



Institute of Design and Innovation

**Performance of Real Time Lip Sync Animation on Viseme Based Human
Speech**

Loh Ngik Hoon

**Doctor of Philosophy
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Performance of Real Time Lip Sync Animation on Viseme Based Human Speech

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A thesis submitted
in fulfillment of the requirements for the degree of
Doctor of Philosophy (Animation)

Institute of Design and Innovation
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APPENDIX

APPENDIX A

Interview 1

Name: Ahmad Noriman Bin Ahmad Saffian

Company: Animonsta Studios Sdn. Bhd. in Cyberjaya, Selangor, Malaysia.

Job position: Head of Animation

Experience: 5 years

Ahmad Noriman explained that lip sync animation is one of the methods to convey messages vocally through visual animation (2D or 3D) to the target audiences. Besides, real time lip sync animation is, when a person or an animator performs a pose or action and that particular pose or action, it will be translated in a software and projected onto the screen in real time. The idea application of viseme based human speech is one of the methods that helps user predicts and understand the visual lip results of the human speaking. He stated that we do not have to model the lip shape exactly like the reality to pronounce the sound, but if we need to achieve the visual convincing lip sync animation, we must keep them consistent with the correct lip shapes in real world. Basically, without correct visual lip shapes and accurate timing, there will be no lip sync animation at all.

Nevertheless, Ahmad Noriman told that, Autodesk Maya software was widely used to create the lip sync motion in Animonsta Studios. He also emphasized that correct mouth position and accurate timing were very crucially to achieve in lip syncing. There were no any rules to lip syncing. Two things were very important in here, it is just the timing and the shapes of

mouth has to be accurate enough to make it believable to the audience. It always were the problems faced by the animators in creating a lip sync animation.

However, different languages will have different types of mouth shapes. Therefore, most animators will face a difficulties in determines lip shapes for that particular languages. The study of lip sync in different languages besides of English languages, like Bahasa Melayu and Mandarin languages could be one of the good subject to fulfil the demand in this area. The real time lip sync animation system could be apply in doing the performance animation, media education and broadcasting performance. For animation production, the real time lip sync system was an ideal approach in future, but it still need a lot of investigation to enhance the usability and quality, so that it can be use widely and helps the animators to reduce the workload, increase the productivity in animation.

Ahmad Noriman also emphasized that this new developed Digital Speech System able to contribute enormously to the animation society especially to the local animation firms. He agreed that this platform can help shorten the period of pre-production process thus helps the local animation firms to produce more quality and accurate lip sync animation to compete with the international animation films.

Interview 2

Name: Chong Bee Fei

Company: Fly Studio Sdn. Bhd. in Petaling Jaya, Selangor Malaysia.

Job position: Animator

Experience: 5 years

Bee Fei explained that lip sync animation is the technique animate character's mouth to synchronize with human voice or audio that pre-recorded. She also described real-time lip sync animation is base on realistic human speak of action's timing. It is important to give the lip sync animation looks natural, appeal, convincing and attractive. The lack of research and observation on mouth's position and its motion will caused problem in doing the lip sync animation. The lip sync animation, modelling and rendering can be done in Autodesk Maya to perform the task. However, the software used also depend on the project itself is in 3D or 2D animation. The 3D lip sync animation mostly done in Autodesk Maya software, and 2D animation commonly done frame by frame drawing or used toon boom software.

It still has the limitation in achieving realistic lip sync animation. The animators always faced a problem in matching the audio sound with the character's mouth movement. The lip sync may not match to the audio and body action exactly 100%, and sometime feel like a bit off. The knowledge in the basic study of human mouth shape to pronounce the sounds, research and observation are most essentially needed to gain more experience in doing lip sync animation.

Most of the animation series in Malaysia produce in different languages, English, Bahasa Melayu and Mandarin, as shown in the cartoon Disney Channel. Lip sync animation might

different with different languages native accent. But basically in animation production for one series animation scene, the lip sync animation movement was still keep the same in all languages, just the different languages dialogue was recorded again to dub into the animation. Therefore, it always happened in the scene that the lip movement of the character always not match with the audio sounds. This problem occur because most of the animation film wants to save the budget and reduce the workloads in order to enable output to produce faster. It is a time consuming process to create the lip sync animation. It depends the cuts duration, longer duration and the types of the animation created, realistic animation or cartoon style animation. Normally, realistic animation always will take longer time than cartoon style animation.

As mentioned by Bee Fei, currently there are no software or platform that can contribute in three languages for lip sync animation. This is a good approach to help the armature animation companies to produce different languages dialogues animation, with affordable software and commercialise our local animation to broke into the international market. This will help to increase the revenue of local animation films and build up our industry in Malaysia. Nowadays, animation firms start growing with various of languages dialogues, to attract more foreign audiences, which is a huge potential that we could crack to the overseas market in order to generate more profit.

Bee Fei concluded that viseme based human speech study are important as a basic understanding of lip sync animation for different languages, until apply in complicated character animation. Besides, real time animation is the animation created and updated in real time engine. This approach can help to fasten the workload with quality output and save money. If the function of algorithm based is used for real time engine system, it is able to run the lip sync animation by calculating the timing in detecting a real time action accurately.

Therefore, this research have touch two essential study in lip sync animation. They are the basic understanding on proper mouth shapes and accurate timing. It is the fundamental things in achieving quality lip sync in animation.

Interview 3

Name: Nik Ab Zarif Bin Nik Ab Hadi

Company: Les' Copaque Production Sdn Bhd., Selangor Darul Ehsan, Malaysia.

Job position: Head of Department Upin Ipin Series

Experience: 5 years

Zarif explained that lip sync animation is a unique animation that animate the character's mouth movement based on the sound. The mouth shapes and its structure plays an important role in doing lip sync animation. However, muscle study also need to take into consideration in this case. To create lip sync animation, they always used the Autodesk Maya software to make the task, including modelling, blendshape, rigging, motion and rendering. Basically, the techniques involve for achieving accurate lip sync animation divided into four important steps. They are foundation, structure, detailing and polishing.

The problem always faced by animators in doing lip sync animation was the wrong structure on adjusting the animation timing, tune and character's mood. The common problem occur with the animated character have too much mouth shapes when it is speaking. It usually make the character looks too busy and slightly off time, which lead to less smoothly movement in the scene. Therefore, to avoid this happen, the animators need to follow several rules or principles, such as timing, emphasis, accent, vowels and anatomy, in order to achieve realistic lip sync animation and make the process easier.

The lip sync animation production was a time consuming process. It depends on the duration of audio and how much the words it is used in the overall animation. The animators need to take mirror and look at the shape of his/her own mouth, study the mouth shapes to pronounce

the phoneme sounds. This process will be recorded as a reference and apply in doing the animation. Hence, the automated lip sync system for different languages was an ideal approach to solve this problem. It enable to deliver the information more effective that make the lip sync process more easy and convenient to use. This technology will contribute for animation field, education, multimedia interactive and navigation in our future.

Lastly, Zarif concluded that Malaysia animation industry starts to well known in the international channel such as Nickelodeon and Cartoon Network, he believes that this platform could help to produce more quality animations to be shown in that channel. It is significant contributions to the Malaysia Animation Industry with the created Automated Digital Speech System in English, Bahasa Melayu and Mandarin, which is the first of the lip sync system designed and supported with three languages.

Interview 4

Name: Keith Voon Lip Khiong

Company: University Lim Kok Wing Borneo. Kuching Sarawak, Malaysia.

Job position: Lecturer of the Faculty of Multimedia Creativity (Animation)

Experience: 5 years

In Keith opinion, he told that lip synchronization process for animation is never easy for the animators. For instance, in 2D animation, matching lip movement with pre-recorded audio (dialogue) needs time and observation of an animator to indicate the movements and expression of a model. Most of the time, animators needs to put in their expression into a character. Traditionally, a mirror is used in this process. Animators will observe their own facial expression and will then portray it onto a character. The process of lip synchronization are as such: Recording dialogue based on a script, voice characterization based on the character in the script, track reading (frame by frame) to determine the movement of the lip, and lastly to draw them accordingly.

Normally for recording, animators will perform studio based indoor recording, just like other normal audio recording. The process is similar whereby the voice of the talent with be recorded onto a track in software like Pro Tools Audio Recording and Music Software, Garage Band, Adobe Premier Pro, Adobe Audition etc. For the animating stage, the raw audio will first be edited to suit the animation. Then, it will be exported into the animating softwares such as Toon Boom Animate Pro, Adobe Flash, Adobe After Effects and so on. Besides, for frankly speaking, the method still remains the same as like what the olden days animators does. Basically the animator have to know what are the basics of animating a lip sync. We have the "mouth-open" and "mouth-close" movement which is much easy to

understand. It is one of the fundamental methods used in today's 2D animation world. For example, 2D Japanese anime - most of their animation uses this method. Secondly, we have the "8 to 10" frames various mouth shape movement. This method is much more accurate should we compare to the first method. The lips movement looks realistically engaging to the audience. One very good example is Disney's very own characters such as Tarzan, Little Mermaid, Pocahantas etc.

Based on Keith experience, he has stated that the crucial part when it comes to animating dialogues in doing lip sync animation is timing of the lip sync. Synchronizing audio with movement is never an easy task. Animators first needs to master one of the animation methodology which is timing and spacing. Secondly, he would say breaking down the movement of the mouth into frames can quite challenging for most animators. Each words is represented by a single mouth shape. Apart from that, the challenges for doing lip sync animation would be that the animator will have to really listen to the voice recording and then later break it down into mouth movement. However he do think that with the basic fundamental understanding of animation lip synchronization, any animators will succeed the challenges.

According to Keith, the process to create and render a lip sync animation is depending the animation duration, but one things can be confirm that 2D animation take less time to render as compare to 3D animation. Basically, more frames in the animation would makes the lip sync look realistic. Breaking down the movement and also to have more mouth or lips movement will illustrate a better outcome. Timing and spacing is also a must in achieving natural and realistic lip sync. In order to achieve realistic lip sync animation, Constant observation, practice and also research on additional methods would be the best suggestion.

The more we observe and analyze, the better we understand about the subject. Previous experience in related field can also ease the process in achieving this process.

Based on Keith explanation, real time animation means capturing live action or motion in present time. For example, a person's lip sync or body movement is capture and transfer onto an existing animation character in a screen. One of the common technique is motion capturing. But he haven used or seen the real time lip sync animation performance yet. In his opinion, he would say that the difficulty in performing the real time lip sync animation has to be hardware support issues. Our industry needs never ending R&D in this subject in order to improve or to sustain the animation industry in Malaysia. For what he aware of is that we have been introduced to motion capturing more than 5 years now, however the understanding of motion capturing only caters to character animation for games and animated films. Research and investment on updated hardware or software is should not be an issue if we are talking about improvements.

Keith also emphasize that the knowledge of recognition human's lip in matching the key sound in lip sync animation is very important for researcher to develop and to carry out beneficial research in animation field, as such to help improve our ICT sector as our country is driven to be a nation of innovation by year 2020. Lip sync animation using real time system technology applied in our Animation, Education and also Tourism industry where we could have a big breakthrough in modern concepts of communicating with audiences. The interaction and experience will be amazing, as in this 21st century of living, people are driven by technology most of the time. For applying multi-languages (English, Malay and Chinese) in the Automated Digital Speech System, enrich and diverse the content of any field that the researcher wants to propose this technology to be applied to. This technology contributes a

lot to our future. One good example is in the education sector, having live animation for mass lecture would totally change the experience of learning. Students will be entertained while they are being educated. He would say the visibility or attention can be grabbed easily by the lecturer if such technology is being applied. Second is in the animation sector, the animator having more easy way to produce lip sync animation to achieve the purpose. It is no longer as "science-fiction".

Interview 5

Name: Syaryfah Fazidawaty Wan Busrah

Company: Universiti Malaysia Sarawak (UNIMAS), Kota Samarahan, Kuching Sarawak.

Job position: Lecturer of the Faculty of Applied and Creative Art (Animation)

Experience: 3 years

According to Syaryfah, she explained that lip sync animation is a technique that makes animated character to speak which matched with the audio track. There were a lots of process involved in doing the lip sync animation. From recording to breakdown, voice characterization, track reading, dope sheet, analyzing dialogue, body language and so on. The types of software and hardware are usually used to create the lip sync animation is depending on the animators. Some of them prefer to use Toon Boom Studio, Lip Sync Pro and etc, of course will need computer & wacom to make their task easier. Currently, the used of Lip Sync Pro software can achieve accuracy for lip sync animation. Lip Sync Pro is a software application for planning ("breaking down") dialogue for animation. Breaking down dialogue before filming means animator can save more time and focus on the characters performance.

Basically, the problem faced by the animators in creating a lip sync animation are the same, which is assigning mouth shape to the audio track. However, different languages have different shape of the mouth to pronounce the words. In addition, most of the animator are not familiar with the languages in assigning the mouth shape to the audio track. They always use the animation handbooks as a guide to simulate the animated mouth position to synchronize to the audio. Commonly, most of the animation handbooks have tables illustrating the mouth position corresponding to the key phoneme sounds. But the problem is different animation handbooks have different mouth position for the phoneme sounds. It can

say that all the animation handbook just focus only on the English phoneme sounds. They have no others languages except of English languages mouth illustration.

The duration to create and render a lip sync animation is depending on the duration of the animation and techniques of animator use. There have no any rules or principle to be follow in order to achieve realistic result lip sync animation. The important thing is try and error. Keep on trying until achieve the great results. It is also sometime depends on the characteristics and emotion of the animation character too to achieve naturalistic lip sync animation.

Based on Syaryfah, real time animaiton is producing and analyzing images in real time. It is the process of using MoCap system to drive a 3D animated character live and in real-time. It involves prompt feedback and interactive. She never used and seen the real time lip sync animation performance, not familiar with it also. But she can ensure that the difficulty in performing the real time lip sync animation is also the same as to sync the voice with the shape of mouth in real time. The knowledge of recognition human's lip in matching the key sound in lip sync animation is extremely important. If not, the animation did not look convincing at all, which will ruin the whole animation performance.

Syaryfah also commented that creating the lip sync animation by using real time system could really attract people, with matching the attitude and characteristics of human voice to animated character in real time. Not just lip sync, but body language makes it more convincing. In addition, the needs for high end technology both software and hardware were required. Besides, application of multi-languages (English, Malay and Chinese) in the Automated Digital Speech System can be widely used by all sorts of races in Malaysia. This

technology will decrease the difficulty in creating lip sync animation. It would also be easier and fun that contribute to animation industry for our future.

Lastly, Syaryfah concluded that there is a need to adapt this technology into animation industry. This research is able to shorten the pre-production process and generate quality lips sync animation in short period of time. It also can be a channel for the animators to do planning and estimation for the overall lips sync animation process. In the same time, animator can focus more on the rigging and rendering process to produce a more realistic and quality animation.

APPENDIX B

Evaluation and Validation Questionnaires

Respondent Number: _____

Universiti Malaysia Sarawak (UNIMAS)
INSTITUTE OF DESIGN AND INNOVATION (INDI)
Research on "Performance of Real-Time Lip Sync Animation on Viseme based Human Speech"

This survey is part of my research on the Performance of Real-Time Lip Sync Animation on Viseme based Human Speech. Here I am carrying an evaluation on Development of Automated Real Time Lip Sync which also known as Digital Speech System for Digital Avatar as a part of my research. I would like to invite you to take part in this questionnaire based on your experiences in real time animation. Your willingness to share your experience is vital to the success of this survey. For all questions please uses "X" to check in the appropriate boxes. Thank you very much for your cooperation. Your feedback is much appreciated.

A. Demographic Background

(Please uses "X" to check in the appropriate boxes)

I . Gender Male Female II .Races: Malay Chinese Bumiputera Others

III. Age 12-19 years old 20-29 years old 30-49 years old 50+ years old

IV. Current position

Animator Lecturer Graduate student Undergraduate student

Others: _____

V. Current experience in the field

<1 – 5 years 5 – 10 years >10+ years

VI. Experience in using animation software

None 1 – 2 years 3 – 4 years 5 – 6 years 7+ years

VII. Software primarily used to do animation

After Effects Motion Builder Blender Flash Maya

3d Studio Max None, pen, paper and camera Others: _____

VIII. How long have you been using the computer?

None 1 – 2 years 3 – 4 years 5 – 6 years 7+ years

IX. On average, how many hours do you spend with computer per week?

None <1 hour 1 – 2 hours 3 – 4 hours >4 hours

B. This section of questionnaire is dealing with system accuracy of lip synchronization.
 (Please use the Digital Speech System and read the sentences below. Use “X” to rate each of the following according to your preferences at the given space)

1) Very Inaccurate 2) Inaccurate 3) Neutral 4) Accurate 5) Very Accurate

English Languages

	1	2	3	4	5
1. Joe took father's green shoes bench out.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. He works in a bank.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. Come here and sit down.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. I met your boss today.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. You can say that again.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. She is talking on the phone.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Bahasa Melayu Languages

	1	2	3	4	5
1. Selamat Pagi Semua. (<i>Good Morning Everyone</i>)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. Dia suka baca buku cerita. (<i>He likes to read story book</i>)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

Mandarin Languages

	1	2	3	4	5
1. 大家早上好. Da Jia Zao Shang Hao (<i>Good Morning Everyone</i>)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. 我过得很好. Wo Guo De Hen Hao (<i>I am doing great</i>)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

C. This section of questionnaire is dealing with system evaluation.

(Please uses “X” to rate each of the following according to your preferences at the given space)

1) Strongly Disagree 2) Disagree 3) Neutral 4) Agree 5) Strongly Agree

	1	2	3	4	5
1. Digital Avatar performance is interesting.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
2. The 3D character animation speech with natural and accurate performance.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
3. It is easy to simulate the lip sync animation without setting the values of the key-frame by using the real time Digital Speech System.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
4. Lip sync animation can be performed without complicated setup.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
5. The Digital Speech system is easy to operate.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
6. The system encourages two-way interactions (human-avatar).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
7. It created a compelling lip sync animation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
8. Digital Speech system allows the avatar speaks in multi languages (English, Malay and Chinese).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
9. The real time concept is useful for doing lip sync animation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
10. The concept of automated real time lip sync animation in multi languages is new to me.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

D. This section is dealing with the system validation

(Please uses “X” to rate each of the following according to your preferences at the given space)

1) Strongly Disagree 2) Disagree 3) Neutral 4) Agree 5) Strongly Agree

11. Application

	1	2	3	4	5
The application is functional.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The application is usable.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The application is Interoperable.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The application has potential.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The application can be used in multi-languages (English, Malay and Chinese).	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

12. Development

The development is appropriate to apply in real time lip sync animation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The development is advanced.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The development is capable in simulating natural lip sync animation and enhance the realism.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The development is adaptable in multi-languages lip sync animation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The development is relevant to simulate a real time lip sync animation.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

13. Performance

The simulation is accurate.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The simulation is engaging.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The simulation is Agility.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The simulation is incredible.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
The simulation is distinctive.	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

14. Visual

- The visual of the animation is realistic.
- The visual of the animation is natural.
- The visual of the animation is interesting and fun.
- The visual of the animation is aesthetic.
- The visual of the animation is effective and convincing.

15. Interactive

- The application is controllable.
- The application is dynamic.
- The application is applicable.
- The application is convenience.
- The application is reflection.

E. Development Platform Suggestion

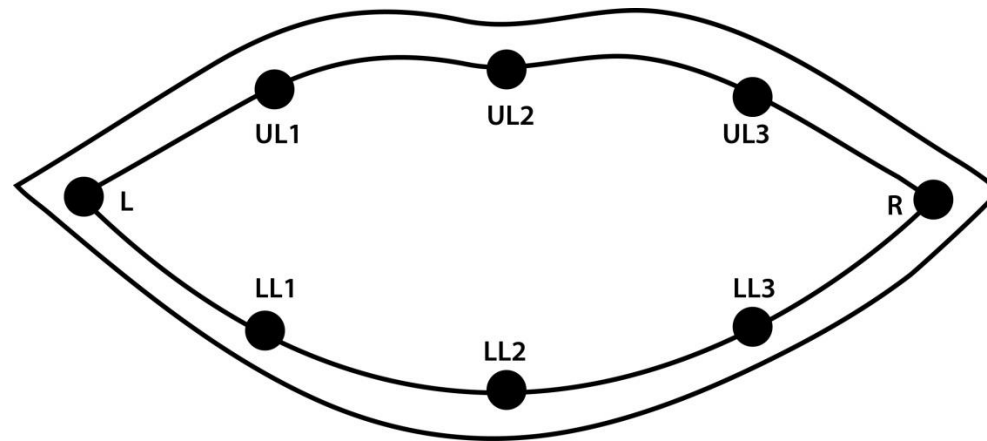
(Answer the following questions)

1. What is your suggestion/comment for this development platform?

2. What do you think the contribute of this technology to our future?

APPENDIX C

Statistical Measurement Data of Lip Shape Features Points for Each Phonemes Sounds IPA



Lip Shape Measurement is according to the above Features Points

UL1 = Upper Lip Point 1
LL2 = Lower Lip Point 2

UL2 = Upper Lip Point 2
LL3 = Lower Lip Point 3

UL3 = Upper Lip Point 3
L = Left Lip Point

LL1 = Lower Lip Point 1
R = Right Lip Point

Measurement Data (mm): Lip Shape Features Points for Vowel / i: / Sound

Video	UL1		UL2		UL3		LL1		LL2		LL3		L		R		Mean (Width/Height)	
	x	y	x	y	x	y	x	y	x	y	x	y	x	y	x	y	IxI	IyI
1	-16.284	3.887	0.000	6.128	13.579	3.891	-16.842	-7.033	0.000	-9.584	13.983	-6.280	-32.357	0.000	26.905	0.000	59.262	15.711
2	-14.507	4.759	0.000	6.498	14.409	4.763	-14.623	-4.609	0.000	-5.647	14.528	-4.628	-28.539	0.000	28.336	0.000	56.875	12.145
3	-14.257	5.101	0.000	5.650	12.048	5.545	-14.911	-7.825	0.000	-10.652	12.528	-7.305	-27.920	0.000	23.242	0.000	51.161	16.302
4	-14.648	4.900	0.000	6.410	13.553	5.053	-14.705	-4.632	0.000	-6.430	13.551	-4.472	-28.777	0.000	26.491	0.000	55.268	12.841
5	-14.863	3.069	0.000	4.103	14.590	3.002	-15.898	-8.650	0.000	-11.754	15.681	-8.755	-29.594	0.000	29.032	0.000	58.625	15.857
6	-16.877	3.712	0.000	4.873	14.468	3.998	-17.321	-6.287	0.000	-7.852	14.844	-5.867	-33.536	0.000	28.622	0.000	62.159	12.725
7	-13.296	2.967	0.000	3.440	13.817	2.941	-13.647	-4.773	0.000	-5.547	14.227	-5.122	-26.456	0.000	27.506	0.000	53.961	8.988
8	-13.118	2.403	0.000	2.854	12.765	2.414	-13.465	-4.863	0.000	-6.825	13.146	-4.959	-26.172	0.000	25.464	0.000	51.636	9.679
9	-12.482	2.689	0.000	3.360	11.604	2.746	-12.634	-3.448	0.000	-4.708	11.801	-3.625	-24.854	0.000	23.082	0.000	47.936	8.068
10	-13.816	3.384	0.000	4.055	15.175	3.328	-14.167	-5.044	0.000	-5.822	15.559	-5.361	-27.429	0.000	30.172	0.000	57.601	9.877
Mean	-14.415	3.687	0.000	4.737	13.601	3.768	-14.821	-5.716	0.000	-7.482	13.985	-5.637	-28.563	0.000	26.885	0.000	55.448	12.219

Rearrangement Data (mm): Lip shape Features Points for Each Videos on Vowel / i: / Sound

Video1	Video2	Video3	Video4	Video 5	Video6	Video7	Video8	Video9	Video10	Mean											
x	y	x	y	x	y	x	y	x	y	x	y										
-32.357	0.000	-28.539	0.000	-27.920	0.000	-28.777	0.000	-29.594	0.000	-33.536	0.000	-26.456	0.000	-26.172	0.000	-24.854	0.000	-27.429	0.000	-28.563	0.000
-16.284	3.887	-14.507	4.759	-14.257	5.101	-14.648	4.900	-14.863	3.069	-16.877	3.712	-13.296	2.967	-13.118	2.403	-12.482	2.689	-13.816	3.384	-14.415	3.687
0.000	6.128	0.000	6.498	0.000	5.650	0.000	6.410	0.000	4.103	0.000	4.873	0.000	3.440	0.000	2.854	0.000	3.360	0.000	4.055	0.000	4.737
13.579	3.891	14.409	4.763	12.048	5.545	13.553	5.053	14.590	3.002	14.468	3.998	13.817	2.941	12.765	2.414	11.604	2.746	15.175	3.328	13.601	3.768
26.905	0.000	28.336	0.000	23.242	0.000	26.491	0.000	29.032	0.000	28.622	0.000	27.506	0.000	25.464	0.000	23.082	0.000	30.172	0.000	26.885	0.000
13.983	-6.280	14.528	-4.628	12.528	-7.305	13.551	-4.472	15.681	-8.755	14.844	-5.867	14.227	-5.122	13.146	-4.959	11.801	-3.625	15.559	-5.361	13.985	-5.637
0.000	-9.584	0.000	-5.647	0.000	-10.652	0.000	-6.430	0.000	-11.754	0.000	-7.852	0.000	-5.547	0.000	-6.825	0.000	-4.708	0.000	-5.822	0.000	-7.482
-16.842	-7.033	-14.623	-4.609	-14.911	-7.825	-14.705	-4.632	-15.898	-8.650	-17.321	-6.287	-13.647	-4.773	-13.465	-4.863	-12.634	-3.448	-14.167	-5.044	-14.821	-5.716
-32.357	0.000	-28.539	0.000	-27.920	0.000	-28.777	0.000	-29.594	0.000	-33.536	0.000	-26.456	0.000	-26.172	0.000	-24.854	0.000	-27.429	0.000	-28.563	0.000

Measurement Data (mm): Lip Shape Features Points for Vowel / I / Sound

Video	UL1		UL2		UL3		LL1		LL2		LL3		L		R		Mean (Width/Height)	
	x	y	x	y	x	y	x	y	x	y	x	y	x	y	x	y	IxI	IyI
1	-13.413	2.310	0.000	4.025	13.773	2.505	-13.830	-5.709	0.000	-8.060	14.132	-5.621	-26.645	0.000	27.326	0.000	53.971	12.085
2	-14.910	2.366	0.000	3.506	13.533	2.508	-16.340	-11.001	0.000	-16.539	15.446	-11.562	-29.632	0.000	26.832	0.000	56.465	20.045
3	-12.099	4.618	0.000	6.521	12.166	4.599	-12.516	-6.137	0.000	-6.773	12.580	-6.118	-23.444	0.000	23.592	0.000	47.035	13.294
4	-16.654	2.588	0.000	3.243	15.526	2.439	-17.680	-9.290	0.000	-12.721	16.166	-8.144	-33.108	0.000	30.861	0.000	63.970	15.964
5	-13.970	5.666	0.000	7.201	13.243	5.979	-14.021	-5.934	0.000	-6.708	13.234	-5.939	-26.748	0.000	25.086	0.000	51.834	13.910
6	-10.457	3.813	0.000	4.929	9.846	4.033	-10.391	-3.442	0.000	-4.483	9.752	-3.568	-20.195	0.000	18.829	0.000	39.024	9.412
7	-12.568	2.974	0.000	3.902	13.735	2.524	-13.208	-6.391	0.000	-6.918	14.405	-6.548	-24.779	0.000	27.241	0.000	52.019	10.820
8	-14.872	1.686	0.000	3.065	12.594	2.641	-15.714	-7.865	0.000	-10.941	13.568	-7.902	-29.662	0.000	25.009	0.000	54.670	14.006
9	-11.467	2.635	0.000	4.512	10.664	2.732	-11.878	-5.143	0.000	-6.439	11.018	-4.906	-22.662	0.000	21.002	0.000	43.664	10.952
10	-15.514	2.948	0.000	3.507	15.578	3.731	-16.364	-7.874	0.000	-8.969	16.364	-7.874	-30.751	0.000	30.751	0.000	61.503	12.477
Mean	-13.592	3.160	0.000	4.441	13.066	3.369	-14.194	-6.878	0.000	-8.855	13.667	-6.818	-26.763	0.000	25.653	0.000	52.415	13.296

Rearrangement Data (mm): Lip shape Features Points for Each Videos on Vowel / I / Sound

Video1	Video2	Video3	Video4	Video 5	Video6	Video7	Video8	Video9	Video10	Mean											
x	y	x	y	x	y	x	y	x	y	x	y										
-26.645	0.000	-29.632	0.000	-23.444	0.000	-33.108	0.000	-26.748	0.000	-20.195	0.000	-24.779	0.000	-29.662	0.000	-22.662	0.000	-30.751	0.000	-26.763	0.000
-13.413	2.310	-14.910	2.366	-12.099	4.618	-16.654	2.588	-13.970	5.666	-10.457	3.813	-12.568	2.974	-14.872	1.686	-11.467	2.635	-15.514	2.948	-13.592	3.160
0.000	4.025	0.000	3.506	0.000	6.521	0.000	3.243	0.000	7.201	0.000	4.929	0.000	3.902	0.000	3.065	0.000	4.512	0.000	3.507	0.000	4.441
13.773	2.505	13.533	2.508	12.166	4.599	15.526	2.439	13.243	5.979	9.846	4.033	13.735	2.524	12.594	2.641	10.664	2.732	15.578	3.731	13.066	3.369
27.326	0.000	26.832	0.000	23.592	0.000	30.861	0.000	25.086	0.000	18.829	0.000	27.241	0.000	25.009	0.000	21.002	0.000	30.751	0.000	25.653	0.000
14.132	-5.621	15.446	-11.562	12.580	-6.118	16.166	-8.144	13.234	-5.939	9.752	-3.568	14.405	-6.548	13.568	-7.902	11.018	-4.906	16.364	-7.874	13.667	-6.818
0.000	-8.060	0.000	-16.539	0.000	-6.773	0.000	-12.721	0.000	-6.708	0.000	-4.483	0.000	-6.918	0.000	-10.941	0.000	-6.439	0.000	-8.969	0.000	-8.855
-13.830	-5.709	-16.340	-11.001	-12.516	-6.137	-17.680	-9.290	-14.021	-5.934	-10.391	-3.442	-13.208	-6.391	-15.714	-7.865	-11.878	-5.143	-16.364	-7.874	-14.194	-6.878
-26.645	0.000	-29.632	0.000	-23.444	0.000	-33.108	0.000	-26.748	0.000	-20.195	0.000	-24.779	0.000	-29.662	0.000	-22.662	0.000	-30.751	0.000	-26.763	0.000

Measurement Data (mm): Lip Shape Features Points for Vowel / e / Sound

Video	UL1		UL2		UL3		LL1		LL2		LL3		L		R		Mean (Width/Height)	
	x	y	x	y	x	y	x	y	x	y	x	y	x	y	x	y	IxI	IyI
1	-13.818	1.131	0.000	2.162	12.936	1.269	-14.394	-6.257	0.000	-8.419	13.292	-5.352	-27.536	0.000	25.840	0.000	53.375	10.580
2	-14.080	5.958	0.000	7.048	11.472	5.953	-14.260	-8.436	0.000	-13.648	11.994	-8.895	-26.883	0.000	21.340	0.000	48.224	20.696
3	-13.094	6.234	0.000	8.844	13.366	6.320	-13.669	-7.947	0.000	-9.526	13.672	-7.343	-24.901	0.000	25.410	0.000	50.311	18.370
4	-14.401	6.944	0.000	8.042	14.699	7.948	-14.019	-5.143	0.000	-5.474	14.087	-5.480	-27.064	0.000	27.064	0.000	54.129	13.516
5	-16.045	3.980	0.000	3.794	15.443	3.921	-18.571	-14.534	0.000	-20.518	17.266	-13.333	-31.589	0.000	30.381	0.000	61.970	24.312
6	-14.621	5.758	0.000	6.946	13.353	5.658	-15.278	-8.477	0.000	-10.254	14.177	-8.659	-28.113	0.000	25.516	0.000	53.628	17.201
7	-12.378	3.199	0.000	3.926	12.553	3.349	-12.884	-6.735	0.000	-10.054	13.160	-7.058	-24.358	0.000	24.665	0.000	49.023	13.979
8	-13.475	2.050	0.000	2.268	13.571	2.448	-13.598	-3.712	0.000	-5.461	13.711	-3.962	-26.795	0.000	26.921	0.000	53.716	7.729
9	-10.828	2.652	0.000	2.734	10.707	2.578	-11.539	-6.735	0.000	-9.570	11.592	-7.083	-21.327	0.000	21.100	0.000	42.428	12.303
10	-12.902	7.924	0.000	10.083	15.424	8.184	-13.257	-9.007	0.000	-11.549	15.508	-8.727	-23.310	0.000	28.634	0.000	51.944	21.632
Mean	-13.564	4.583	0.000	5.585	13.352	4.763	-14.147	-7.698	0.000	-10.447	13.846	-7.589	-26.188	0.000	25.687	0.000	51.875	16.032

Rearrangement Data (mm): Lip shape Features Points for Each Videos on Vowel / e / Sound

Video1	Video2	Video3	Video4	Video 5	Video6	Video7	Video8	Video9	Video10	Mean											
x	y	x	y	x	y	x	y	x	y	x	y										
-27.536	0.000	-26.883	0.000	-24.901	0.000	-27.064	0.000	-31.589	0.000	-28.113	0.000	-24.358	0.000	-26.795	0.000	-21.327	0.000	-23.310	0.000	-26.188	0.000
-13.818	1.131	-14.080	5.958	-13.094	6.234	-14.401	6.944	-16.045	3.980	-14.621	5.758	-12.378	3.199	-13.475	2.050	-10.828	2.652	-12.902	7.924	-13.564	4.583
0.000	2.162	0.000	7.048	0.000	8.844	0.000	8.042	0.000	3.794	0.000	6.946	0.000	3.926	0.000	2.268	0.000	2.734	0.000	10.083	0.000	5.585
12.936	1.269	11.472	5.953	13.366	6.320	14.699	7.948	15.443	3.921	13.353	5.658	12.553	3.349	13.571	2.448	10.707	2.578	15.424	8.184	13.352	4.763
25.840	0.000	21.340	0.000	25.410	0.000	27.064	0.000	30.381	0.000	25.516	0.000	24.665	0.000	26.921	0.000	21.100	0.000	28.634	0.000	25.687	0.000
13.292	-5.352	11.994	-8.895	13.672	-7.343	14.087	-5.480	17.266	-13.333	14.177	-8.659	13.160	-7.058	13.711	-3.962	11.592	-7.083	15.508	-8.727	13.846	-7.589
0.000	-8.419	0.000	-13.648	0.000	-9.526	0.000	-5.474	0.000	-20.518	0.000	-10.254	0.000	-10.054	0.000	-5.461	0.000	-9.570	0.000	-11.549	0.000	-10.447
-14.394	-6.257	-14.260	-8.436	-13.669	-7.947	-14.019	-5.143	-18.571	-14.534	-15.278	-8.477	-12.884	-6.735	-13.598	-3.712	-11.539	-6.735	-13.257	-9.007	-14.147	-7.698
-27.536	0.000	-26.883	0.000	-24.901	0.000	-27.064	0.000	-31.589	0.000	-28.113	0.000	-24.358	0.000	-26.795	0.000	-21.327	0.000	-23.310	0.000	-26.188	0.000