Sign Language and Computing in a Developing Country: A Research Roadmap for the Next Two Decades in the Philippines

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Abstract. This paper presents the current situation of Filipino Sign Language in the Deaf community and milestones in sign linguistics research. It highlights key computing research, particularly in Asia as well as enumerates research attempts to date of Philippine academic institutions which have applications in sign language recognition. This paper also touches on technical considerations, economic feasibility, partnerships and other sociocultural considerations appropriate for a developing country such as the Philippines.

Keywords: Filipino Sign Language, Philippines, sign language recognition, research agenda

1. Introduction

1.1.The Filipino deaf community

The last Census on disability reports over 121,000 Filipinos with hearing loss (NSO 2000). The deaf community (as with the other disabled sectors) remains widely marginalized from the mainstream of society, lagging behind recognized disadvantaged groups such as peasants, urban poor, fisher folk and indigenous peoples. Despite this, the Filipino Deaf remain a vibrant and dynamic assemblage of communities throughout the archipelago bound by their visual language. This complex spatial-gestural rule-governed mode of communication endows a strong sense of collective identity. Sign language is at the core of the progressive view of deafness as a culture, and of deaf people as a linguistic minority.

1.2.Research on Filipino Sign Language

There are only several recent milestone studies on the visual-spatial language of the Filipino Deaf community (i.e., Filipino Sign Language or FSL) initiated by Filipinos themselves. In the seventies and eighties, publications by North American writers, drew largely from American Sign Language (ASL) and artificial sign systems to publish highly prescriptive material. The earliest descriptive works are comprised by the pioneering research of Liza Martinez on the

sociolinguistics and structure of FSL beginning in the early nineties. To date, the most comprehensive linguistics reference was initiated by Martinez herself (PDRC and PFD, 2004).

Recent papers presented at the 9th Philippine Linguistics Conference covered several topics on the structure and sociolinguistics of FSL. Noteworthy also are the publications of the Philippine Federation of the Deaf on the use of sign language in the Philippines (2008), on regional variation (PFD, 2005, 2007), as well as by the Philippine Deaf Resource Center on applied issues (Tiongson and Martinez, 2007).

1.3.Current Issues on the Status and Use of Filipino Sign Language

Filipino Sign Language has only recently begun to be documented because of the young state of sign linguistics research in the country. It is largely unrecognized by government in the language domains of schools, courtrooms, the workplace, hospitals and mass media. In the community, both deaf and hearing Filipinos may still disregard FSL as an authentic linguistic entity. Despite the considerable research efforts for nearly two decades, the language and its users remain at the periphery of Filipino society. Language policy is virtually non-existent for sign language use (PDRC, 2005).

2. Overview of Current Trends in Automatic Analysis of Sign Language and Related Research

Pavlovic and Sharma (1997) provide a useful review of human-computer interactions for hand gestures although there have been considerable additional discoveries in the past decade. Ong and Ranganath (2005) discuss future scenarios for automatic sign language analysis. Other key studies include Wu et al. 2005, Nolker et al. 2002, Yang et al. 2002 and Chen et al., (in progress).

For specific sign languages, a well established literature on the linguistics of ASL coupled with strong community advocacy for its use have resulted in several computer science collaborations on automatic analysis in the U.S. This include overall gesture recognition (Wei 2008) as well as specific handshape recognition (Athitsos et al., 2008; Potamias and Athistsos 2008; Thangali and Yuan 2008; Vogler, and Goldenstein, In press; Huenerfauth 2005, Vogler & Metataxas, 2001).

In Asia, active collaboration in China by researchers in Beijing and Harbin have been pioneering vision-based recognition systems for Chinese Sign Language (Zhang 2005, 2004) and proposing innovative methods e.g., homography and invariant sign language recognition to minimize problems in viewpoint variance during recognition and testing (Wang 2007, Wang et al, 2006). The research group of Sagawa in Tokyo, Japan has likewise been studying vision-based methods in recognition for Japanese Sign Language for the past several years (e.g., Nakano et al. 2007; Xu et al., 2000).

In the Philippines, current research on FSL number recognition (Sandjaja, 2008) at De La Salle University Manila is studying feature extraction and recognition from a video stream using the Hidden Markov Model and Artificial Neuron Fuzzy Network. Underway are research in the same university for NMS feature extraction (Pamparo, In progress) and recognition of continuous signing (Sarmiento, In progress). Past studies in the same institution with potential contributions to sign language recognition and its applications are strongly motivated by the presence of a large tertiary level program for Deaf students in its academic system: investigations on a sign language modeler (Mejia, et al., 2002), translators (Aguilos, 2007;

Canono, 2004), hand pose graphical interface (Abola, 2004), animation (Cadiz et al., 2003), teaching applications (De Guia et al., 2001; Garin, et al., 1993, Aldea et al., 1993), and communications application (Brosas et al., 2003).

Research by Basa (2000) at the national University of the Philippines has been done on handshape recognition of still images.

3. Considerations

3.1.Technical Considerations

There are two general approaches to capturing hand shape and gesture data: direct measure devices and vision based devices. Direct measure devices provide exact information about hand shape, orientation, location and movement; however, they are often impractical to use outside the lab since people rarely go about their business wearing motion-capture gloves. Computer vision provides a more natural approach.

Sign languages (SL) are fully visual languages. A sentence in SL often contains much more information than a similar spoken or written sentence. Sign languages make extensive use of classifiers, inflections, various spatial grammatical devices through the simultaneous channels of the hands, face and body, thus making vision-based analysis of SL several times more complex than recognition of spoken or written languages. Orientation of the signer relative to the viewer may partially or completely occlude the hands of the former introducing additional challenges. Stereo or multi-camera setups may be required to get around this problem.

Sign language recognition systems need to examine five elements: gross arm movement, hand location, hand shape, hand orientation, and non-manual signals (NMS) which include facial expressions and body posture. However, most previous research have concentrated on the hand and arm gestures. Very little research has been done on NMS, and their integration with the hand gesture data.

Signer independence is another critical area in need of further research. Most prior research use a single signer for training and testing. Error rates increased dramatically when a different signer was introduced.

Increasingly larger vocabulary sets and discourse data also need to be eventually targeted by future research. Research to date have limited their scope to a small number of isolated signs.

3.2.Socioeconomic feasibility and relevance

Where is the place of scientific inquiries on machine intelligence, and human-machine interactions in a small Asian country with a runaway population, a volatile political structure and a large proportion of its citizens faced with the most abject poverty? In an environment where a typical family might earn no more than $8 a day, and barely have enough food on the table or access to the basics of clean water, electricity and education, *on top of* having a member with a hearing disability, what *is* the role of this research?

Ironically, it is precisely this plight of seeming hopelessness that such scientific endeavors need to be pursued. To the Deaf, sign language *is* the core of their existence and connection to the world. And in order to penetrate the barrier of discrimination, the Deaf community needs innovative and visionary science to draw it back into the realm of mainstream society. This

kind of scientific research that has *real* applications in the lives of Filipinos, shall lessen (rather than widen) the often mentioned chasm between the technological *haves* and *have-nots*.

Since machine intelligence and human machine interactions do not aim to replace human interpretation or be mechanical rivals, but rather supplement or compliment such resources, then it could bypass typically unproductive aspects of human interactions in Philippine society such as: corruption, endless politicking, and others.

The technology and skills needed to develop, build, and deploy sign language recognition systems fall under the domain of science and engineering. The Philippines must increase the number of science and engineering professionals in order to meet the demand. Policy changes must be made to support research and development; more than just business process outsourcing. The educational system, starting at the lowest levels, must be improved with additional emphasis on science and math.

Attitudes towards science and technology must also change. More than anything else, interest in science and technology beyond simple consumerism is critical to success in the fields of computer vision and intelligent systems. Filipinos must escape the mindset that we are *only* consumers of technology. We *must* nurture the mindset that we are creators, developers, and builders of technology.

Filipino talent in the IT domain has been gaining recognition (Cristobal, 2006; Damarillo, n.d.). Harnessing this creativity is a logical and relevant strategy in a country beset with numerous economic and political challenges. It is an important thrust based on the fact that "creative-sector occupations in science and technology… have grown since 1980 from 12 percent of the work force to between 30 and 40 percent in most advanced countries today…" and at the same time, "…disturbing that the poorest countries and regions around the world continue to export more than half of their scientific and engineering talent to advanced economies" (Florida, 2006).

Directions in the Philippine IT industry have also been gearing towards tapping this resource. For instance, the 1st Cebu Open Source Summit last month (Cebu Sunstar 2008) recommended the creation of innovation systems and the promotion of technology entrepreneurship as the pillars of development. Metropolitan Cebu's software development sector is generating around $60 million annually, and the population of software developers jumped from 1,000 in 2003, to 3,276 in 2007.

3.3.Sociocultural impact on the Filipino Deaf community

Understanding of natural language processing and modeling of human intelligence will be a strong validation of the Deaf mind and its cognitive processes. This shall help dispel the stigma that Deaf people are mentally *deficient* simply because they use a visual language, and are not native users of written language. By bringing the Deaf into active partnership with academe, scientists, engineers, there shall be further validation of this language community.

Proving structural differences of FSL and ASL from the phonological through the syntactic levels require highly systematic methodologies which can handle dissecting subtle differences in the lexicon and linguistic hierarchy. Applied aspects of computational linguistics will have much to offer in this arena.

Specific targeted language domains for application are: education – development of classroom tools for literacy; legal – stenographic notation during court trials; medical – hospital

interviews; workplace – office communications; media / telecommunications: mini-translators, videophones and public facilities / services – instructions / directories.

3.4.Partnerships

The potential impact on, and benefit to the Deaf community of intelligent systems shall hinge on critical partnerships. Deaf people's organizations need to work closely with the academe in the areas of Computer Science, Engineering as well as Linguistics. The Deaf community needs to be constantly giving feedback during the conceptualization and development of research agenda so that the research activity and direction remain relevant. A good example of such collaborations at work is the ongoing "Development on an online Philippine corpus" a joint undertaking between academe, Deaf people's organizations, NGOs and government entities.

To its advantage, the Philippines has a very strong civil society sector. Nongovernment organizations number from 50,000 to 100,000. They serve not only the Filipino people but also cooperate with overseas government agencies and non-governmental organizations. They also have varied scope and expertise in special fields (JICA, n.d.).

4. The Vision

At the initiation of a Sign Language Imaging Group comprised of graduate students from De La Salle University and the University of the Philippines, with the NGO, the Philippine Deaf Resource Center, this research roadmap is proposed for the next two decades:

- By 2013 (5 years hence, or sooner): A good handle on imaging from a phonological perspective; accumulation of 30,000+ (handshapes, NMS, etc.) information

- By 2018 (10 years hence): Grammar of Filipino Sign Language (FSL) documented and in use by imaging researchers

- By 2028 (20 years hence): Real time translation of natural discourse by signer into text (English / Filipino / Philippine language) for nonsigners

5. Potential Challenges and Difficulties

With the current economic crisis, funding for research activity is certainly going to be a primary challenge. The technical challenges shall also depend on the openness of academic administration of Computer Science, Engineering and Linguistics to integrate these applications into its curricular agenda. Coordination across the disciplines shall have to be taken on by leaders who can capably coordinate academe, the Deaf community and government and nongovernment entities. The state of research on sign language linguistics shall also present challenges. The recognition of handshapes, nonmanual signals or segments of sign language discourse shall depend on extensive data and analysis in the linguistics of FSL.

6. Conclusion

The Philippines is poised to make an impact on sign language recognition and computational linguistics in the next 20 years. Partnering of talent in science and technology with strong grassroots deaf empowerment and social responsibility of its other stakeholders shall ensure that this developing democracy shall not drown out the voices of its marginalized minority. Mindful coordination across sectors and disciplines shall hopefully bring about scientific investigations

that are not only academically innovative but also concrete, socially relevant and appropriate to the local situation.

References

Abola, J.J.L., M.A.G. Benedicto, L.J. Chiu and I.M. Sarain. 2004. Hand Pose Interpolation. B.S. thesis. De La Salle University - Manila, Philippines.

Aguilos, V.S., C.J.L. Mariano, E.B.G. Mendoza, J.P.D. Orense and C.Y. Ong. 2007. ApoL: A Portable Letter Sign Language Translator. M.S. thesis, De La Salle University - Manila, Philippines.

Aldea, G.M.V., N.G. Guevarra, R.A. Torredondo and S.M.M. Tuvida. 1993. Computer-Assisted Instruction on Elementary English for the Deaf. B.S. thesis. De La Salle University - Manila, Philippines.

Athitsos, V., C. Neidle, S. Sclaroff, J. Nash, A. Stefan, Q. Yuan, A. Thangali. In press. The American Sign Language Video Dataset. Proceedings: IEEE Workshop on Computer Vision and Pattern Recognition for Human Communicative Behavior Analysis.

Basa, T. 2000. Recognition of Static Hand Gestures Using Support Vector Machines. M.S. thesis, University of the Philippines, Diliman, Quezon City, Philippines.

Brosas, J.M.B., L.A.A. Chan, F.C. Escolar and I.T. Lim, Iceal. 2003. A PC-Based Telephone Device for the Deaf using Speech-to-Lip Speaking Animation. B.S. thesis. De La Salle University - Manila, Philippines.

Cadiz, M.M.E. 2003. Sign Language Using Motion Capture Based Animation. M.S. thesis. De La Salle University - Manila, Philippines.

Canono, P. III.T., M.C.G.Leonor, D.O.O. Santos, J.V. Suratos and P.G. Tuason. 2004. Letter Sign Language Translator. B.S. thesis. De La Salle University - Manila, Philippines.

Cebu Sunstar. 2008. ICT Stakeholders Aim to Make Cebu an Innovation Destination.

Chen, Q., N. Geogranas and E.M. Petriu. In press. Hand Gesture Recognition using Haar-like Features and a Stochastic Context-Free Grammar. IEEE Trans. Instrumentation and Measurement.

Cristobal, A. 2006. Unleashing Filipino Creativity and Talent through IP Education, Training and Research. National Symposium on Intellectual Property Education, Training and Research, Jan 30-31, Makati, Philippines.

Damarillo, W. n.d. www.exist.com/blogs/ Funding-software-innovations-Philippines.html.

Florida, R. 2006. Minds on the Move. In: Damarillo, W. n.d.

Garin, V., J.J. Jimenez, J. Miranda and R. Santos. 1992. Word-Image Conversion for Deaf Education (WICONDED). B.S. thesis. De La Salle University - Manila, Philippines.

Huenerfauth, M. 2005. Representing Coordination and Non Coordination in American Sign Language. Proceedings: ASSETS '05, Oct.9-12, 2005. Baltimore, Maryland, U.S.A.

Japan International Coordinating Agency. n.d. http://www.jica-ngodesk.ph/english/Page4.htm.

Mejia, M.M.I., M.J.G. Pantig, N.R.P. Que and J. Velasco. 2002. HandTalk : An Interactive Web-Based Sign Language Modeler. B.S. thesis. De La Salle University - Manila, Philippines.

Nakano, Y., K. Murata, M. Enomoto , Y. Arimoto, Y. Asa and H. Sagawa. 2008. Modeling Human-Agent Interaction Using Bayesian Network Technique. New Frontiers in Artificial Intelligence. Lecture Notes in Computer Science. vol. 4914. Heidelberg: Springer Berlin.

National Sign Language Committee. 2008. Status Report on the Use of Sign Language in the Philippines. Metro Manila: Philippine Federation of the Deaf.

Nolker, C., H. Ritter. 2002. Visual Recognition of Continuous Hand Postures. IEEE Trans. Neural Networks, 13(4), 983-994.

Ong, S. C.W. & S. Ranganath. 2005. Automatic Sign Language Analysis: A Survey and the Future Beyond Lexical Meaning. IEEE Trans. Pattern Analysis & Machine Intelligence, 27(6), 873-891.

Pamparo, D. I. In progress. Extraction of Facial Action Units for Filipino Sign Language.

Pavlovic, V.I. , R. Sharma, & T.S. Huang. 1997. Visual Interpretation of Hand Gestures for Human-Computer Interaction: A Review. IEEE Trans. Pattern Analysis & Machine Intelligence, 19(7), 677-695.

Philippine Deaf Resource Center. 2005. Preliminary Sectoral Position Papers for an Initiative in Language Planning for Sign Language Policy for the Republic of the Philippines: A Compilation. Unpublished manuscript, Quezon City.

Philippine Deaf Resource Center and Philippine Federation of the Deaf. 2004. An Introduction to Filipino Sign Language. Quezon City: Philippine Deaf Resource Center.

Philippine Federation of the Deaf. 2007. A Compilation of Signs from Regions of the Philippines, Part 2. Metro Manila: Philippine Federation of the Deaf.

Philippine Federation of the Deaf. 2005. A Compilation of Signs from Regions of the Philippines, Part 1. Metro Manila: Philippine Federation of the Deaf.

Potamias, M. and V. Athitsos 2008. Nearest Neighbor Search Methods for Handshape Recognition. Petra. 1-8.

Sarmiento, E. In progress. Vision-Based Continuous Filipino Sign Language Recognition.

Thangali, A. and Q. Yuan. 2008. Handshape Recognition for Query-by-Sign ASL Dictionary. 2008 Boston University Computer Science Research Open House. http://www.cs.bu.edu/IAP/ResearchDay2008/IAP08.pdf

Tiongson, P. and L. Martinez. 2007. Full Access: A Compendium on Sign Language Advocacy and Access of the Deaf to the Legal System. Quezon City: Philippine Deaf Resource Center.

Vasilis, A., M. Potamias, P. Papapetrou and G. Kollios. In press. Nearest Neighbor Retrieval Using Distance-Based Hashing. Proceedings: IEEE Conference on Data Engineering, April 2008.

Vogler, C. and S. Goldenstein. In press. Facial Movement Analysis in ASL. Universal Access in the Information Society.

Vogler, C. and D. Metaxas. 2001. A Framework for Recognizing the Simultaneous Aspects of American Sign Language. Computer Vision and Image Understanding, 81, 358-384.

Wang, Q., X. Chen, C. Wang and W. Gao. 2006. A Verification Method for Viewpoint Invariant Sign Language Recognition. International Conference on Pattern Recognition, 1, 456-459.

Wang, Q., X. Chen, C. Wang and W. Gao. 2006. Sign language Recognition from Homography. IEEE International Conference on Multimedia and Expo, pp. 429-432.

Wei, K. 2008. American Sign Language Finger Spelling Recognition System. http://kevinhaptics.blogspot.com/

Wu, Y., J. Lin and T. S. Huang. 2005. Analyzing and Capturing Articulated Hand Motion in Image Sequences. IEEE Trans. Pattern Analysis & Machine Intelligence, 27(12), 1910-1922.

Xu, M., B. Raytchev, K. Sakaue, O.Hasegawa, A.Koizumi , M. Takeuchi and H. Sagawa. 2000. A Vision-Based Method for Recognizing Non-Manual Information in Japanese Sign Language. Advances in Multimodal Interfaces - ICMI 2000. Lecture Notes in Computer Science, 1948. Heidelberg: Springer Berlin.

Yang, M-H, N. Ahuja and M. Tabb. 2002. Extraction of 2D Motion Trajectories and its Application to Hand Gesture Recognition. IEEE Trans. Pattern Analysis & Machine Intelligence, 24(8), 1061-1074.