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Battle Royale Game : In Search of a New Game Genre

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Abstract

As most of game elements are limited within the category of genre and they are preferential criteria for players to select a game, there have been sustained efforts for game genre classification and for its system. In this paper, we tried to explore the possibility that battle royale games could be classified into a specific genre by comparing and analyzing gameplay style and characteristics of battle royale games and FPS games. With four types of games (battle royale 2, FPS 2) as research target, characteristics of gameplay have been derived through expert's playing test and observation experiment. It presents new implications for studies on game genre classification to set both rules of play and actions of play in terms of game mechanics and player-centered viewpoint. In addition, it will be possible to find a way to differentiate game play by highlighting genre characteristics of a specific game.

Keywords-gameplay;game genre;rules of play;battle royale;FPS game

1. Introduction

As Battle Ground (2017, serviced by Steam) attracts players' attention, games that claim to be of so-called battle royale genre are serviced through various platforms (PC, Xbox, Mobile, etc). Recently, Battle Ground attracts considerable interest from players, taking the first ranking in PC game [1]. The term battle royale started being used upon a Japanese film (Battle Royale, 2000) produced in 2000. It expressed the film's settings and backgrounds with the word 'battle royale' and the game Battle Ground borrowed most of the film setting and adopted it for game elements, which led to generalized use of the term battle royale. The topic of the battle royale game, which represents a new genre, seems to be spreading rapidly because it has similarities with the playing methods of FPS game genres familiar to existing players [2].

Game genre affects most of game elements except audio and visual elements. Various game elements are limited within the category of 'genre', from play mode (Single or Multi) to goal setting (Goal) [3]. Game genre serves as a preferential criterion for a player to select a gameplay format that he intends to play. Games categorized as a certain genre, therefore, can be referred to as sharing intrinsic gameplay methods and characteristics. Gameplay is defined as a process of interaction with various game elements in order that a player achieves a given goal and in addition, play pattern that occurs through game rules in the process of interaction can also be delineated as gameplay [4]. In other words gameplay refers to the entire actions that a player can do in accordance with game rules and actual actions of the player. Gameplay gives aims toward which a player interacts with game elements and decides how to operate character, what action to take and how to deal with changed environment with a player's action. Thus, gameplay is a tool to set game elements upon stage of game production and to make a player obtain game experience and it can also be criteria of classifying player's action. To set gameplay, therefore, can serve as criteria to categorize a game's genre [5].

In this paper, we try to find out the possibility that battle royale games can be classified into specific genres by comparing and analyzing gameplay style and characteristics of battle royale game and FPS game. The characteristics of game play were derived through expert play test and observation experiment on 4 kinds of games (battle royale 2, FPS 2). This provides new implications for game genre settings, including specific comparison categories and content when using the characteristics of gameplay as a criterion for

classifying a particular game genre. In addition, it will be possible to find a way to differentiate game play by highlighting genre characteristics of a specific game.

2. Game Genre

The genre of the game is not fixed but constantly transformed through the process of change [5]. With production environment and platform for gameplay being diversified, game genre evolves and changes. This is a process of establishing a certain genre's uniqueness. Games in the same genre, therefore, share most of game elements except game's certain visual and audio elements [6]. Different matters including game mode (Single or Multi) and game goal setting as well as development of story and game itself are restricted and also shared within the category of genre.

From the past to the present, classification of game genres has been tried from various perspectives. With development of game production technology and diversification of platform, it has become difficult to identify game's characteristics and mix between different genres has further confused definite game genre classification. For this reason, various perspectives have emerged to classify game genres. <Fig. 1> summarizes the changes in the game genre classification from the 1980s when the game genre classification was attempted.

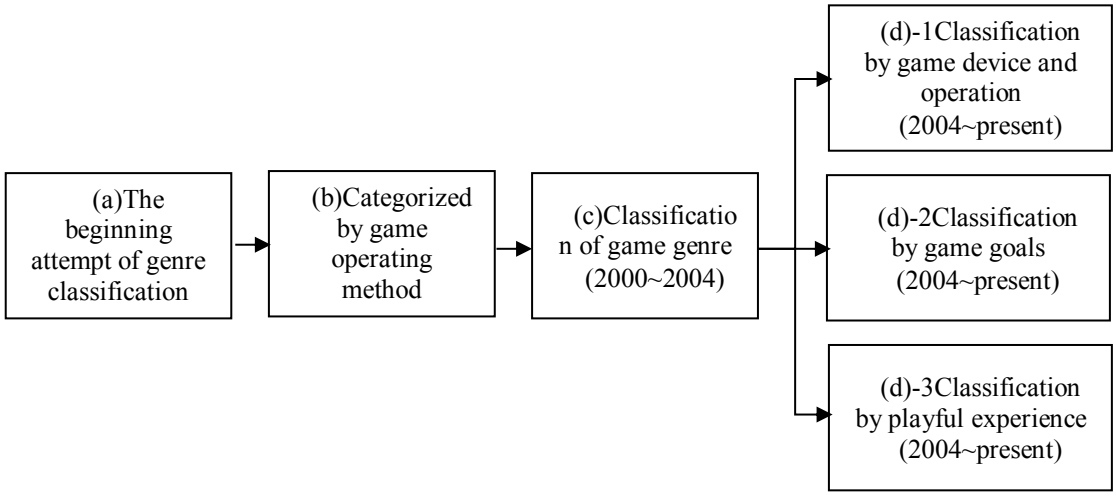

Fig. 1 Changes of Classification in Game Genre

Chris Crawford first attempted game genre classification in 1984[7]. <Fig. 1_(a)> classifies the then popular games into ones that require a certain operation command and skill and others that demand strategic actions for play. With 2 broad categories (action and strategy), it enables a player to select a gameplay form that he prefers. Game genre classification subsequently followed naturally as various games were released and it was attempted to establish specific criteria to classify game genre in 1996. <Fig. 1_(b)> is an attempt to classify genres based on game's operating method[8]. However, it was restrictively applied to games released that time so it had limits to comprehensively cover games on which new gameplay was adopted. As game development and release became active in the 2000s, the existing genre classification was subdivided. Classification criteria of <Fig. 1_(c)> are identical with those of <Fig. 1_(b)> but genre is diversified with new genres emerged which were not classified upon <Fig. 1_(b)>[9]. In 2004, a variety of criteria were sought to classify game genres as a turning point. <Fig. 1_(d)-1> is procedural classification of game genres in two steps; first with game device and then operating method followed. It enables to match a number of game titles with certain genres as it facilitates genre classification with varied combinations [10]. <Fig. 1_(d)-2> is of classification based on player's action necessary to complete a given game goal. It has significance that it suggests new classification criteria beyond the conventional classification taken for granted that used operating method [11]. <Fig. 1_(d)-3> refers to classification that focuses on the process of player's completing a given goal. It has significance that this classification is based on playful experience that can be obtained through repeated gameplay processes with player's sequence of motivation-selection-action.

Game genre classification has long been attempted in many ways and a certain game's genre sometimes changes in accordance with classification criteria and methods and a new genre emerges as well. It has

become more difficult to definitely classify game genre recently as characteristics of multiple genres are mixed. However, in the game design process, the game genre is an essential set-up element that allows the developer to predict and guide the player's behavior. It can also be an indicator for a player to select a certain game experience. Therefore, the game genre is a priority and meaningful game element for both developers and players.

3. Gameplay and Rules

Gameplay is interpreted in two perspectives; one is to define as interaction between player and game element by interpreting it from player's viewpoint and the other is as rules and actions of play in the perspective of game mechanics [13,14,15]. The former includes game elements that a player faces from the game start to its end and every action that occurs upon interaction and structurally considers arrangement of game elements by giving meanings to every action of player. The latter regards gameplay as game rules and consequent gameplay pattern and systematically sets player's action based on game environment and player's reaction that is affected by environmental changes. The two perspectives on gameplay are rather interpretation that should be considered both on stages for gameplay, contents and system design than a conflicting or opposing concept.

Game mechanics is a gameplay's systematic concept to facilitate interaction with game elements by generating a certain action through receiving input and producing output in accordance with rules set by developer. Game mechanics, therefore, serves as an important tool to induce a player's continuous game actions even when it is not represented as visual game element. There are largely three rules (Manipulation Rules, Goal Rules, Meta rules) that form mechanics within a game and induce interaction between player and game elements [16]. Manipulation Rules are on how to operate game environment's various elements as well as player character by player's input to game system. Goal Rules are on final game goal and missions that a player should complete. Meta rules define how to control or modify game. Manipulation Rules and Goal Rules are not modifiable as they are set by developer and they are given as a game element. On the other hand, Meta rules are to define actions of play that can influence game element and to induce Challenges in order to achieve game goal [17]. These three fundamental rules are draw and induce certain actions for interrelationship between them.

Therefore, setting the game play determines the rules about the interaction between the player and the game element through the setting of the fun element, the game element, and the like which induce the player's experience. It is closely related to characteristics that a certain genre of game contains and pursues. As shown on <Fig. 1>, game genre classification has been attempted with game goal and player's playful experience as criteria since 2004. It has significance that it tries genre classification based on gameplay with player-centered viewpoint but it failed to concretely present gameplay components. This study sets both rules of play and actions of play in terms of game mechanics and player-centered viewpoint as a concrete gameplay category and materializes genre characteristics of certain games.

4. Gameplay Test: Battle Royale and FPS Games

This experiment is to draw features of gameplay of recent battle royale games and to conduct comparative analysis with FPS games that have similarity in aspect of gameplay by setting rules and actions of play as a category.

4.1. Material and Method

The analysis targets are four kinds of games with two battle royale games (Battle Ground, Fortnite) and two FPS games (Sudden Attack, Special Force)[1]. They were analyzed through two experts' playing test and observation experiment.

4.2. Playing Test

<Table 1> is the result from playing test and observation experiment on battle royale games(Battle Ground and Fortnite). Battle Royale Games' ①Manipulation Rules follow 3D game's basic operating method including character's omni-directional movement and viewpoint change. ②Goal Rules are prerequisite combat rules in order to achieve the final goal of last player standing by eliminating other

players. Large setting of combat rules varies depending on game mode (single or group battle). ③Meta Rules are to induce Challenges to achieve game goal and make unique play style of game title.

Table 1. Rules and Actions of play in Battle Royale Games

Rules of Game	Rules of Play	Actions of Play
① Manipulation Rules	Character Control	Omni-directional movement : walk, run, jump, idle, lie face down, sit
	Combat Method	Shooting, Use of weapons, armor, vehicles, and other items
	Driving Method	Steering a vehicle, Operating a parachute
	Change of Viewpoint	Exploring the environment by camera control
② Goal Rules	Last player or Last team standing	Eliminate other opponents Avoid being trapped outside of a safe area
③ Meta Rules	Starting with minimal equipment	Customizing the appearance of player character Combating to obtain equipment from eliminated players
	Scattering around the map benefits for combat and survival	Searching the map for beneficial items while avoiding being killed by other players
	Decreasing in size of safe area	Acquisition the information of random area Moving into magnetic field and out of red zone

<Fig. 2> is Actions of play created by Meta rules of Battle Ground and Fortnite game. <Fig. 2_(a)> show an action for finding magnetic field to prevent damage on player with meta rule that safe area decreases as play time passes and for obtaining information on game space by utilizing game map to move to a position as a player wants to be located. <Fig. 2_(b)> demonstrates a player's combat action to eliminate other players in order to acquire necessary equipment for meta rule to start play with minimal equipment. <Fig. 2_(c)> represents a player's using vehicle to move into a position where he wants to be based on acquired information.

(a) (b) (c)

Fig. 2 Actions of Play Created by Meta Rules of Battle Royale Games

<Table 2> is result drawn from playing test and observation experiment on FPS games (Sudden Attack, Special Force). FPS games' ①Manipulation Rules follow 3D game's basic operating method for character's omni-directional movement. Unlike battle royale games, however, viewpoint cannot be changed. ②Goal Rules are to complete Goal given at every game level. ③Meta Rules are, like battle royale games,

to induce Challenges to achieve game goal. However, FPS Games make game title's unique play style in the process of completing small missions by game level unit.

Table 2. Rules and Actions of play in FPS Games

Rules of Game	Rules of Play	Actions of Play
① Manipulation Rules	Character Control	Omni-directional movement : walk, run, jump, idle, lie face down, sit
	Combat Method	Shooting, Use of weapons
② Goal Rules	Achievement of Game Level Goal	Complete a given goal per game level
③ Meta Rules	Starting with given equipment	Combating to obtain equipment from eliminated players
	Missions per game level	Install bombs in specific areas of the game level Rescue hostage hidden in game level

<Fig. 3> is Actions of play created by Meta rules of Sudden Attack and Special Force. <Fig. 3_(a)> shows an action to install bombs at a certain point of game level with metal rule to complete missions on every game level. <Fig. 2_(b)> also demonstrates an action to find and rescue hostage hidden in game level also to complete missions given. <Fig. 2_(c)> represents eliminating other players in order to acquire extra equipment in addition to given one while completing missions.

(a) (b) (c)

Fig. 3 Actions of Play Created by Meta Rules of FPS Games

Battle royale games' final goal is survival. One hundred players use various weapons and strategies and continue combat for a last man standing. A player should move into safe area using vehicle. When not in the safe area, the player is constantly damaged by magnetic field and in red zone, he is damaged by random surprise attack set by system. Rules of play on battle royale games, therefore, are for a player to set his start point both with items and vehicle and to farm those items to induce actions of play in order to combat against opponents favorable to him. On the other hand, FPS games' final goal is to achieve specific goals of game level (Annihilation, Explosion, Mission). A player may explode a certain area, eliminate opponent team or complete given missions based on game level's goal. Rules of play on FPS games, therefore, are to limit the number of items that a player has upon game start and then to restrict the quantity of item's drop after eliminating opponent to induce actions of play that a player can focus on winning the battle against opponent team.

4.3. Results and Analysis

<Table 3> organizes comparison between battle royale games and FPS games in the perspective of gameplay.

Rules of play on Battle royale games are to continuously farming items (mid-range weapon, short-range weapon, throw weapon, recovery item, etc) for combat against opponents in favor of player to achieve the final goal of a last man standing. In this process, a player obtains information on penalty area on the system and constantly changes his position or utilizes vehicle. Actions of play refer to detailed actions that occur

while following the rules. A player utilizes vehicle for movement (escape, trace, infiltrate) or explores area using map for advantageous combat against opponents and farming items according to his preference.

Table 3. Comparison of Battle Royale and FPS Games by Gameplay Perspective

Gameplay	Battle Royale Games	FPS Games
Rules of play	Final goal : A survival game with last player standing Character control : Omni-directional movement with changing viewpoint Penalty by safe area and red zone Continuous item farming and Change Select suitable items	Final goal : Completion of missions in each game level Character control : Omni-directional movement without changing viewpoint Use only given items at game start (obtain items partially after eliminate opponents)
Actions of play	Movement(escape, trace, infiltrate) and Control viewpoint Covering up for survival and Searching opponents Control vehicles Obtaining information on safe and damage zone using maps Farming items Eliminating all other opponents	Movement(escape, trace, infiltrate) Covering up for survival and Searching opponents Completing small missions by game level goal Obtaining space information by exploring the terrain Combating with other opponents Obtaining items partially

Rules of play on FPS games are to complete missions inherent in every game level in order to achieve given goals. Combat against opponent's team constantly occurs in that process and a player disturbs opponent's team in completing missions. Actions of play refer to combat against opponent's team that occurs while a player explores the terrain and acquires information on game space and moves into mission area on game level. A player can partially obtain items through combat.

Battle royale games and FPS games has three similarities and differences in terms of gameplay. As to the similarities, 1) combat against opponents continuously occurs and in that process, 2) a player hides himself and explores opponent's location in order for favorable combat. And 3) items utilized for combat are in the form of projectile and throw weapon. For these similarities upon combat situation, battle royale games share shooting genre features of FPS games. On the other hand, battle royale games and FPS games also have distinctive differences. 1) Every action on battle royale games is toward achieving the only prerequisite of survival. That on FPS games, however, is toward completing missions specifically given at every game level. 2) A player on battle royale games continuously search information and moves his position using map to avoid penalty on system and ultimately to survive as the last man and in that process, he can use vehicle. In other words, movement using parachute and vehicle and farming are actions as significant as combat. On FPS games, however, combat that occurs while completing specific missions given at game level is of great importance. 3) A player on battle royale games can freely change his viewpoint during the play so he can obtain information on direction in addition to movement and direction of progress. FPS games, however, have a fixed viewpoint in a character's vision so its player should frequently change movement and direction of progress to obtain necessary information.

5. Conclusion

In this paper, we investigated the possibility that battle royale games could be classified into a specific genre by comparing and analyzing gameplay style and characteristics of battle royale games and FPS games. Although there have been various attempts for game genre classification, this paper sets both rules of play and actions of play in terms of game mechanics and player-centered viewpoint as a concrete gameplay category and materializes genre characteristics of battle royale games and FPS games through playing test and observation experiment. Battle royale games and FPS games share gameplay features of shooting game with similarity in their actions of play on combat situation. However, with the difference of final goal on

each game features on actions of play (how to acquire information, explore and make movement and importance among actions of play) are of distinction. Battle royale games facilitate a player's accessibility through gameplay features similar to those of FPS games but they have unique characteristics as battle royal genre, which confirms that it provides a player with new gameplay that he hasn't experienced before.

Therefore, it is considered meaningful to set concrete categories based on features of gameplay and to try to distinguish game genres, and it is thought that game play can be differentiated in order to highlight genre characteristics.

Acknowledgment

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Case Study of PreVis Work Process of VR movie

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Abstract

With the recent developments in technology and hardware, attempts are being made to get viewers experience visual content in virtual reality using realistic video content. Based on the previous examples, it is proven to be necessary to have a new way of approach to distribute VR contents for user convenience using experimental VR video contents not only in hardware but also in camera and directing methods. In the text, pre-imaging was performed to present a suitable working process with motion capture and CG tasks to enhance the camera settings of VR movies and ease the audience's listening. In order to produce the pre-image for VR contents, it is necessary to identify and modify the location and movement of the objects, including the main characters, cars, and many other elements in 360 degree spaces, and to communicate with the director quickly. Several suggestion are proposed regarding VR imaging, and additional research is being planned on processing immediate correction and setup the flow of extra and crowd included in the 360 degree screen to increase the degree of completion with the pre-image production.

Keywords- ***PreVis, VR, Motion Capture***

1. Introduction

With the change in projection from film to digital in the 2000s, computer graphic technology has introduced 3D films. After the movie <Avatar>, theaters started to show a 4D movie with three-dimensional and motional chairs and other devices that emit wind and fragrance. Theaters are also considering introducing VR, with VR devices being recently released and experimental VR short films being produced. Korea has announced the world's first VR 4 DX film, "Meet the Memory," in order to keep pace with the production of world-class VR films. 4DX VR is a contents technology that experiences environmental effects such as motion chair, water, and wind as well as stereoscopic images that are seen by audiences while wearing Head Mounted Display (HMD). Although unfamiliar to movie makers, theaters and audiences, a new approach is now being made to allow moviegoers to watch movies in theaters without having to look at the screen.

Fig. 1. VR 4DX movie, meet the memory[1]

[1] https://movie.naver.com/movie/bi/mi/reviewrea d.nhn?nid =4617518&code=167655

VR images are much more realistic than traditional 3D images. They often complain of dizziness due to prolonged viewing or camera movements and heavy feeling when wearing a headset for a long time. There are still many problems to be solved, including the limitations of seats using headsets. But problems are expected to be solved as technology develops. HTC Bive Pro, which is currently leading the game headset, implements high resolution with 2880 X 1600 (615 dpi) to increase visual fidelity. Samsung Gear VR, which uses mobile devices, is increasing user expectations by releasing patents that increase viewing angle. Since the viewing angle of a human being is 200 degrees, the viewing angle of a traditional headset is about 110 degrees, causing problems with visual frustration. To address this, it is expected that the technology to increase the viewing angle will provide a stronger sense of reality and reduce motion sickness or dizziness due to the narrow viewing angle.[2]

(1) (2)

(3) (4)

Fig. 2 (1) Pearl , (2) The Lost Key of Tralla, (3) Mr. Robot, (4) L.A. Noir[3]

Along with the growth of this hardware, attempts to reduce the dizziness experienced by wearing VR headsets are continuing through changes in filming techniques or planning representation within the current technology. For example, in Figure 2, looking clockwise, the first animation shows the changing situation of time and space in 360 degrees using VR as a result of the setting to be in a car without moving the camera. While reducing the shortcomings of VR, they not only understand the story but also experienced the advantages of VR. The second animation aims to create space movement through intentional camera movement while taking advantage of VR by shifting the audience's attention through the lines, sound, and movement of characters on the expedition. This thematic production allows the audience to experience both freedom and coercion at the same time. In the case of short films, we see more of a concern for the production. Unlike in the traditional 2D image, which showed the director's intention in the position of the camera by the laws of tripology. VR cameras are placed between the characters to encourage the audience to naturally move the headset to read the actor's facial expressions or emotions. Attempts to express the cinematic filming and production techniques of moving cameras and making cut changes using VR are gradually advancing the VR movie era.

[2] https://blog.naver.com/gkrwja88/221236589186

[3] https://www.youtube.com/watch?v=WqCH4DNQBUA,https://www.youtube.com/watch?v=TkkA6jvk -yQ, https://www.youtube.com/watch?v=I9UP2y-cEGQ,https://www.youtube.com/watch?v=q6RWf x IKMMQ

2. Body

2.1 Need of PreVis

PreVis stands for pre-visualization and is also called 'previsualization.' PreVis uses CG and digital actors to create a production process that was constructed in the past through the concept art, conti, and storyboards to improve cost savings and perfection of the work. PreVis check the actors' performance space and movement paths at the filming location, how many extras are needed to fill the filming space, and how they are supposed to move and act in advance. The bigger the movie is and the more budget it has, the more important it is to produce the PreVis.

(1) (2)

Fig. 3 World War Z (1) PreVis (2) Movie[4]

Let's compare the PreVis image of < World War Z > to the actual film. The movement of cars, the main characters, and numerous zombies' movements and actions were carefully produced through PreVis and the filming was conducted only after final confirmation. You can't solve these big accident scenes with rehearsals or storyboards. PreVis images can be produced through computer graphics to enable simulation to identify events that can be caused by collisions between people, cars and zombies. After this process, the actual filming can be performed reliably.

The PreVis image, which was created to produce high-budget films seeking cost reduction and accuracy, is not an option but a must for VR movies. VR movies basically need to take into account 360 degree space. It is difficult to predict whether the audience's attention shifts in the direction intended by the director with the way the audience displays only one side depending on conventional camera views and storyboards. The production of PreVis video with 360 degree view enables the staff under supervision to check what they see with the eyes of the audience. In addition, PreVis image indicates layouts of all environments including characters, so the location of the object such as automobile or character's moving lines should be able to be modified and the movement of the track required by film directors should be reflected immediately. Therefore, it is necessary to reset the location and circulation of equipment and props such as VR cameras, characters and cars, and prepare a feedback process that can be checked again with VR headsets in a short time. Many problems remain to be solved in this process for further development.

2.2. Using Motion Capture Equipment

While motion capture equipment in the past used to capture a certain amount of space marker movement using optical displays, recently, gyroscope devices such as Xsens are used to maximize space utilization. The downside of the Xsens equipment is that it is difficult to establish a simultaneous filming environment that requires interaction of two or more people because it is a one-person suit which is high-priced equipment. Moreover, although the movements of the Y axis such as sitting or walking upstairs are technically complementary, the resulting figures appear to be inaccurate compared to the optical images of the space. Despite these shortcomings, gyroscope is a very good equipment for producing digital actors or PreVis images of movies because of its excellent spatial expansion. Modification of motion capture data will be handled by an animator or motion capture animator in the relevant field. Modifying motion capture will be done in the opposite process to key frame animation, which is usually performed by an animator. A typical key frame animation production step first poses a motion on a default character that has no action.

[4] https://www.youtube.com/watch?v=EkzpWzjyITQ, https://www.youtube.com/watch?v=w8ui9l0krZk

The key frame is then applied from one pose to the next, and the key frames are defined between the poses for spacing, then added to the intermediate movements, in-between movements. In contrast, the process of correcting motion capture data is to compensate for or add the motion required for the existing motion, or to correct the motion that is bouncing or penetrating from the captured motion data. These are all processes that are conducted when the captured data are relatively stable. If the data are inaccurate, the task of revising the basic data should begin. This approach is very complex and often shows poor results. Thus, the modification of motion capture data is a particular process that can be created only after measures are presented for effective modification on the assumption that the data to be worked on is stable.

3. Manufacturing process example

3.1. Manufacturing process configuration

The basic VR prefabe production process is as shown in Figure 4. There is a difference between a typical PreVis and that is the output process to the headset is added because it is not easy to determine whether the camera is positioned properly until the headset is worn and the final image is viewed. It's necessary to decide whether to put the game engine into the process or the sequence rendering course into the process depending on which headset you wear for checking. In this project, we have applied it to both and the pros and cons of each case are described in the text.

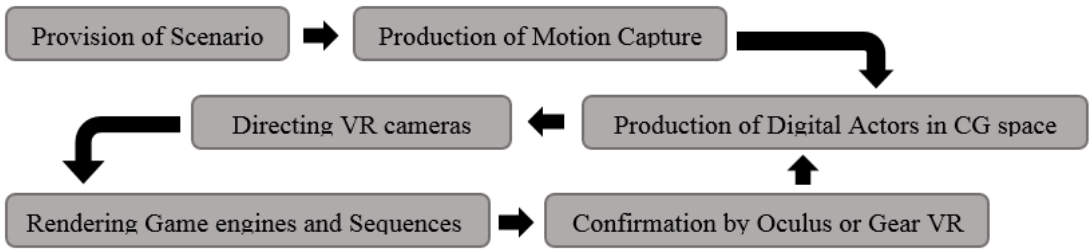


Fig. 4 VR PreVis Production process proposal

3.2. Motion capture production process3

It can be said that the production begins with motion capture actors filming their motion motions according to the scenarios provided to illustrate the production process in Figure 4. Motion capture actors should not only film motion, but act like real actors by speaking lines. The first reason is that the timing of the connection between the lines and the performance is crucial. The second reason is that if you only put off the action without lines, taking multiple shots of the same action will lead to time differences in the action. However, since it is impossible for a motion capture actor to memorize lines like a professional actor, he first picks up the script and records the rehearsal. With the recorded lines, not only do motion capture recording take no burden to motion capture actors, but also take a similar amount of time. In addition to motion capture equipment, motion capture is also filmed using regular cameras. This is because key frame animation is needed because finger movements are not filmed with motion capture equipment. In addition, when positioning motion captured characters in CG space, they can be used as reference material for help. Since a film director or staff members do not create lip-synching expressions on the face of a CG character even when checking the PreVis image, all sound files including dialogue are supposed to be included in the PreVis image. Recording not only motion capture but also pre-sounding and video is a necessary process. Characters' actions can be categorized into two main types with analyzing film scenario, which are talking or moving. On the left is an optical motion capture equipment and on the right is a gyroscope equipment. The advantage of optical motion capture equipment is that more than one person can be filmed simultaneously and produces relatively accurate location values within the space. It is efficient to use optical equipment for dialogue that requires the interaction of two individuals.

If you want to film the interaction between two actors in a gyroscope, you need to photograph each person and put them in one scene because only one person can take a picture of a gyroscopic motion capture device. There is a problem that becomes very difficult to modify with the timing gap of the two clips interacting between each other's change. Because gyroscopic motion capture equipment can be filmed in a

relatively wide range of locations regardless of indoor and outdoor, for example, it can be considered highly suitable for walking up and down stairs.

(1) (2)

Fig. 5 Motion capture shot (1) Optical equipment, (2) Gyroscope equipment

There are not many requests for modification on PreVis images for dialogue. On the other hand, since many variables appear depending on VR environment when characters move, director often makes requests for change of movement of positions. It would be time-consuming to call in motion capture actors and shoot the motion again. It is significantly important to prepare for a quick response to requests for motion correction by filming actors' movements separated as shown in Table 1 in such a case like this.

Table 1. Basic Breaking Behavior Chart

move			Stay			
walk	run	jump	sit	squat	knee	stand
walk slow	run slow	jumping place	sit up	stand-squat-stand	stand-knee-stand	hands by the sides
walk fast	run fast	lean forward	sit-stretch	squat with hands on knee		hold arms across chest
walk-turn back	acceleration run	forward jump	stand-sit-stand	hands on sb's hand -squat		keep look around
walk-stop-turn around	run-stop	keep jump				catch the thing
walk-stop-turn around-turn back	acceleration run-sharp slowdown					hide
						cheer
walk -run	run-jump					stand at attention
walk-run-walk	run-call sb					lean on or against

It is the quickest way to modify these distinct actions by making them into clips and pasting clips into layers as requested. You can use layers to start and repeat actions at any time, or to control the speed. The clips overlap each other so that the movements are naturally connected through blending. The left image of Figure 6 shows the process of connecting clips together on a motion builder's track and making them one action. The image on the right shows that the starting point of the motion is aligned with the end of the front clip, so that new movements can start at the end of the different movements, making them naturally one movement.

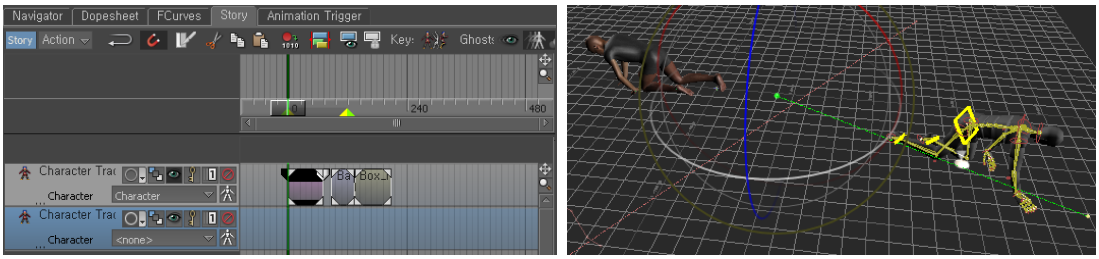
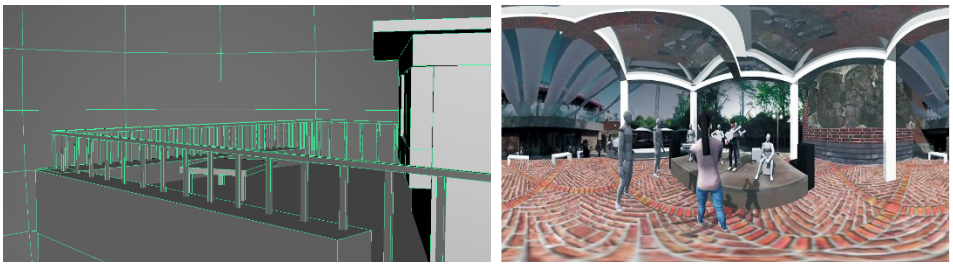


Fig. 6 Modifying the movement of clips with the Match option in the Motion Builder track

3.3. Manufacturing and printing processes

Motion capture motion data is applied to CG characters using CG tools such as Maya and the filming space will be located in a computer-replicated modeling environment. For a 360 degree viewing space, the CG production of everything will not only hit the production time limit, but also affect the subsequent tindering time. As shown in Figure 7, a basic form of modelling is produced for floors or buildings with direct contact and interaction with the character. The 360 degree background which can measure the location of the four sides of the world, maps and uses a preformed 360 degree image. The interior of the sphere to which basic building modeling and background images are mapped can be seen in the left image of Figure 7, and the right image shows a scene representation with texture image.



(1) (2)

Fig. 7 PreVis (1) Modeling (2) Modeling with Texture

The most ideal PreVis imaging process is to produce the video while checking the location and circulation of VR cameras and characters. Currently, there is no way to identify camera views as VR within Maya program. Using Marui which is a plug-in developed in Japan, VR images can be seen through Oculus in the Maya Perspective Viewer. However, there is a limitation that can only be achieved by moving the MaruI camera to the Maya camera's location, not by the Marui camera and the Maya camera. In other words, the exact start position, rotation, and movement of the Maya cameras have not been matched, only showing the potential for auxiliary functions. Because the images of PreVis can only be viewed accurately through specific devices such as Gear VR or Oculus. In order to check the location and circulation of the camera without image-rendering during the production process, it is necessary to check the data by transferring the data to a game engine such as Unreal because the images of PreVis can only be viewed accurately through specific devices such as Gear VR or Oculus. If a game engine is used, the modeling space, moving cameras and characters are stored and moved in fbx file format by CG tools as shown in Figure 8. The cuts must be specified as a level and the level movements must be made so that the cut-specific sequence gets proceeded in order for the cut to be connected and played in the game engine.

It was the best way to provide immediate feedback to the director and the crew of the film to check the PreVis video after moving the data to the game engine. Including staff members, actors and director wanted to perform the filming by viewing the PreVis video on site immediately, while experiencing the PreVis image with Samsung Gear VR, the platform of final images for the audience. Because they wanted to analyze the psychological actions of the audience through this process, they had to adopt a rendering method that offered more than 2K images.

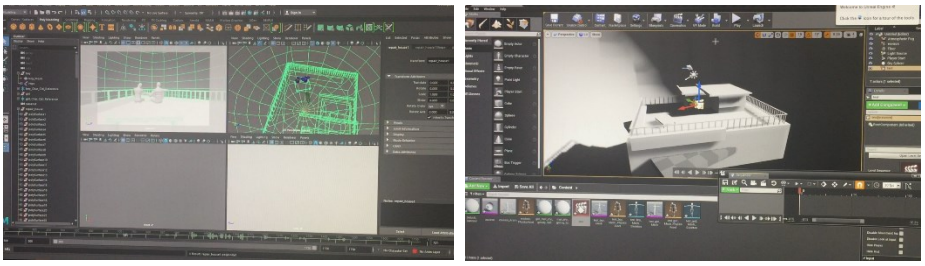


Fig. 8 Sequence Creation after data moving Maya to Unreal game engine

A specific Renderder for speed is required for image output beyond 2K and feedback. A GPU based renderer was considered to be the most suitable renderer, and it was possible to create about fourteen 2D-images per minute by setting the optimal figure. It was expected that 2,000 frames per cut would take about two hours, and 50 hours would be spent each if the 30 minutes of feedback were tracked. Because feedback can be completed in about 5 hours after rendering 10 GPUs, it was able to create a process that can provide about twice daily feedback.

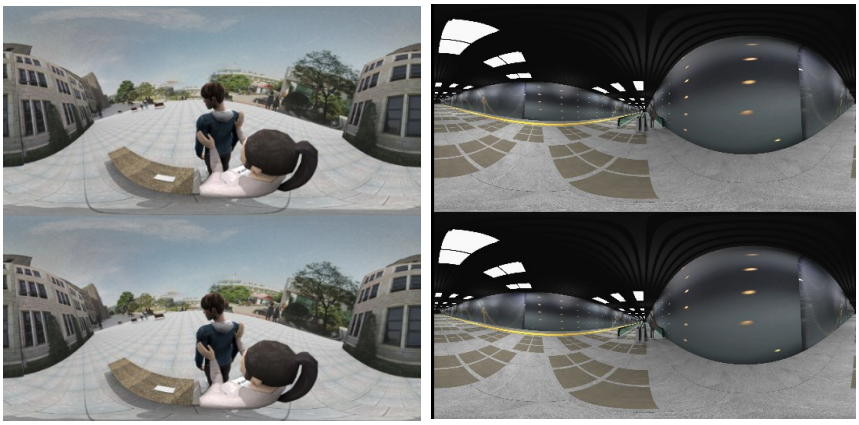


Fig. 9 VR Stereoscopic PreVis image output through rendering

3.4. Feedback process

In the process of the director's feedback, requests for correction are made based on whether the audience's mind moves to the attention and whether there is a psychological awkwardness in VR video production. As shown in Table 2, the content of the feedback can be summarized into the production of the camera. If you look at the way the eyes change in VR movies, the audience is turning their head following the actors' acting while cameras get fixed. Depending on the location of the camera, there will be several position modifications made to the audience to give them a sense of eavesdropping or to look elsewhere. In the case of character placement, unlike the traditional rule of trisection in picture grammar, characters had to be placed in the middle of the screen to achieve stable cut-specific switching. The effective movement of the camera to show the setup, it seems effective for a truck-down to start that can be psychologically stable while showing much visibility due to VR characteristics. When the cut was changed due to VR characteristics, the transition was not awkward when the camera started moving around the character that it was trying to show. When working on the movement in various directions, it was necessary to create a psychological camera movement that would be left in the eyes of the audience to guide the movement to take place according to the director's intention. Lastly, the basic position of the camera to consider is that shoulder length shots are common for movies. On the other hand, PreVis confirmed that VR movies have a serious depth when placed at shoulder level. Therefore, it was judged that placing the camera at the chest level, which is slightly lower than the shoulder, would deliver a sense of psychological stability from screen.

Table 2. A comparison chart of shooting methods of movies and VR movies

	Movie	VR Movie
Eye movement Way	- Camera move - Cut Switch	- Fix the VR Camera - Audience moves to headset
Person placement	- Place a person according to the rule of thirds	- Place among people - Even when other characters are introduced through cut-through switching
Spatial change	- Panning the camera - Camera zoom in / out	- Truck down
Move Camera	- Various production possible	- Move around the character
Default camera location	- Over the Shoulder	- Height lower than face

4. Case study of Process operation

The VR PreVis production process can be described as a process in which a 360 degree image created for HMD can produce quick revision and feedback upon request from supervision. Most of the requests for modification have been made by camera location at the time the character's motion took place, by changing the movements of main characters and extras, and by changing the initial positions of the characters. A quick fix should present a process for the outcome to be checked by the supervision, and the problems generated can be summarized in two ways. First, workers who work with PreVis cannot confirm whether VR cameras are located properly until they see the results as VR headset.

Moving the Maya scene to an unreal engine is the fastest way to determine the location and circulation of VR cameras and characters without rendering, because sound was limited to limited screen conversion effects such as offset or fade as video running time was extended, it could not satisfy demands of staff members and film director.

Second, when directors and actors check their results through the game engine, the non-real engine, VR stereo image can reduce the process of rendering, thus providing feedback images quickly. The film director made a request to take a look at the final result with Samsung Gear VR because it is difficult to use the software freely on the scene because of the limitations of the software and the reason to connect to the PC. The addition of image rendering time from CG tools and rendering time to final images after editing was a problem when this process was selected. Rendering using GPU was best done in order to modify 30 minutes of video and produce feedback images. It also used optimal lighting and selection of renderer options to solve time-consuming problems.

5. Conclusion

One of the goals of the film is to impress the audience through visual indirect experience. For this, the audience pays for the indirect experience, and the ultimate goal of the experience is to feel realistic as if the characters in the movie are with them. In Steven Spielberg's movie <Ready Player One, 2018> the main character wears HMD and experiences characters from various movies in the past, allowing the audience to coexist with the characters in the content, which is a movie that makes people predict and expect VR films to be produced in the future. Traditionally, filming a movie has been set in a way that the audience shift their gaze along the cameras within the film director's intention and make predicted response. VR films show a space of 360 degrees, so the motion of the camera is restricted, but the eyes of the audience can be moved freely according to the scenario, actors, or the intention of the surrounding environment. It is becoming more important to produce PreVis images, a task that constantly checks and modifies the director's intention of production and response to audience's eye movement before starting filming for this reason. There are many problems with VR images including hardware and software, which is being solved little by little as hardware continues to develop and filming techniques progress, and software also creates

new image grammar that is stable for VR through various productions. This study analyzed the results of the production process of PreVis images of VR films using motion capture to identify problems and propose measures to resolve them. The spread of contents to various media is expected as the VR content market becomes more common in the near future. Later, we will study and present an effective production process in which video can be viewed in virtual space through simultaneous connection using game engine, and modifications can be made according to production and feedback.

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Android Based Chatbot and Mobile Application for Tour and Travel Company

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Abstract

Mobile Applications are rapidly growing segment of global mobile market. This paper involves an application for the android base operat ing system for a travel agent which will conduct booking transactions for train tickets, airline tickets, hotel, theme park, and tour. This application is integrated with a chatbot, an instant messaging applications. Chatbot is a computer program that can communicate with users. The purpose of chatbot is to support and scale business teams in their relations with customers. This chatbot can be placed in Facebook Messenger, telegram and own website, so it gives the potential to reach a bigger audience. Customers do not need to install new applications. The customer just simply adds chatbot as a friend and starts transacting with a conversation, without needing to understand the intended user interface in an application. By using chatbot, the company can also shorten sales transactions. Company can also broadcast information directly to customers easily. In this paper, we first discuss about chatbot and mobile application system design. Finally we will discuss about the system implementation.

Keywords-chatbot; flight; hotel; tour and travel; theme park; tour; train

1. Introduction

Nowadays, the internet and mobile devices have changed how one interacts with others as well as how one interacts with a company [1]. Internet and mobile devices have increased the use of mobile e-commerce (m-commerce), with m-commerce users can perform e-commerce activities using mobile devices [2]. Increased use of internet and smartphones allow companies to interact directly with corporate customers [3].

In line with the development of m-commerce, the use of instant messaging applications is also increasing. Therefore, many companies such as airlines, fashion, and insurance companies provide customer service facilities through instant messaging applications. Through instant messaging applications, companies can conveniently communicate with customers [1]. Chatbot or conversational agent can be used to automate the interaction between the company and the customer via instant messaging applications. Chatbot is a computer program that can communicate with users. Chatbot widely used to facilitate customer service. However, chatbot is currently growing in the commercial direction. Chatbot can respond in the form of text, recommendations, updates, links or buttons to call, moreover customers can also purchase products by selecting from the carousel in the chatbot interface [4][5]. Chatbot can also facilitate the sales process, ordering process, and delivery process [6]. Chatbot is also free from the platform because chatbot uses the infrastructure of the instant messenger app so the application install process is no longer needed [6]. Moreover the use of chatbot is cheaper than using someone else's services to handle customer [1].

Currently, tour and travel companies only rely on websites and telephone or chat to make sales transactions. Website used for sales transaction is not a responsive website, so the customer must be in front of a computer to be able to conduct transactions. Beside the website, transactions must be done by phone or chat, but the company cannot always be ready to be contacted.

Therefore it takes an m-commerce application that is easy to carry so that customers can make reservations transactions wherever and whenever. In addition, it is also required a chatbot integrated with

instant messaging applications so that customers do not need to install new applications. By using chatbot the company can also shorten sales transactions conducted.

2. Review of Literature

2.1. Chatbot

Chatbot or also known as bot or chatterbots or conversational agents is a computer program that can do a conversation with humans via voice or text [7]. Nowadays, the design of chatbot has developed sophisticatedly. Chatbot is even used in some sectors such as education, e-commerce, entertainment, and the public sector. Some chatbots use some sophisticated Natural Language Processing (NLP) systems [8], but there are also chatbots that use easier systems such as searching for keywords from inputs and then generating replies with similar keywords or by searching almost identical word patterns in a database. Chatbot is currently used in virtual assistants like Google Assistant, and is widely used in corporate applications or websites. Chatbot also utilized various instant messaging applications like Facebook Messenger and Telegram.

2.2. Representational State Transfer (REST)

One form of interaction between the user and the Internet is through web aplication by using a web service that uses the concept of Service Oriented Architecture (SOA). One of the frameworks used in web services is Represantational State Transfer or often called REST [9]. A RESTful web service uses Universal Resource Identifiers (URIs) to access existing resources in the web service. Each interaction with a resource is stateless, meaning that each request contains the state or state required to handle the request either inside the URI, query-string parameters, request headers or request body. In addition each response also contains the status or state of the resource either in the body, response codes, or response headers [10].

3. System Design

3.1. Chatbot System Design

The system design of the chatbot application can be seen in Fig. 1. This chatbot application using a MySQL database and connected to a web service that has been provided by the company. In addition, this chatbot runs on Facebook Messenger and using Facebook API to receive and send data to user. The database is used to store data of user login, destination city, airports, stations, airline names, train names, and countries. Web services are used to search, order, and issue transaction.

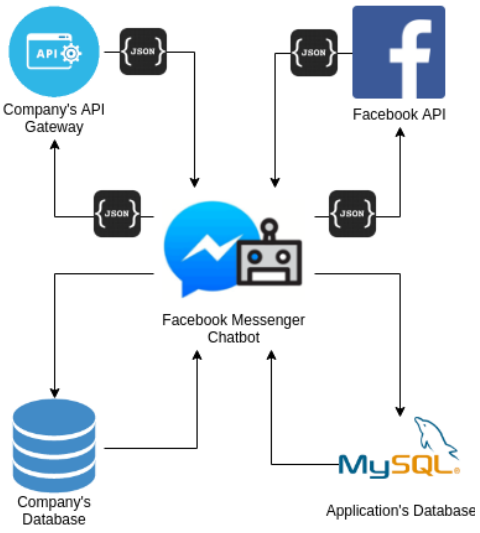

Fig. 1 Chatbot System Design

3.2. Mobile Application System Design

The system design of the mobile application can be seen in Fig. 2. This mobile application using MySQL database and connected to a web service that has been provided by the company. The database is using to store data of user login, destination city, airports, stations, airline names, train names, and countries. Web services are used to search, order, and issue transaction.

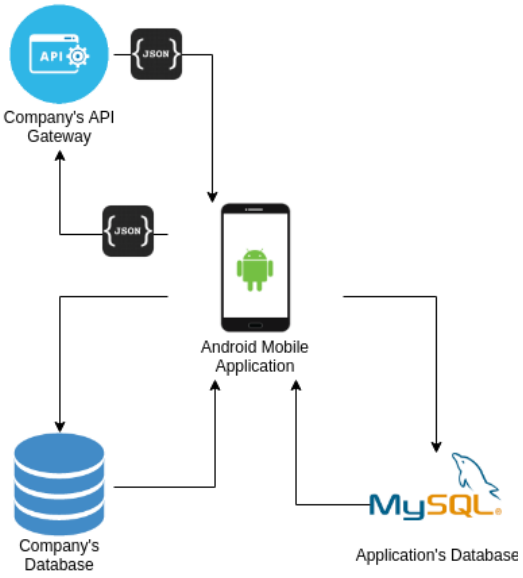

Fig. 2 Mobile Application System Design

4. System Examination

4.1. Chatbot

4.1.1. Login Chatbot

Login in chatbot needs username and password that has been given by the company. Chatbot login form can be seen in Fig. 3. After login, the user will be redirected to the main page of chatbot.

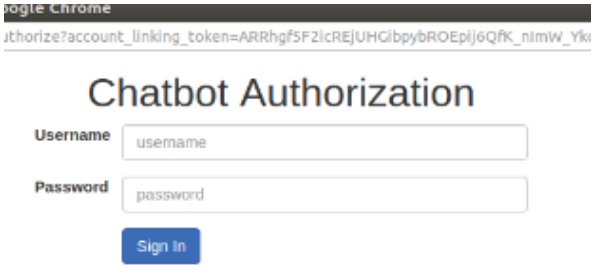

Fig. 3 Chatbot Login Form

4.1.2. Search Flight or Train in Chatbot

To search flight or train in chatbot, the user need to enter keywords such as the city or airport or station code of origin and destination of the trip sought. In Fig. 4 the user entered the sentence 'surabaya singapore 1 orang'. Because the date of departure data is not inputted then chatbot will ask for it. Users can also filter data to determine the selected trip. Views of search results can also be seen in Fig. 4 and Fig. 5.

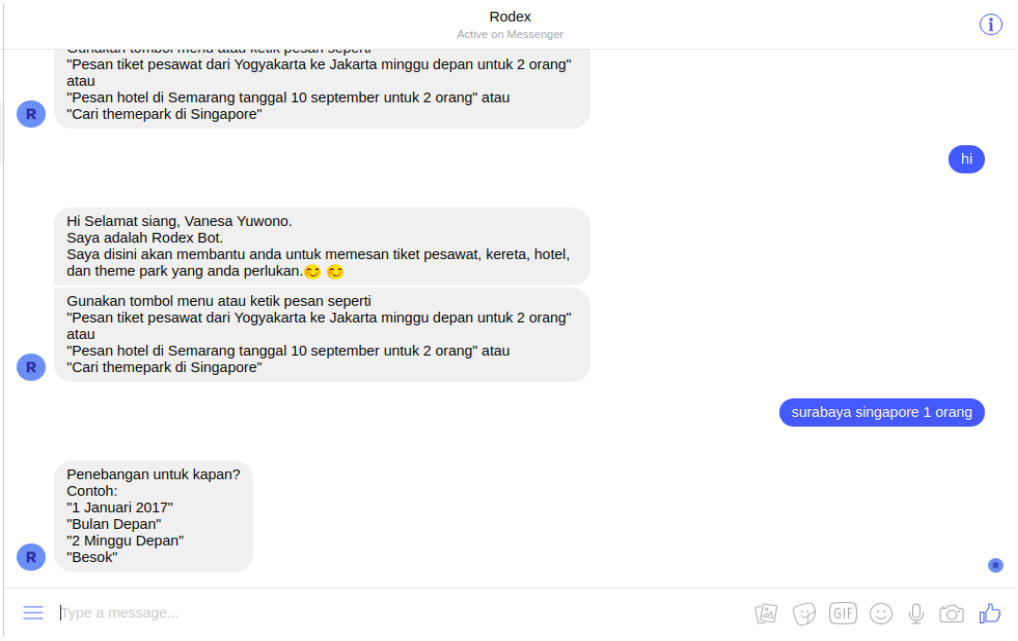

Fig. 4 Form of Search Flight

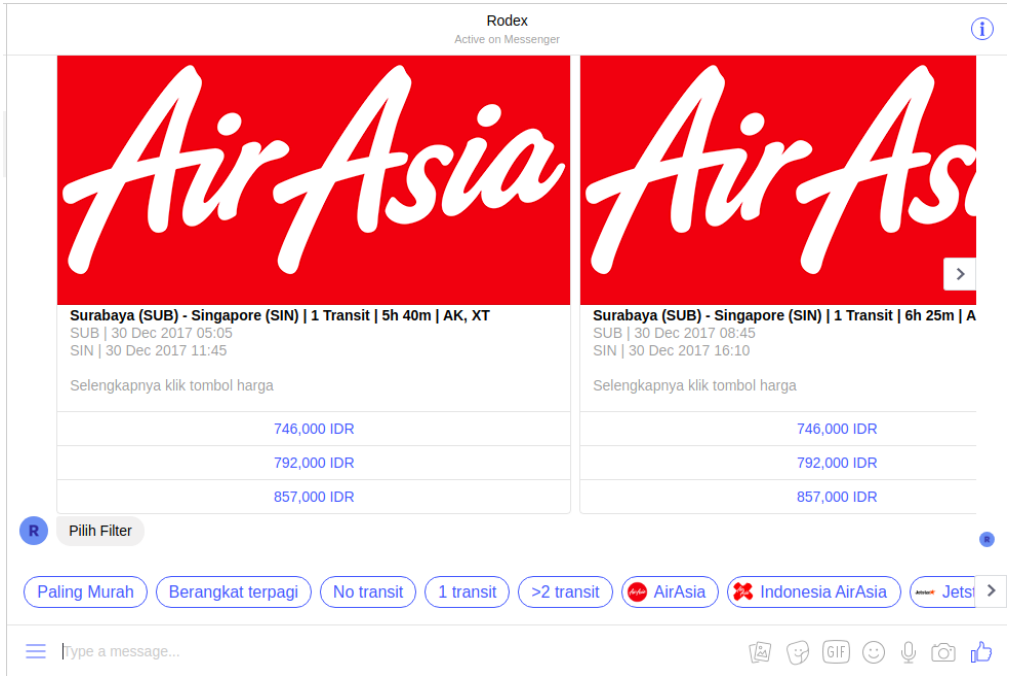

Fig. 5 Result of Search Flight

4.1.3. Book Flight or Train in Chatbot

After searching the flight or train, users can select the desired trip by pressing the price button on the search results view. After that, chatbot will display the details of the trip as shown in Fig. 6. Users can continue the order by pressing the 'yes' button.

After ordering, chatbot will display questions about the booker and all passenger that can be seen in Fig. .6 If all data is filled correctly chatbot will display the ordering result.

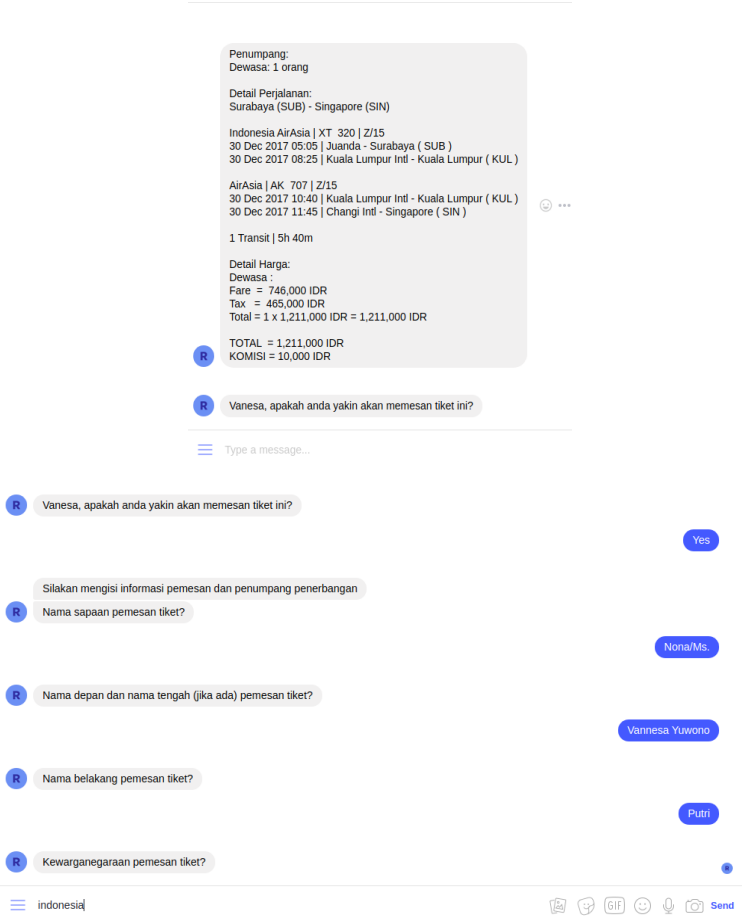

Fig. 6 Flight Detail and Passenger Form

4.1.4. Issue Flight in Chatbot

To issue a flight transaction the user can choose the 'issue flight' menu, then the user will be instructed to fill in the order number of the flight reservation. If the user has sufficient balance to make a payment then chatbot will issue the order as can be seen in Fig. 7.

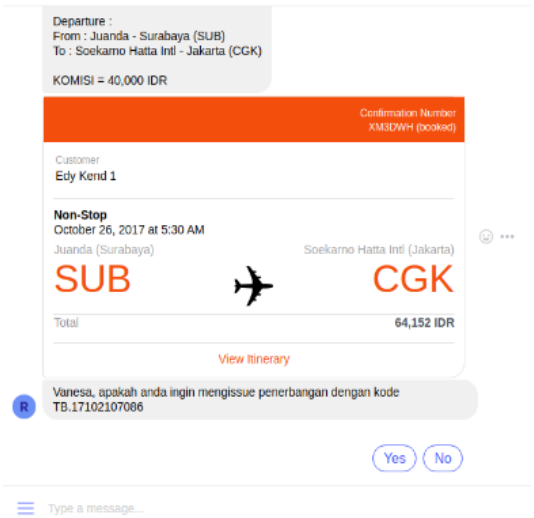

Fig. 7 Issue Flight

4.1.5. Search Hotel or Theme Park in Chatbot

To perform a hotel search, the user can enter keywords such as city or hotel or theme park name sought. If the user input is incomplete or unrecognized then chatbot will ask those data. If the data is complete, chatbot will search the hotel or theme park.

4.1.6. Book Hotel or Theme Park in Chatbot

After searching for hotel or theme park, users can select the desired hotel or theme park by pressing the price button on the search results view. After that, the chatbot will display details of the hotel or theme park. Users can continue ordering by pressing the 'yes' button.

After ordering, chatbot will display questions about the booker and all customer that can be seen in Fig. .6 If all data is filled correctly chatbot will display the ordering result.

4.1.7. Book Tour in Chatbot

To make a tour package reservation, user can choose tour menu, then chatbot will show all tour packages available. Users can choose the tour package by pressing the price button displayed.

After ordering, chatbot will display questions about the booker and all customer that can be seen in Fig. .5 If all data is filled correctly chatbot will display the ordering result.

4.1.8. Search Promo in Chatbot

To view the ongoing promo, the user simply press the promo button contained in the main menu. Then chatbot will display all promos that apply at the time.

4.2. Mobile Application

4.2.1. Login User Mobile

Login in the mobile application is done by using the username and password that has been given by the company when the user enroll. The mobile application login form can be seen in Fig. 8. After successful login, the user will be redirected to the main page of the mobile application.

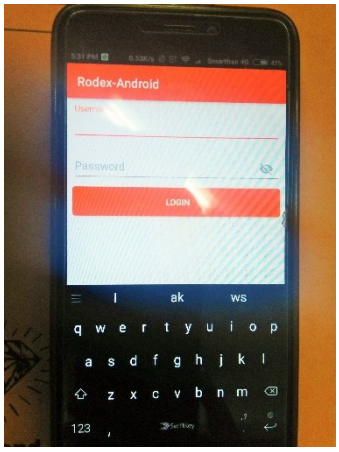

Fig. 8 Mobile Login Form

4.2.2. Mobile Main Menu

Mobile main menu is the start page of the mobile application. The page view can be seen in Fig. 9. There are 8 types of menus that can be selected by the user, such as the flight menu, train menu, hotel menu, theme park menu, tour menu, promo menu, customers menu, and logout menu.

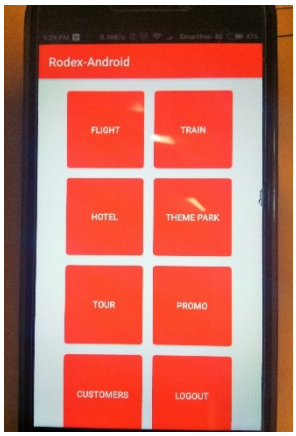

Fig. 9 Mobile Main Menu

4.2.3. Search Flight or Train in Mobile

To perform search flight or train ticket users can select the flight or train menu then press the search / book button. After that users will be guided to the search page form to fill in search data. The search page form can be seen in Fig10. After the user input the data correctly, the user will be taken to the search result page. Search flight result view can be seen in Fig. 10.

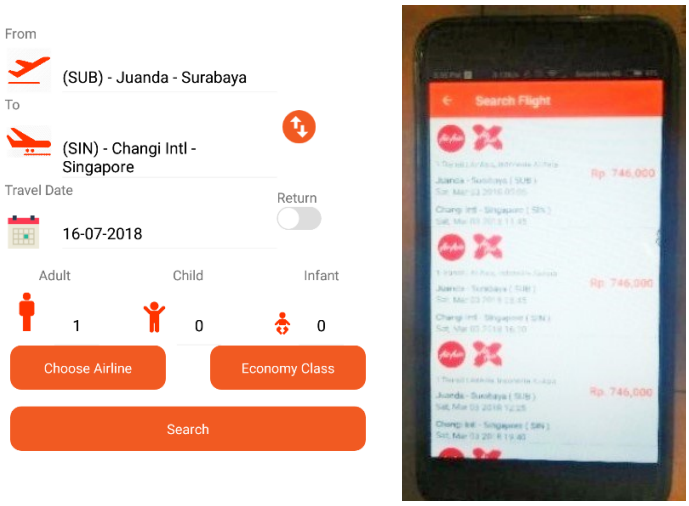

Fig. 10 Search Flight Form and Result

4.2.4. Book Flight or Train in Mobile

After searching the flight or train, the user can choose their desired trip by pressing the list view. Then, they will be redirected to the detail page showing the details of the trip. Detail flight page view can be seen in Fig. 11. To make a reservation the user can press the booking button and fill the booker and passenger data which can be seen in Fig. 11 After all data is filled correctly, user can make a reservation by pressing confirm book button. Then the user will be redirected to the booking page to see the order's result and status.

4.2.5. Issue Flight in Mobile

To issue a flight, user can choose flight menu then issue flight. After that the user will be led to the issue flight form page where the user must enter the order number they want to issue. The issue flight form will show to user all information about the flight booking. User usually use to do re-checking about their booking.

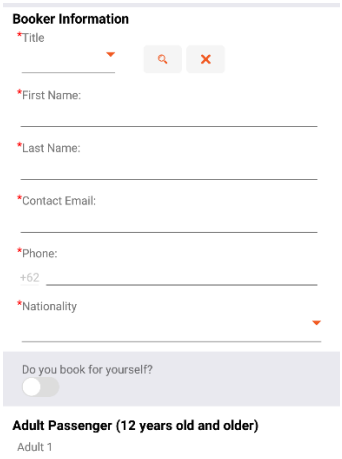

Fig. 11 Passenger Form

4.2.6. Search Hotel or Theme Park in Mobile

To perform search hotel or theme park users can select the hotel or theme park menu then press the search / book button. After that users will be guided to the search page form to fill in search data. The search page form can be seen in Fig10. After the user input the data correctly, the user will be taken to the search result page.

4.2.7. Book Hotel or Theme Park in Mobile

After searching the hotel or theme park, the user can choose their desired hotel or theme park by pressing the list view. Then, they will be redirected to the detail page showing the details of the hotel or theme park. To make a reservation the user can press the booking button and fill the booker and passenger data which can be seen in Fig. 11. After all data is filled correctly, user can make a reservation by pressing confirm book button. Then the user will be redirected to the booking page to see the order's result and status.

4.2.8. Book Tour in Mobile

To make a tour package reservation, user can choose menu tour. After that, the app will display all the tours that can be ordered. To order the tour user simply select the desired tour and fill the booker and customer data which can be seen in Fig. 11. After all data is filled correctly, user can make a reservation by pressing confirm book button. Then the user will be redirected to the booking page to see the order's result and status.

5. Conclusion

From the results of the questionnaire, it can be concluded that:
1. The Android mobile application is responsive on various screen of Android smartphone.
2. All in-app features of Android mobile application and chatbot can be run.
3. Chatbot and mobile application can be used to help the tour and travel company's sales transaction whenever and wherever.

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New Safety-Reinforced Interior Concept for the Autonomous Car

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Abstract

With the car becoming fully autonomous, the behavior of commuters will change with the emergence of new activities in the car, such as working, gaming, sleeping, etc. These activities cause the commuters to be in different positions and locations in the car that is not possible with non-autonomous cars. This study assesses the concepts being developed and showcased by major automakers that feature lounge-like interior environments with no backup safety features and lack of innovative ergonomic features for the different positions and activities of the commuters. The text also assesses how the safety features of non-autonomous cars are inadequate for the autonomous car. The goal of the study is to envision a new intelligent and adaptive seat for the autonomous car that integrates other emerging technologies into the interior environment. The intelligent and adaptive seat considers work productivity as well as leisure and allow the commuters to fulfill multiple tasks while being equipped with proper safety features.

Keywords; Autonomous, Autopilot, Data, Multi-Function, Safety, Seats, Interior, UX

1. Introduction

Many car makers have been developing an autonomous car technology and reaching level 3 (autopilot on the highway) since Google announced the success of 1,000-mile road test of the driverless car in 2010 [1]. The Society of Automotive Engineers (SAE) defines six levels of driving automation, spanning from 'no automation' (driver does all the work, level zero) to 'full automation' (sit back and be chauffeured, level 5). Drivers using a level 5 autonomous car will be able to make full use of their time in the car without distractions [2]. With the autonomous car becoming less focused on the driving, there is a prediction that the interior will be designed for productivity, entertainment, exercise and/or rest [3]. A large portion of the research community has focused on the possibilities of usage regarding the interior of an autonomous car.

With the use of the interior for purposes other than driving, the commuters are projected to be in more varied seating positions due to the range of possible activities, be less aware of the external surroundings of the car due to their lack of involvement with driving, and be more complacent with regard to safety in the autonomous car interior due to an overall reduction in traffic accidents. Once only autonomous cars are driving on the roads, it is anticipated that autonomous cars will drive at much faster speeds, have reduced safety features as the number accidents will be significantly reduced, and have closer car distances to allow for more efficient transport of commuters [4].

Although the overall number of traffic accidents would be significantly reduced on the road if all of the autonomous car's features were to function in full, the radical change of possible activities in the autonomous car requires a significant shift in thinking with regard to commuter safety.

Many recent autonomous concepts have relied heavily on this problem-free scenario and lack the necessary safety features in case an accident does occur. This study looks into this aspect of commuter safety in the context of autonomous car interiors as the current system of seat belts and airbags is inadequate for the envisioned activities that will occur in the autonomous car.

2. Safety Considerations for the Autonomous Car

In order to develop an autonomous vehicle, every single task and feature, both internal and external of the car, must be considered. All actions involved with driving may seem the same, and the goal might be simple, such as safely going from point A to point B, but each instance of driving entails different locations and conditions [5]. The autonomous car must be designed to safely operate among various factors that are present when driving in different environments. In the case of driving through a city, the autonomous car has to navigate through aggressive drivers, slow drivers, bicyclists, trucks, motorcycles, stop signs, and other factors that a driver usually experiences.

Data have been collected by testing the autonomous car in the real world. By testing and analyzing the autonomous car in busy cities in the US and around the world, the performance and safety of the autonomous car will improve. This collection of data is designed to identify potential challenges, and the safety system is designed even when the autonomous car faces an unexpected challenge.

3. Recent Autonomous Car Interior Concepts

Automakers have recently been introducing their new autonomous car interior design concepts in the Consumer Electronics Show (CES) in Las Vegas and other motor shows. BMW's concept at the CES was a moving living room. This concept included wide, comfortable chairs facing a giant flats-screen TV. Rolls-Royce had a concept car that also had a big couch and a TV with a lot of room for relaxing. Volkswagen Group debuted a concept car in March 2018 that only has space four seats [6]

Fig.1 Rolls-Royce Interior Concept: Living Room

The car resembles a pod and the passengers can face each other without feeling cramped. Renault showcased its Symbioz concept at 2018 Frankfurt Motor Show. This concept also has four chairs that allow the passengers to face each other. The most sophisticated seat idea is Adient's 'zero-gravity' concept seat that features head restraints, dual-sided arm rests, and leg rests that are synchronized to move with the body [7].

In terms of any kind of control panel or console, Waymo, a spinoff of Google, patented a console with simple buttons like, "Go" and "Stop Now" to still give the commuter some control of the car.

There have been propositions of a morphing-interface concept. When the driver selects autopilot, the steering wheel disappears into the dash, the pedals raise to serve as footrests, and a table folds out from the center console while the screen on the dash moves directly in front of the driver [8]. Continental's concept involves morphing interfaces that will reveal or hide displays according to the driver's need. By using a system that register's the driver's eyes, voice, and hand gestures, the driver can interact with a touch-free infotainment system. Automakers will continue to work on features such as, user control design, intelligent UX design, new seating configurations and possibilities, gesture recognition, and voice recognition technology [9].

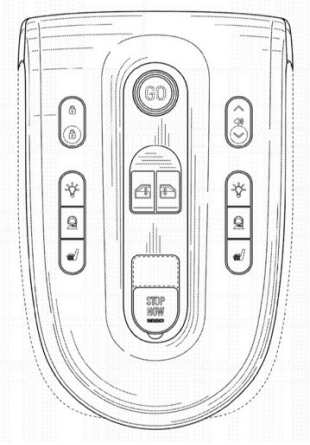


Fig. 2 A drawing of a car console designed for a self-driving car. The US Patent and Trademark Office granted Waymo a patent for the drawing on August 15, 2017. Waymo/US Patent and Trademark Office

As listed above, many concepts from automakers display interior design that focuses on comfort with a large screen that replaces the outside view. However, if automakers limit themselves only to lounge concepts, the commuters are forced to share the same screen and the same activity, and the space does not foster individual productivity. Commuters should have more freedom in their choice of activities even though the space is shared.

Automakers need to find ways for the autonomous car interior to provide something more unique than a lounge environment. The types of activities that can be enjoyed in an autonomous car are still in development, but as the commuters will become engaged in various activities in various positions, the concern for and the complexity of safety will require development as well.

4. Ergonomics considerations for different usage modes

Adapting to various usage modes, ergonomics should be a primary factor in consideration to provide the best commuter seating condition.

A. Working Mode

A working mode without proper ergonomics will cause drivers to suffer from neck and back pain or sore wrists and fingers. Correct seat height, adequate equipment spacing, and good posture must be considered for the commuter and the commuter's joints to stay comfortable during work mode. The seat must support the commuter's spinal curves. The design for the seat must include a height adjustable feature so that the driver's feet can rest flat on the floor or on a footrest [10]. The commuter's thighs will then be orientated parallel to the floor and, with adjustable armrests, the driver's arms can be gently rested on the armrests while the shoulders are relaxed.

An interactive tool, like a keyboard, a mouse, or a controller, should be placed within easy reach of the commuter. The clearance for the commuter's knees, thighs and feet should be considered. The monitor should be directly in front of the commuter.

With these ergonomics factors, the recent lounge and living room concepts with a large monitor might not fulfill the ergonomic requirements of the working mode.

B. Relaxing Mode

This mode adapts a reclining system with a foot rest. The seat contains two components: a seat back which tilts backwards and a foot rest that raises upwards. In keeping with the principles of ergonomics, it is not enough to design a recliner that allows the commuter to lie back and put his/her feet up. The reclining seat provides plenty of support to the neck and back to avoid discomfort and damage to the musco-skeletal system [11].

C. Entertaining Mode

This mode needs several different seating positions depending on entertainment content, such as watching TV or movies, listening to music, and gaming. For TV watching, semi or full relax mode seating position is more suitable. For gaming, depending on the type of game, the commuter can choose a seat position like an upright mode or a semi relax mode.

5. Analysis of Current Car Interior Safety Features

Safety features in current cars, that is non-autonomous, are air bags, seat belts, head injury protection, and head restraints. These features are adequate for current vehicle interiors, but not suitable for the adapting and swiveling seats of the interiors of the autonomous car. The current seat belts and airbags are designed to be used together in order to maximize effectiveness and are no longer functional in the non-restrictive environment of the autonomous car.

A. Air Bags

In current cars, air bags are installed in the center of a steering wheel, dashboard, and front windshield pillar. The center of a steering wheel is a main spot for the airbag that saves driver's life by cushioning the impact during the collision. Front air bags are not designed to offer protection in rollovers, rear, or side impacts. In addition, you can significantly reduce the risk of injury from an air bag by buckling your seat belt and keeping about 10 inches or more between your breastbone and the air bag. This study proposes an alternative solution for the use of airbags by adapting a new application of airbag locations incorporated with new seat frame structures. Amount of air bag will be considered when using a seat belt or without using seat belt.

Fig. 3 Air bags Deploy Image: Who Invented Airbag January 11, 2017 by Neo

B. Seat Belts

The main function of seat belts is to keep the drivers and passengers in the car and reduce the risk that the driver could collide with the steering wheel, dashboard, or windshield. The seat belt in a driving position still puts physical pressure over the driver and is uncomfortable. With the new seat design, the seat belt will be cumbersome during mode transitions, and its effectiveness will diminish in certain modes or positions.

C. Head Injury Protection

Head injury protection consists of foam or other energy absorbing material under the trim of the car interior and is likely to be invisible to car occupants. Some cars have head air bags. While all head air bags are designed to deploy in side impacts, some are also designed to deploy during rollovers. Both types of air bags are designed to help protect occupants from injuries caused when their head strikes the upper interior of a car.

D. Head Restraints

Head restraints are extensions of the car's seats that limit head movement during a rear-impact crash, thus, reducing the probability of neck injury. Head restraints meeting specific size and strength requirements are required in front seats, but not in rear seats. While you must adjust most head restraints manually, some adjust automatically with changes in seat position or dynamically in a crash. In general, dynamic head restraints provide the best protection [12].

6. Assumptions and Limits

There have been a number of accidents reported with autonomous or semi-autonomous cars. Tesla has offered an autopilot assistance feature in some of their cars since 2015 and has been dealing with controversies of if their cars killed the drivers or if the death was caused by user error [13]. The accidents are reminders that self-driving technology is still in the experimental stage and that backup safety needs to be an important part of the autonomous car development.

This study has largely accepted the possibilities of envisioned activities that have been proposed by other studies for the interior of the autonomous car and have designed the safety issues based on those assumptions. The development of autonomous cars is still in the early stages so there might arise the possibilities of safety issues from the transition period where the autonomous and driven cars will be on the same roads. This study will be applied toward the length of an average daily commute of a normal person and will not include other possibilities, such as long-distance travelling, disabled personnel, etc.

A. Desired Freedom of Movement

With the interior focused on aspects such as productivity, entertainment, exercise, and/or rest, the seating position and posture of the passenger would not be as static as the current configurations and archetypes. Furthermore, with no clear need to fix the commuter's position due to driving, they would not want to feel constrained in their seats but would like to feel a sense of freedom within the interior that would correlate with their choice to use an autonomous car.

B. Complacency Regarding Safety

As the commuter would not be heavily involved with the driving of the autonomous car, and with traffic accidents significantly reduced, the commuter using the autonomous car would start to feel complacent regarding safety and focus on their required activities in the interior. The importance of seat belts might become downplayed, as people would and would prefer a more non-restrictive safety mechanism.

C. Sudden Evasion

The most promising proposal for the autonomous car in order to sense its environment is using a combination of sensor-based and connectivity-based solutions. The sensor-based solution allows the car itself to sense around itself while the connectivity-based solutions use wireless technologies to communicate in real-time from car to car and from car to infrastructure.[1] The combination of these two solutions allows for a close proxy for human senses. In a dangerous situation, people predict that an algorithm can be worked out to evade a collision. However, with the autonomous car travelling at high speed and close travelling distances, the sudden evasion maneuver might put the commuter in danger due to the sudden change in direction and might cause commuters to be thrown off balance. Hence, even though there might not be a collision, the evasive maneuver is still dangerous.

D. Inevitable Collision

Despite the ability to evade accidents, there are scenarios, especially during the transitional period where there are still non-autonomous cars on the road, where the risk of injury to the commuters could be reduced from a collision instead of a sudden evasion maneuver. The autonomous car needs to decide on the best

way to collide so that there would be the least impact and least injury to the commuter(s) and/or pedestrians. This could be in highly populated areas where a sudden evasive maneuver due to a sudden obstacle on the road (e.g. pedestrian dashing onto the road) could be more dangerous compared to crashing into a side rail to reduce possible danger to other pedestrians or the commuter.

7. Conclusion

The autonomous car is still in the early stages of development. Since the need to drive will be eliminated in an autonomous car environment, the interior needs to be designed for future activities. Most current interior concepts for the autonomous car lack safety features to accommodate the new kind of commuters that will be allowed to engage in various activities while the car is in automation. The lounge-like setting does not equip the commuter with any safety features in the event the automation system fails.

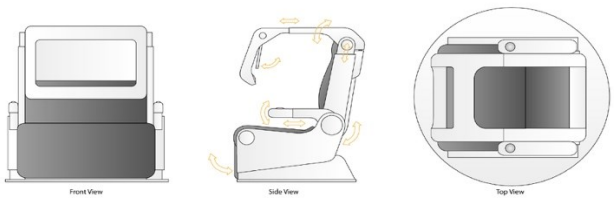
Although there have been discussion of new seat design and new features for the autonomous car interior, there have not yet been any concept that combines those two features. This new seat development is the first initiative for enabling the commuters to enjoy all of the benefits that the autonomous car can offer without sacrificing the comfort evaluated and tested.

The solution is for the autonomous car to be a two-seater car, storage at the back of the car, and an internal adaptive structure that continuously tracks and follows the commuters as the commuters move within the interior of the autonomous car.

Each seat will have its own touch screen monitor and control pad that adjusts according to the individual mode selection. This adaptive seat structure will have a monitor that uses a 'electric glass' material that allows for augmented reality through the use of a clear touch screen and productivity through the use of an opaque touch screen or an opaque screen controlled by a control pad located on the armrests of the seat. The monitor will work similarly to Google Glass. This promotes the ergonomics that the commuters need when using a screen. Once the screen is on and the commuter engages in a task, the seat will adjust automatically to suit the needs of that particular task. When a commuter turns on a video game, the seat will adjust to entertaining mode. When a commuter turns on the launches word processor or an app or a software that is associated with work, the seat will adjust to working mode. When a commuter turns on a game to play, the seat will adjust to relaxing or entertaining mode depending on what kind of game it is.

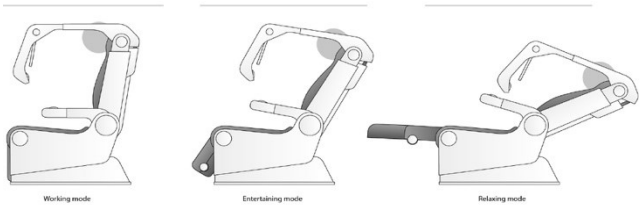
To address the big concern of safety in the commuter being in different positions at any given time, the adaptive seat structure will also have airbags that are housed in various critical positions to 'catch' the commuter in the incident of collision or sudden evasion movement. This will allow for a non-restrictive approach in keeping the commuter safe while enabling greater freedom of movement within the interior. This means that even though the commuter may be in different body positions, the adaptive airbag system will continue to track and monitor the commuter's position so as to react accordingly when an emergency situation occurs.

When a sudden evasive maneuver or an inevitable collision occurs, the airbag as well as a fold and release mechanism will activate according to the severity of the maneuver or the collision. If the sensors pick up a potentially strong collision, it will activate the full safety system to ensure the commuter is kept safe. If a minor evasive maneuver is required, it will only activate the fold and release mechanism to hold the person in position instead of the full safety features. Therefore, the adaptive seat structure will combine various needs of the commuter in the interior of the autonomous car and be able to address safety concerns all in one unit.



Front View Side View Top View

Fig. 4 Intelligent and Adaptive Safety Reinforced Seat Design Orthography by Author



Working Mode Entertaining Mode Relaxing Mode

Fig. 5 3 Different Seating Modes by Author

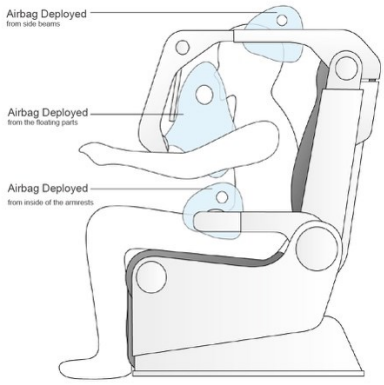


Fig. 6 Airbags deploy in Working Mode by Author

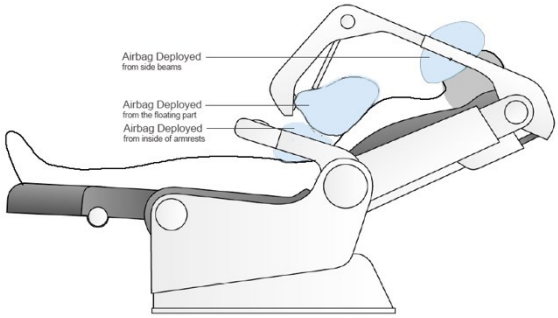


Fig. 7 Airbags deploy in Relaxing Mode by Author

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An Efficient Algorithm for Denoising Images with High Density Single Noise and Mixed Noises

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Abstract

An image is often corrupted by noise in its acquition and transmission. Image denoising is used to remove the additive noise while retaining as much as possible the imp-ortant signal features. In practice, the removal of noise, especially for high density noise and mixed noise, has always been a challenging task for image processing. We propose a novel image denoising strategy based on median and mean filters, termed Mixed-Median-Mean (MMM), is presented in this paper. The proposed algorithm skillfully retains the advantages and ameliorates the weaknesses by effective conversion of peer group values, which are the closest pixels to the contaminated one. The novel idea is to adjust the weight of each pixel around it. The experiments not only focus on the single high density noise, but mixed noise, including Gaussian white noise, Impulse noise and Multiplicative noise. Numerical results confirm the effectiveness and robustness of the proposed algorithm.

Keywords Median filter; Mean filter; impulse noise; Gaussian noise; multiplicative noise; mixed noise.

1. Introduction

Due to the diversity and complexity of noise distribution, noise removal is a challenging task that always demands intense attention in image processing. The median filter and mean filter are two classical algorithms for noise removal. The median filter is introduced by Tukey [1], it is best known for its salt and pepper noise removal aptitude. The mean filtering is also an intuitive and easy to implement method of smoothing images, and is often used to reduce noise in images. Conventional median and mean filters are weak for high density noise or mixed unknown noise, so some researchers constantly put forward new innovations such as [2]-[7]. In this paper, an integration of median and mean filtering algorithms is proposed in order to make up for deficiencies of their single ability. The median and mean filters are the cornerstone of better recovery by the MMM algorithm.

In practice, the observed images are commonly prone to high density noise and mixed noise. [8] [10] aims to remove high density impulse noise, while using [9][11][12] for mixed noise. There are many other techniques to reduce the noise level in a signal, such as Wiener filtering [14][15] and wavelet thresholding [13][16][17]. Wiener and wavelet can work together for image denoising [18][19]. Wavelet filter is also combined with Kuan filter for image despeckling in [20]. Some specific algorithms, such as genetic programming, can be employed for filter construction [21].The rest of the paper is organized as follows. Section II introduces the median and mean filtering. The detailed description of MMM is provided in Section III. Section IV presents extensive simulation results.

2. Background

The main idea of median filter is to run through the signal entry by entry, replacing each entry with the median of neighboring entries. The pattern of neighbors is called the "window", which slides, entry by entry, over the entire signal. For images, the sliding window is shown in Fig 1

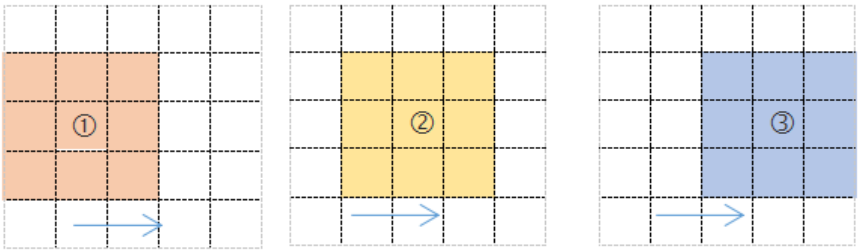

Fig.1 The 3x3 window moving from one pixel to the next

Note that, for 2D (or higher-dimensional) signals, more complex window patterns are possible (such as "box" or "cross" patterns); 3x3 and 5x5 windows are used in this paper. In addition, if the window has an odd number of entries, then the median is simple to define: it is just the middle value after all the entries in the window are sorted numerically. For an even number of entries, there is more than one possible median, see [1] for more details. The median filter can be described as an arithmetic expression:

$$y_{ij} = median\{x_{st} \mid s,t \in w\} \quad (1)$$

Where w represents a neighborhood defined by the user, centered on location (i,j) in the image.

The mean filter is also a sliding-window spatial filter that replaces the center value in the window with the average (mean) of all the pixel values of its neighbors. The window, or kernel, is usually square but can be any shape. The mean filter can be presented as:

$$y_{ij} = \frac{1}{ab}\sum x_{st}, s,t \in w \quad (2)$$

where a and b represents the length and width of window w.

An example of mean filtering and median filtering of a single 3x3 window of values is shown in Fig2. Sorting the unfiltered values:1,1,9,9,12,13,14,16,78. The sum is 153(1+1+9+9+12+13+14+16+78=153). The corrupted pixel 16 is replaced with the median value 12 for median filter and average value (153/9=17) for mean filter.

1	9	78
13	16	1
12	14	9

(a)

*	*	*
*	12	*
*	*	*

(b)

*	*	*
*	17	*
*	*	*

(c)

Fig.2 (a) unfiltered values (b) Median filter (c) Mean filter

3. The proposed algorithm

The proposed algorithm is composed of three stages： (1) median filtering stage, (2) replacement stage, and (3) mean filter stage. Step1-3 are for median filter. In step 4, the corrupted pixel is replaced by proposed MMM algorithm based on the number of the filtering window. The mean filter is enforced in step 5.

Mixed-Median-Mean Algorithm

Input: image X polluted by single and mixed noise, size m x n

Output: restored image Y

Initialization: array=[ ] /*storage pixels of $3*3$ window*/
Iterative procedure:
for $i = 1:m$
  for $j = 1:n$
    $x_{ij} = MMM(array);/*\ MMM\ \ process\text{sin}\ g\ */$
  end
end

MMM processing steps:

step1. Assembling 9 pixels of $3*3$ window

$$array = \{x_{i-1,j-1}, x_{i-1,j}, x_{i-1,j+1}, x_{i,j-1}, x_{i,j}, x_{i,j+1}, x_{i+1,j-1}, x_{i+1,j}, x_{i+1,j+1}\}$$

step2. Sorting 9 elements $array = \{x_1, x_2, x_3, x_4, x_5, x_6, x_7, x_8, x_9\}$,

Here $x_1 \le x_2 \le x_3 \le x_4 \le x_5 \le x_6 \le x_7 \le x_8 \le x_9$ after */

step3. Finding the median value, $median = x_5$

step4. Replacing the three largest num and three smallest num with median value

$$array(k) = array(10-k) = median, k = 1,2,3.$$

step5. Replacing $x_{i,j}$ with mean value

$$x_{i,j} = (x_5 + x_5 + x_5 \le x_4 + x_5 + x_6 + x_5 + x_5 + x_5)/9$$

The MMM algorithm is shown in Fig3 by an example. The corrupted pixel is 16 that is the kernel of 3x3 window in Fig2 (a). At the same time, the other 8 values (1,9,78,13,1,12,14,9) are acquired around it. After ordering these nine values (1,1,9,9,12,13,14,16,78), the median value12 is a substitution for the polluted pixel 16 in Median filter. But in MMM algorithm, the three largest values (14,16,78) and three smallest values (1,1,9) are replaced with 12. Finally, 16 is restored to 11 by mean filter. Using MMM, the value 11 is considered as a better recovery for the contaminated pixel.

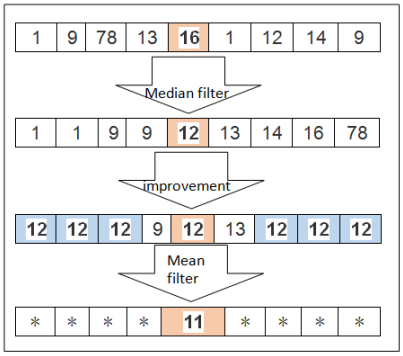

Fig.3 Fundamental steps of MMM by 3x3 window

4. Numerical Simulation and Discussions

This section makes a comparison between original algorithms (the median filter and mean filter) and the proposed MMM respectively. Experiments are carried out based on four kinds of noise: Gaussian noise, impulse noise, Poisson noise, and multiplicative noise. All experiments are conducted at Windows 7,

3.4GHZ processor, 4GB Random Access Memory(RAM) and Matlab 2012a. Note that, all of experimental results are obtained via 500 simulations. PSNR(Peak signal-to-noise ratio) is used to evaluate the image quality.

$$PSNR = 10\log_{10}\left(\frac{MAX_I^2}{MSE}\right) \quad (3)$$

Here, MAX_I is the maximum possible pixel value of the image.

A. Single High Density Noise

Salt and pepper noise is used to simulate impulse noise. In this experiment, the noise density and variance are variables. Three pictures, Qinghai picture comes from DATATANG (www.shujutang.com), Shepp-Logan phantom and Lena image are used for testing. The size of images is 256x256.

Fig.4 shows how MMM algorithm works with great performance. With the increase of noise density, the ability of median and mean filters fall sharply, the MMM algorithm is far beyond the median and mean level. Furthermore, the greater the noise density, the better the competitive advantage appears. It is prove that MMM algorithm is more suitable for high density noise. More detailed display in Table1.

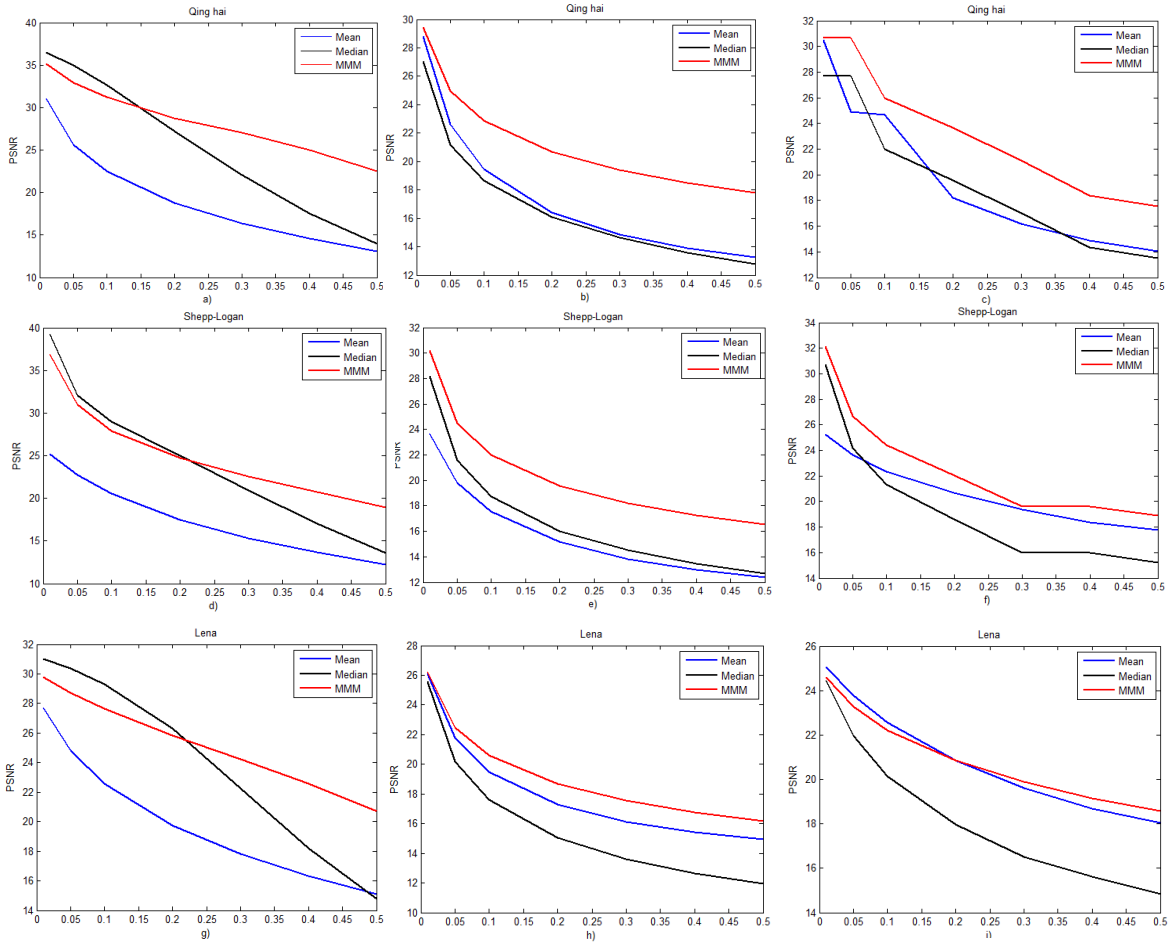

Fig. 4 Image reconstruction according to different noise. Qinghai: a) salt and pepper noise, b) Gaussian noise, c) multiplicative noise. Shepp-Logan: d) salt and pepper noise, e) Gaussian noise, f) multiplicative noise. Lena: g) salt and pepper noise, h) Gaussian noise, i) multiplicative noise. Here, the noise density of salt and pepper varies from 0.01 to 0.5; Gaussian and multiplicative noise, mean=0, variance ranges from 0.05 to 0.5.

Table 1. PSNR values at different single noise for MMM algorithm

Single Noise	Qing hai			Shepp-Logan			Lena		
	Mean	Median	MMM	Mean	Median	MMM	Mean	Median	MMM
Impulse (noise density 0.3)	**16.3832**	22.0334	**27.0105**	15.3299	20.9381	22.5559	16.3137	18.2088	22.5623
Gaussian (mean=0,variance=0.1)	19.4497	18.6347	22.8539	**17.5248**	18.719	**21.9899**	19.4710	17.6292	20.6090
Multiplicative (mean=0,variance=0.5)	14.0621	13.4970	17.5286	17.7656	15.1945	18.7091	19.5027	**16.0305**	**19.6231**

Table1 demonstrates that MMM is better than Mean and Median filter, especially for high noise density, and the highest gain is to roughly 11DB (27.0105 -16.3832=10.6273). For the three types of noise, the ability to eliminate salt and pepper is best; the effectiveness of denoising Gaussian noise outperforms multiplicative noise. Real results on real images are shown in Fig. 5.

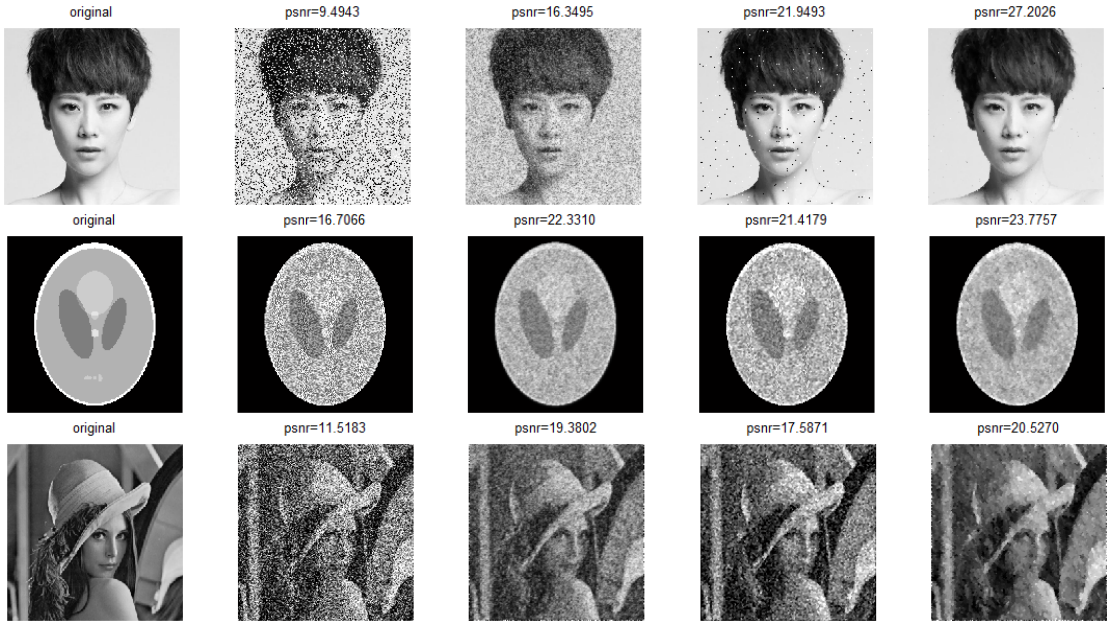

Fig.5 The left column (from top to bottom): the original image Qing hai, Shepp-Logan and Lena. The second column: Hai qing image corrupted by salt and pepper noise (noise density 0.3), Shepp-Logan by multiplicative (mean=0, variance=0.1), Lena by Gaussian (mean=0,variance=0.1), respectively. The next three columns are the images restored by mean filter, median filter, MMM filter, respectively

B Mixed Noise

In this section, we consider the various combinations of mixed noise, such as impulse noise plus Gaussian noise, impulse plus multiplicative, Gaussian plus multiplicative, and impulse plus Gaussian plus multiplicative. Noise density is indicated by specific parameters. The experimental strategies are based on regulating these parameters. If there are two parameters, the one is fixed, the other is ranging from a small value to a big value. Otherwise, there are three parameters, the two parameters chosen keep invariant, the rest one is changing.

The developing processes are shown in Fig6, and Table2 extract some combination to present the recovered results in detail. The image restored can be seen in Fig.7. The results verify that, for mixed noise, MMM algorithm still exceeds median and mean filters.

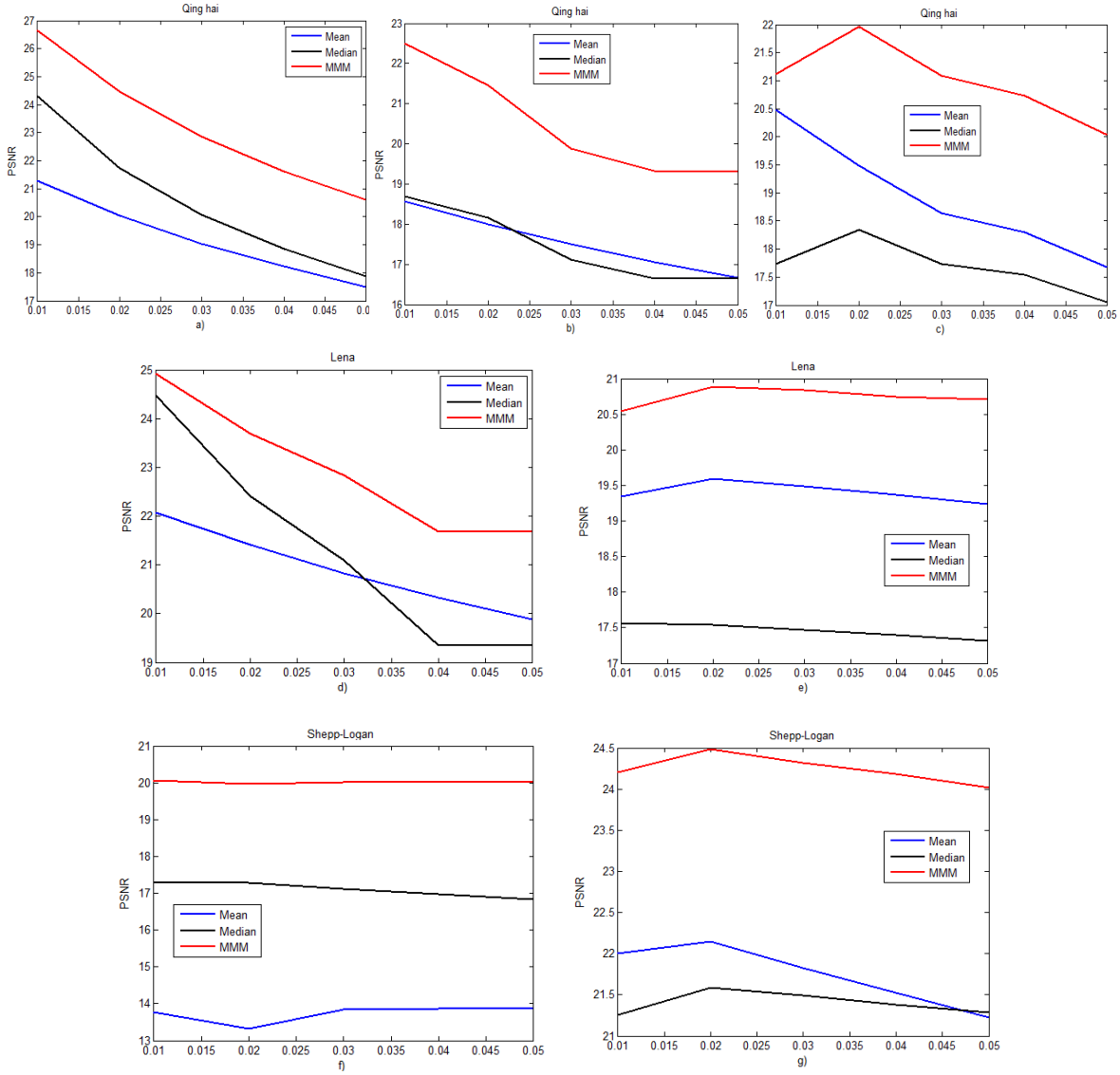

Fig.6 Recovered image contaminated by different mixed noise model. Qinghai contaminated by salt and pepper, Gaussian, and multiplicative noise.(a) fixed noise density of salt and pepper 0.1, varying variance of Gaussian and multiplicative noise from 0.01 to 0.05. (b) fixed variance of Gaussian noise 0.1, varying noise density of salt and pepper and variance of multiplicative noise from 0.01 to 0.05. (c). fixed variance of multiplicative noise 0.1, varying noise density of salt and pepper and variance of Gaussian noise from 0.01 to 0.05; Lena blurred with salt and pepper and Gaussian noise.(d) fixed noise density of salt and pepper 0.1, varying variance of Gaussian from 0.01 to 0.05. (e). fixed variance of Gaussian 0.1, varying noise density of salt and pepper from 0.01 to 0.05; Shepp-Logan polluted by salt and pepper and multiplicative noise. (f) fixed noise density of salt and pepper 0.4, varying variance of Gaussian from 0.01 to 0.05. (g).fixed variance of multiplicative 0.1, varying noise density of salt and pepper from 0.01 to 0.05.\

Table 2. PSNR values at different mixed noise for MMM algorithm

Noise combination	Qing hai			Lena		
	Mean	Median	MMM	Mean	Median	MMM
Impulse+Gaussian (0.04+0.04)	**22.2737**	**21.6460**	**25.6613**	21.5340	20.6682	22.7009
Impulse+Multiplicative (0.3+0.1)	14.4669	15.8464	20.9899	**18.1361**	**18.9115**	**21.4822**
Gaussian +Multiplicative (0.04+0.04)	21.4207	19.8106	23.1653	21.8527	20.3417	22.3451
Impulse+Gaussian+Multiplicative (0.1+0.01+0.04)	19.9217	21.0229	24.1664	21.7819	22.5076	23.6649

Noise combination	Shepp-Logan		
	Mean	Median	MMM
Impulse+Gaussian (0.1+0.1)	15.7788	17.5972	20.5610
Impulse+Multiplicative (0.4+0.04)	13.8631	16.9654	20.0401
Gaussian +Multiplicative (0.1+0.04)	17.1583	18.3453	21.1083
Impulse+Gaussian+Multiplicative (0.1+0.01+0.04)	**18.9994**	**22.3738**	**23.7944**

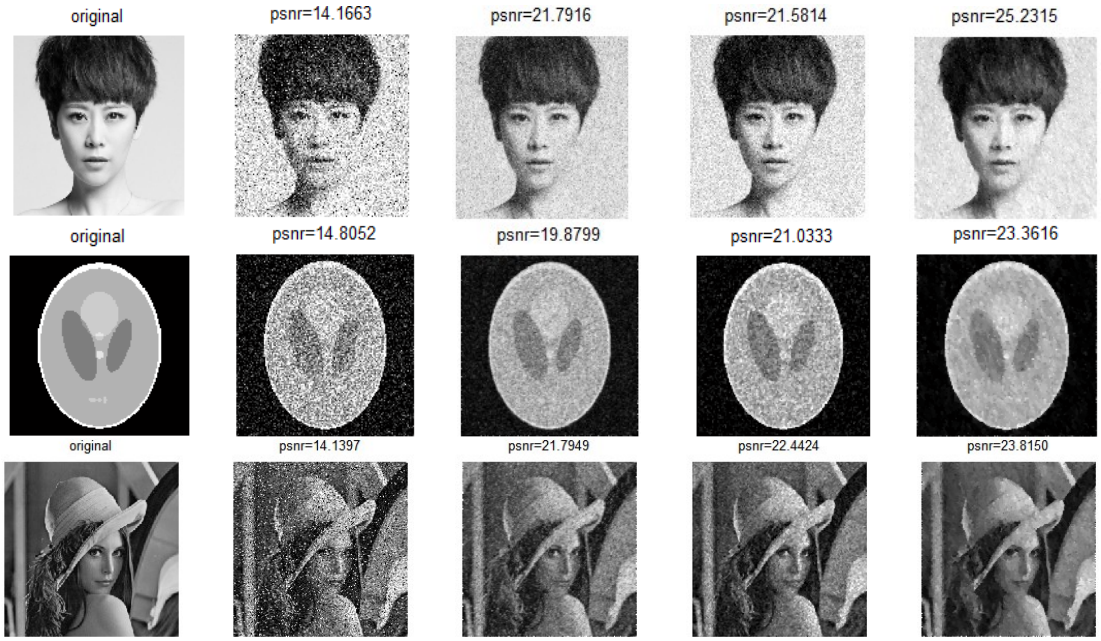

Fig.7 The left column the original image Qing hai, Shepp-Logan and Lena. The second column (from top to bottom): the image Qing hai corrupted by salt and pepper (noise density 0.04) and Gaussian noise(mean=0, variance=0.04); Shepp-Logan polluted by multiplicative (mean=0, variance=0.04) and Gaussian noise(mean=0, variance=0.04);Lena blurred with by salt and pepper (noise density 0.1),Gaussian (mean=0,variance=0.01), and multiplicative (mean=0, variance=0.04). The next three columns are the images restored by mean filter, median filter, MMM filter, respectively.

5. Conclusion

In this paper, an efficient novel algorithm termed Mixed-Median-Mean (MMM) is proposed. This algorithm learns from median and mean filter to improve the performance of eliminating high density noise. The biggest advantage of this technique is the removal of high density noise and mixed noise in images. Simulation results verified the strength of the MMM algorithm, this is clearly highlighted when noise density is added. This proposed algorithm not only considered three noises (impulse noise, Gaussian noise, multiplicative noise), but also various combinations of mixed noise are surveyed.

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$$\int_0^{r_2} F(r,\phi)\,dr\,d\phi = \left[\sigma r_2 / (2\mu_0)\right] \cdot \int_0^{\infty} \exp(-\lambda|z_j - z_i|)\,\lambda^{-1} J_1(\lambda r_2) J_0(\lambda r_i)\,d\lambda. \quad (1)$$

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