and 100.0% accuracies. As a result, the design accuracies show that the digital human designers in this study used the latent semantic engineering design specification, design selection, and design configuration methods to fully automate the design process.

4 Digital human users

4.1 The digital human users in this study

The digital human users in this study were structural models of users. Therefore, the digital human users in this study were digital human models. The digital human users in this study duplicated the structures (heights) of users. Therefore, the digital human designers in this study used the digital human users in this study to determine the effects of individually customised car designs (headroom) on user structures (fit). As a result, the

digital human designers in this study also used the digital human users in this study to fully automate the design process.

5 Conclusions

5.1 This study

This study creates digital human designers. The digital human designers in this study were a design specification designer, a design selection designer, and a design configuration designer. Therefore, the digital human designers in this study used the latent semantic engineering design specification, design selection, and design configuration methods to identify user needs, select design concepts, and create designs. As a result, the digital human designers in this study used the latent semantic engineering design specification, design selection, and design configuration methods to fully automate the design process.

The design accuracies show that the design specification designer created individually customised car designs that matched user choices and user needs with 91.4 and 90.7% accuracies, the design selection designer created individually customised car designs that matched user choices and user needs with 97.2 and 95.8% accuracies, and the design configuration designer created individually customised car designs that matched user choices and (user-selected) design concepts with 100.0 and 100.0% accuracies.

The digital human designers in this study also used the digital human users in this study to determine the effects of individually customised car designs (headroom) on user structures (fit). As a result, the digital human designers in this study also used the digital human users in this study to fully automate the design process.

5.2 Future studies

The digital human designers in future studies can use complete body, soul, and spirit modules to sense, speak, and act, think, feel, and initiate, and consider, approve, and select to create designs. The body modules in future studies can use eye, ear, nose, mouth, and hand modules to sense, speak, and act to create concepts, designs, and prototypes. The soul modules in future studies can use mind, emotion, and will modules to think, feel, and initiate to create concepts, designs, and prototypes. The spirit modules in future studies can use fellowship, conscience, and intuition modules to consider, approve, and select to create concepts, designs, and prototypes.

The digital human designers in future studies can be design specification designers, design selection designers, and design configuration designers. Therefore, the digital human designers in future studies can use the latent semantic engineering, Kansei engineering – latent semantic analysis, Kansei Engineering, conjoint analysis, or quality function deployment design specification, design selection, and design configuration methods to identify user needs, select design concepts, and create designs. As a result, the digital human designers in future studies can use the latent semantic engineering, Kansei engineering – latent semantic analysis, Kansei engineering, conjoint analysis, or quality function deployment design specification, design selection, and design configuration methods to fully automate the design process (Akao and Ishihara, 1994; Deming, 1980,

2000; Green and Rao, 1971; Nagamachi, 1974, 1989, 1995, 2002; Smith and Smith, 2011, 2012; Smith et al., 2013).

The digital human users in future studies can be behavioural, functional, or structural models of users. Therefore, the digital human users in future studies can be digital human models. The digital human users in future studies can duplicate the behaviours, functions, or structures of users. Therefore, the digital human designers in future studies can use the digital human users in future studies to determine the effects of individually customised designs on user behaviours, functions, or structures. As a result, the digital human designers in future studies can also use the digital human users in future studies to fully automate the design process (Bekey, 1998; Bicego, 2005; Carruth et al., 2007; Choi et al., 2008; De Magistris et al., 2013; Demirel and Duffy, 2007a, 2007b; Hardy et al., 1984; Hsu and Chen, 2012; Ishihara et al., 2005; Jung et al., 2009; Kao and Smith, 2011; Kuffner et al., 2003; Li and Zhang, 2007; Liu et al., 2010; Lu and Smith, 2006; Lu et al., 2010; Maldonado-Bascon, 2007; May et al., 2011; Miller et al., 2010; Minami et al., 1994; Noble et al., 2012; Oguri et al., 2000; Rohrer, 2007; Smith and Smith, submitted; Smith and Yen, 2010; Smith et al., 2012a, 2012b; Taish et al., 2011; Tokuda et al., 1998; van den Broek, 2010; Zhang and Tan, 2013; Zimmer and Miteran, 2001).

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