Is Video Analytics a Game Changer for Market Research?

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Abstract. Intelligent video analytics (IVA) has been growing in the past decade, with a variety of applications from fraud detection to traffic control. This research focuses on the impact of IVA as a decision support tool for market surveys. We compiled a comparative list of existing market survey methods, and identified potential cognitive biases that these methods may impose. In order to look at the efficiencies and accuracies that can be gained by IVA, we conducted experiments and analyzed the results that are automatically captured by the software in real time. Our results show some unexpected variations that may not be obvious to a market researcher. We conclude that the use of IVA can enhance decision-making by improving response rate and accuracy, and reduce some of the cognitive biases that may be affecting quantitative primary data. However, even though it can identify age, gender, location and time of target audience, with its current capabilities IVA cannot be a substitute for qualitative survey methods.

Keywords. Decision Support, Video Analytics, Market Research, Market Survey Methods, Primary Data

Introduction

In today's business environment, organizations strive to meet the constantly changing global business dynamics. To survive in an increasingly competitive information-centered economy, today's organizations must constantly assess and update their strategies, techniques, and tools. This research looks into the potential use of intelligent video analytics (IVA) as a decision support tool in market research. Market research refers to any effort to gather information about markets or customers [1] and it relies on several techniques and their combinations to obtain primary data. Most of these techniques are still mostly manual and subject to different cognitive and behavioral biases [2]. Since technology is evolving and developing rapidly, market researchers need to find creative ways of meeting increased expectations to improve efficiency and effectiveness of their surveys. Our focus is on understanding how IVA may change the current market research and market survey landscape, and how it may impact the timeliness and accuracy of decisions.

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Intelligent video systems (IVS) and intelligent video analytics (IVA) are "any video surveillance solution that utilizes technology to automatically, without human intervention, process, manipulate and/or perform actions to or because of live or stored video images" [3]. In the past decade, we have observed a substantial growth in video analytics driven mostly by a wide range of applications from transportation to healthcare [4].

In this research, we try to understand the role of IVA on current market survey methods for obtaining primary data. First, we compile a comprehensive and comparative list of market survey methods focusing on capabilities, flexibilities, cost, and response rates. In this section, we also compile a list of the most common potential biases these methods may impose. Then we investigate the current state of IVA and its role as a next-generation decision support tool. After a brief section on our choice of video analytics tool, the Intel AIM suite, we discuss how IVA may impact current market research and survey methods. We then lay out our experimental design to assess and understand the impact of IVA on market research. After presenting our experimental results and data analysis, we discuss advantages and limitations of using this approach, as well as potential next steps.

1. Current Landscape of Market Research Survey Methods

According to ICC/ESOMAR, in its widest definition market research refers to anything and everything that the firm does to learn about and understand markets and customers [5]. It includes social and opinion research, and is also defined as the systematic gathering and interpretation of information about individuals or organizations using statistical and analytical methods of the applied social sciences to gain insight or support decision making [5]. Market surveys are an important part of market research, in which members of the target audience are directly contacted. Primary data are observed and recorded or collected directly from respondents after employing various market survey methods [6]. The objective is to obtain direct feedback from customers and other stakeholders; however, each survey method has its own advantages and disadvantages.

1.1. Comparative Analysis of Survey Methods for Gathering Primary Data

There are a lot of studies on various market survey methods but not very many that compares these on multiple attributes. In this section, we analyze current market survey tools available to market researchers for gathering primary data in a systematic and comparative way.

Mail surveys are a traditional method to gather both quantitative and qualitative data [6]. However, this approach has a high labor cost and a very low response rate. Because of the low response rate, representativeness of the sample is questionable. This method is not flexible, since the researcher predetermines the number and the form of questions and there is no way to change the survey in the process [7].

Telephone surveys represent a survey method in which respondents are asked survey questions over the phone and the interviewer records their answers [6]. Currently, fewer and fewer people are willing to participate in telephone surveys [8], which is an obvious threat to response rate and an alert for non-representative samples. Moreover, the cost of a telephone survey is quite high and the respondent's behavior is

not directly observable. Compared to mail surveys this method is more flexible, because it allows probing questions during interaction with the interviewer [6].

Internet surveys are any surveys that use the Internet as a medium to conduct the surveys [7]. In spite of the attractively low cost, the reliability and quality of information gathered from these surveys are questionable [9], [10]. This method allows researchers to reach global audiences, and also allows a certain level of flexibility since the survey questions can be quickly modified online.

Personal interview surveys can give the researcher valuable qualitative information and in-depth answers [11]. It is the most flexible method, because the interviewer can ask probing questions and lead the interview on a certain, desired path. However, it is difficult to reach a number that is statistically reliable due to high costs and the time required to conduct each survey [6], [11]. In most cases, samples for the personal interview have to be predetermined in a way that ensures interviewers can obtain the most valuable feedback.

Focus groups are formed to elaborate on the topic of research, and the main feature is interaction between members. Therefore, the interviewer can receive both individual and group opinions about the topic. Focus groups allow the researcher to ask probing questions, which makes this method highly flexible [12]. The biggest challenge is to define the target audience, and therefore the cost and time for such interviews are as high as for personal interviews [13].

Observations are straightforward and they do not have the main problems of other survey methods, such as motivating respondents to state their true feelings or opinions [6]. By observing respondents directly, researchers can obtain more accurate and reliable patterns of behavior. However, flexibility is limited by observers' ability and available technology [6], [13]. Also, this method is associated with high costs, depending on the technology used and the labor involved.

The mobile survey method is a relatively new, cost-effective and fast survey method. The cost is low and limited to mobile provider rates for Internet or mobile connection. This method is not flexible, since researchers can only ask short questions fitting the mobile phone screen. Usually the respondent is given an option of multiple-choice answers only, leaving no room for probing questions or alterations to the survey. Also, the pool of respondents has to be predetermined [13].

All these surveys mentioned above use a different medium or channel to understand their target audience, which evokes biases. Survey organizations are increasingly using mixed-mode designs for market research. In other words, they use several ways to collect data in order to eliminate non-response bias and other biases related to the type of survey [14].

1.2. Cognitive Biases of Survey Methods

Cognitive biases in surveys are systematic distortions of the information due to the subjective perception of situations, people or objects by every individual [15]. The purpose of market researchers is to minimize potential biases so they can acquire objective and valid data and perform accurate analyses and targeting.

Respondents might not always be open and give a true response when asked personal questions; they tend to give answers that will be socially approved. This is called social desirability bias [16].

Recall bias refers to a person's inability to recall events from the past in perfect detail and also his or her potential to recall events that never happened [16], [8].

Non-response bias is concerned with the possibility that an important part of the population was not surveyed due to survey method [8].

Rating bias is concerned with a person's inability to achieve an acceptable degree of precision and objectivity. When an individual has to place his opinion on a scale from 1 to 5, for example, he can give a different score for the same event depending on his own personality or even physiological state at that exact moment [16].

Interviewer bias is a systematic error related to the personality of the interviewer and the emotional response it evokes in survey respondents [6], [11], [13].

Observer bias occurs when data have to be interpreted for analysis. While conducting the survey, the observer's mind, eyes and hands suffer from systematic human errors that are called "non-iterational artifacts" [16].

Table 1 lists biases related to survey methods. A positive sign (+) is used if a certain type of bias is observed with a survey method. A negative sign (-) is employed if a method is not significantly impacted by a particular bias.

Table 1. Bias related to survey methods

	Mail Surveys	**Telephone Surveys**	**Internet Surveys**	**Personal Interview Surveys**	**Focus Groups**	**Observations**	**Mobile Surveys**
Social desirability bias	+	+	+	+	+	-	+
Recall bias	+	+	+	+	+	-	-
Non-response bias	+	+	+	-	-	+	+
Rating Bias	+	+	+	-	-	-	+
Interviewer Bias	-	+	-	+	+	-	-
Observer Bias	-	-	-	+	+	+	-

As can be seen from the table, all the surveys listed above suffer from a variety of biases that may cause inaccuracies and create inefficiencies in marketing investments. Observations have the least number of biases, and they are not related to a respondent's cognition or behavior. The biggest limitation of observations is the ability of the observer to catch the right information and to interpret it correctly. With recent technological developments, it is now possible to use IVA to enhance observations. IVA can also be used to complement other market research tools to reduce these biases as well as address other limitations mentioned in Section 1.1.

2. Intelligent Video Analytics

An Intelligent Video Analytics (IVA) is "any video surveillance solution that utilizes technology to automatically—without human intervention—process, manipulate and/or perform actions to or because of either live or stored video images" [3]. IVA helps government, public and commercial organizations to transform video surveillance into a real-time, proactive, event-driven process. According to RnR Market Research, revenues for the global Intelligent Video Surveillance (IVS); Intelligence, Surveillance & Reconnaissance (ISR); and Video Analytics (VA)

industries totaled $13.5 billion in 2012 [17]. Homeland Security Corporation estimates that the market is expected to grow at 13.8% compound annual growth rate from 2012 to 2020 [18]. In their extensive survey, Liu et. al. list management, traffic control and transportation, intelligent vehicles, healthcare and life sciences, security and the military as application areas of IVA [19].

In the area of marketing and retail, loss prevention, in-store operations and merchandizing are the main functions of video analytics as a decision support tool. Some other applications include planning store layouts based on computer path statistics, and staff planning based on historical and instantaneous customer counts at store entrances, departments, and check-out queues. Decisions like choosing the location of a display or measuring its effectiveness are also supported by IVA [20]. Store managers can also use IVA for customer counting and traffic flow.

In this research, we are analyzing the use of IVA for market surveys. IVA is able to capture anonymous audience data such as total number of viewers, average attention span, and gender and age of viewers, as they pass by a screen with an embedded camera in real-time. IVA can then create and send viewership information to an analytical server for further analysis.

2.1. Intel's Anonymous Video Analytics

In the past few years, many companies have developed products of intelligent video systems driven by academic and industrial demands. In order to understand the impact of video analytics on market research and survey methods we used Intel's Audience Impression Metrics (AIM) Suite Silver Edition. According to their website, with software installed on a PC and connection to a simple off-the-shelf web camera, AIM Suite Silver's algorithms detect and count the number of people who look at visual messaging in a defined area, and then log how long each of them are watching, as well as their gender and approximate age [21]. All of the data are then made available online for review. Silver users can also generate reports automatically and send them to a designated email address using the AIM Suite dashboard.

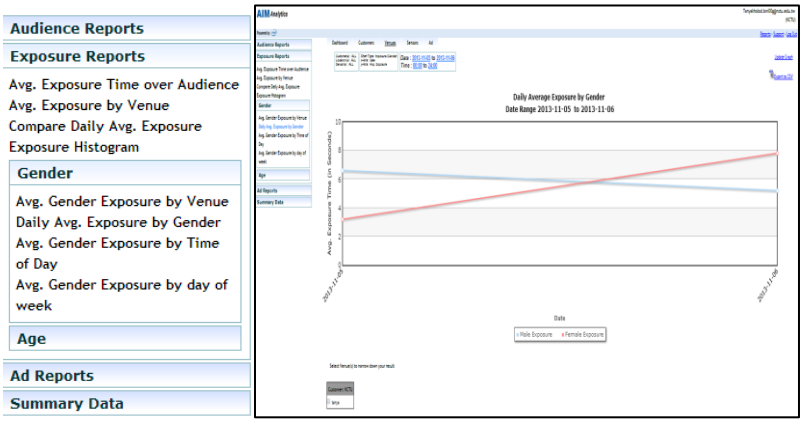

Figure 1. AIM Suite Functionality

AIM uses Anonymous Video Analytics (AVA), which is a passive and automated audience measurement technology based on computer vision theory. Audience data are broken down by time of day as well as day of the week. More advanced data correlations are also possible, such as matching anonymous viewership data with point-of-sale data. Figure 1 depicts a screen shot from the software, where reports can be generated based on the attributes listed on the tab on the left. As can be seen from Figure 1, AVA can detect a viewer and record the start time, end time and duration of his/her viewing behavior. In addition to the recognized demographic features, a viewing event reports when, where, and which type of viewer watched the digital sign, and the length of time he or she was engaged. By correlating the viewing events with ad playing events that state when, where, and how long each ad was displayed, the AVA system can create various viewing relationship reports and statistics, such as total number of viewers, average attention span, etc. These reports and statistics tell how effective the displayed ads are and what kind of audience is being attracted automatically.

3. Methodology

Our objective is to understand the impact of Video Analytics on market survey methods. Due to the characteristics described above, IVA can potentially impact more than one form of market survey method, and potentially reduce more than one type of bias mentioned in Table 1.

3.1. Experimental Design

In order to understand how IVA improves reliability, flexibility and accuracy of primary data collection in market surveys, we conducted two-stage experiments using IVA software that we connected to a 57" LCD screen. For each stage, we chose two alternative advertisements of the same product to observe if there were any variations in measurements depicted in Figure 1. For the first stage, we compared a static advertisement vs. dynamic advertisement. There was a strong preference for the dynamic advertisement. Therefore, for the second stage we compared two dynamic advertisements: an animated cartoon advertisement vs. a live-action film advertisement.

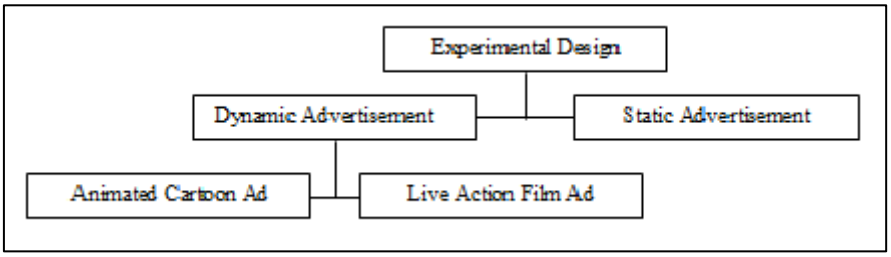

Figure 2. Experimental design

We hypothesized that the animated cartoon advertisement would be more attractive for our audience of mostly Asian students. This hypothesis is based on the fact that Taiwan is a high-context communication culture [22]. Results for both stages of the experiment were evaluated in terms of gender and age. A summary of the experimental design is presented in Figure 2.

3.2. Procedure

The experiment was conducted in Dining Hall 2 of National Chiao-Tung University (NCTU) campus in Hsinchu, Taiwan. There are only two dining halls on the campus. The total student population is 13,491, of which 9,751 (62%) male and 3,750 (38%) female students were registered at the time of the experiment. Therefore, we expected to obtain a significant sample size at the experiment location.

Figure 3. Area Map and a Photo of the Experiment Site

For the experiment, we set up the screen for IVA near the entrance of the dining hall, which is designated for marketing materials varying from posters to table set-ups including the 57" LCD screen that we attached to the IVA software. Figure 3 shows the area map and a photo of the experiment site. We showed each of our advertisements for 1.5 hours at lunch time on two consecutive days. The sensor catches the viewer only if his or her face is frontal to the screen, so the software does not detect individuals that pass by without turning their faces and glancing at the screen.

For the purpose of the first experiment, we showed a swimwear commercial with both a dynamic and static advertisement choice. For the second experiment, we showed a luxury car advertisement. The model of the car was the same for the animated cartoon and live-action advertisements. The length of the video was almost the same and the storyline was comparable.

4. Results and Discussion

The software we chose generates more than 40 automatic reports about audience, time, location, gender, and age and exposure time. All the data and reports are available to the user in the form of graphs, dashboards or .csv files. In this section we will present three types of reports: total audience count, exposure time count by gender, and age groups.

4.1. Audience Report

Audience reports show the total number of viewers that was automatically captured by the software.

Table 2. Audience Report

Stage	Advertisement	Total audience	Female	Male	F/M ratio
I	Dynamic	384	139	245	0.57
	Static	185	52	133	0.39
II	Animated Cartoon	341	124	217	0.57
	Live-Action Film	225	31	194	0.16

As can be seen in Table 2, the dynamic ad attracted twice as many viewers (384 vs. 185) as the static ad. It also attracted comparatively more female viewers. The ratio of female to male viewers for the dynamic ad was 0.57 whereas the general female/male ratio in the university is 0.38; indicating females viewed the dynamic ad 50% more. By contrast, the number of viewers for the static ad was lower, and the ratio of female to male viewers differed only slightly from 0.38 (the general ratio of female to male students at NCTU).

Since the dynamic advertisement was a winner, we compared animated cartoon vs. live-action films for the second stage of our experiment. As can be seen from Table 2, the animated cartoon attracted a 1.5 times larger audience in general (341 vs. 225). There was also a gender difference in viewing patterns. To our surprise, more female viewers liked the animated cartoon ad, while the male audience was more interested in the live-action film.

4.2. Average Exposure Time

In this section, we report average exposure time, i.e. how long a person stared at the screen. Table 3 contains overall average exposure time for the two stages of the experiment, and average exposure time by gender.

Table 3. Average Exposure Time

Stage	Advertisement	Avg. Exposure Time (sec)	Avg. Exp. Time Male (sec)	Avg. Exp. Time Female (sec)
I	Dynamic	5.88	4.2	9.5
	Static	1.92	0.6	3
II	Animated Cartoon	6	5.2	7.8
	Live-Action Film	6	6.6	3.2

The average exposure time was 3.06 times longer for the dynamic ad (1.92 sec. vs. 5.88 sec.). We also observed an interesting gender distribution in average exposure time that we had not anticipated. More female viewers were interested in the dynamic ad, staring at the screen 2.26 times longer on average (9.5 sec. vs. 4.2 sec.) than males. When comparing dynamic ads, overall average exposure time for both types of movies was exactly the same at 6 seconds, but there was a surprising difference in gender breakdown. Differences were in opposite directions for each type of film: female audience exposure time for the animated cartoon ad was longer than for male students (7.8 sec. versus 5.2 sec.) whereas the male audience had more than twice the exposure time for live-action film (6.6 sec. vs. 3.2 sec.). There was not a significant difference in male exposure time between the two types of films (5.2 sec. vs. 6.6 sec.) whereas for females the difference was more than double (7.8 sec. vs. 3.2 sec.). Figure 4 shows exposure histogram which breaks down the exposure time by seconds.

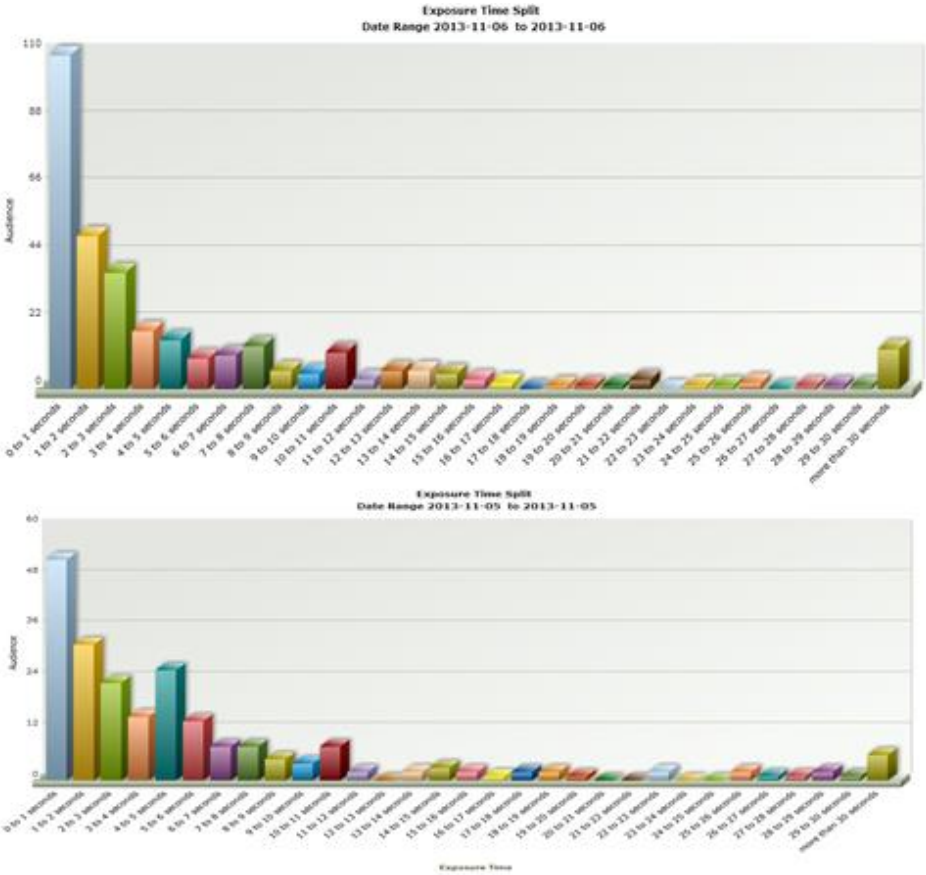

Figure 4. Animated Cartoon vs. Live-Action Film Exposure Time Histogram

4.3. Age difference

The IVA software also captures average estimated age. We expected most of the sample to be adults and young adults, since the experiment was conducted on a university campus. Figure 4 shows the age dispersion for the animated cartoon vs. live-action film experiment. The left bar of the diagram shows results for the live-action ad, while the right bar displays those for the animated cartoon ad. The bar divisions reflect the number of participants for each age group, including children at the bottom followed by young adults , adults , and seniors at the top.

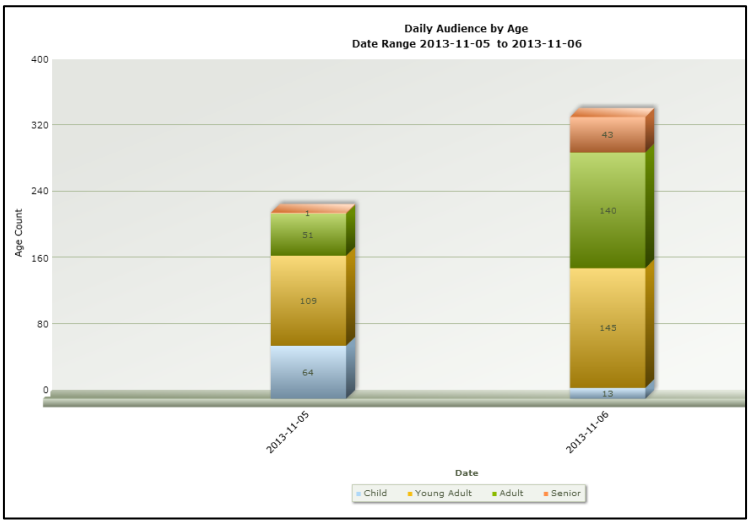

Figure 5. Animated Cartoon vs. Live-Action Film Age Dispersion

Figure 5 shows that the software detected almost 64 children looking at the live-action advertisement. On the contrary, the animated cartoon advertisement attracted just 13 children. Possible explanations for these surprising results could be the lack of the ability of the software to detect the ages of the target audience in Asia. More repetition of the experiment may be necessary to understand this observation. However, our objective here was to demonstrate the capabilities of IVA as a decision support tool for the market researcher.

Figure 1 shows all the other possible report types and their combinations that can be analyzed by the market researcher. For example, the reports can be generated to look at the breakdown by gender and venues, exposure time, time of day, and ad type by gender.

5. Conclusion

The current economic uncertainties and the re-evaluation of budgets have resulted in more critical views of marketing research. This climate challenges market research agencies to find creative ways of meeting the increased expectations [23] and adapt to newly available technology. In this research, we tried to show the capabilities of IVA

as a new decision support tool. Our aim was to understand how it may change the current market survey landscape and help market survey research improve accuracy and efficiency. We conclude that although IVA may not fully replace existing survey methods it has an impact in many different ways.

5.1. Review of Findings

With the capabilities demonstrated in the Results and Discussion section of this paper, we can conclude that for the software we tested IVA can enhance existing survey methods in several ways.

We have shown that IVA can collect quantitative data including exposure time, gender, age, time of day, and day of the week, and then compare different combinations of these data categories. For surveys that require qualitative data, IVA may not appear to be a good solution. However, since IVA observes the subjects anonymously, some qualitative research questions can be presented in the form of a video, and answers may be deduced from the combination of available audience reports. IVA has an initial setup cost, but does not have the ongoing costs of conducting and analyzing results that are mentioned for other manual survey methods. Also because the reports and dashboards are generated automatically from the data detected by an algorithm, the manual data collection and manual calculation errors are eliminated. The way the data are presented may help the researcher see hidden trends or correlations that may not be initially obvious.

The results that are collected through IVA are fast compared to mail and telephone surveys and do not require cooperation from the respondent. They can be used as a preliminary profiling stage for interviews and focus groups, mobile surveys and Internet surveys. In this way, IVA eliminates low response rate and reporter biases. Also, none of the other survey methods can capture or calculate the unbiased exposure time broken down into 1 second intervals which may be critical in understanding customers' behavior directly.

Since the data collection is automated and no human interaction is needed, the interviewer bias is eliminated. Also, there is no self-reporting during IVA data collection, so related biases such as social desirability, rating and recall bias are no longer a concern. There is literally no response needed from the audience so non-response bias is also eliminated.

The IVA imitates the Observation Method of market surveys without the observer's bias and providing more reliable and accurate data. This enables the observer to focus on attributes that are not automatically captured.

5.2. Limitations and Future Research

Our objective was to demonstrate the types of data that IVA can capture, and to show how IVA can support market surveys and address the cognitive biases these surveys impose. Ultimately, our experimental results were able to demonstrate the capabilities and limitations of IVA. Since this research was limited to one software choice, Intel's Audience Impression Metrics (AIM) Suite Silver Edition, we were unable to evaluate the ability of other software programs to distinguish Asian and Western facial features (gender). In addition, our study sample was restricted to university students at NCTU, which showed potentially smaller age dispersions and different preferences than other audiences. However, these experiments can be

extended to test different software programs with distinct capabilities. As a next step, we would also like to conduct experiments comparing IVA software programs in different countries and in venues containing distinct demographics. As the use of IVA continues to proliferate, we may need to address new privacy and data-sharing concerns that were not present when we captured data anonymously in the current study.

In the future, we would like to design a theoretical framework to understand and quantify the impact of IVA on reducing biases and increasing efficiencies as a new decision support tool. We also plan to conduct more experiments in which we evaluate multiple survey methods.

References

[1] E. F. McQuarrie, *The Market Research Toolbox: A Concise Guide, 2nd ed*, Thousand Oaks, Sage Publications, California, 2006.

[2] P. M. Podsakoff, S.B. MacKenzie, & N. P. Podsakoff, Sources of method bias in social science research and recommendations on how to control it, *Annual Review of Psychology* **63***(2012)*, 539-569.

[3] D. Elliott, Intelligent video solution: A Definition, *Security* **47** (2010), 46-48.

[4] H. Liu, S. Chen, & N. Kubota, Guest editorial special section on intelligent video systems and analytics, *IEEE Trans. Ind. Inf*, **8** (2012), 1-90.

[5] ICC/ESOMAR, *International Code on Market and Social Research, 4th ed.*, ICC/ESOMAR, Amsterdam, 2008.

[6] W. Pride & O. Ferrel, *Foundation of Marketing 3rd ed.*, Houghton Miffin, Boston, 2009.

[7] P. Hoonakker & P. Carayon, Questionnaire survey nonresponse: a comparison of postal mail and internet Surveys, *Intl. Journal of Human–Computer Interaction* **25** (2009), 348-373.

[8] A. Bhattacherjee, *Social Science Research: Principles, Methods, and Practices*, USF Tampa Bay Open Access Textbooks Collection, 2012. http://scholarcommons.usf.edu/oa_textbooks/3

[9] J. R. Evans & A. Mathur, The value of online surveys, *Internet Research* **15** (2005), 195-219.

[10] W. Fan & Z. Yan, Factors affecting response rates of the web survey: A systematic review, *Computers in Human Behavior* **26(2)** (2010), 132-139.

[11] S. Hart, The use of the survey in industrial market research, *Journal of Marketing Management* **3(1)** (1987), 25-38.

[12] A. Gibbs, Focus groups and group interviews, *Research Methods and Methodologies in Education* (2012), 186.

[13] E. K. Macdonald, H. N. Wilson, & U. Konus, Better customer insight in real-time, *Harvard Business Review* **90(9)** (2012), 102-108.

[14] C. Cobanoglu, B. Warde, & P. J. Moreo, A comparison of mail, fax and web-based survey methods, *International journal of market research*, **43(4)** (2001), 441-452.

[15] M. G. Haselton, D. Nettle, & P. W. Andrews, The evolution of cognitive bias. In D. M. Buss (Ed.), *The Handbook of Evolutionary Psychology*, John Wiley & Sons Inc., Hoboken, NJ, US, 2005, 724–746.

[16] R. Rosenthal & R. Rosnow, *Essentials of behavioral research 3rd edition*, McGraw-Hill, 2008.

[17] http://www.rnrmarketresearch.com/intelligent-video-surveillance-isr-video-analytics-technologies-global-market-2013-2020-market-report.html

[18] http://www.prweb.com/releases/2020-intelligent-video/surveillance-market/prweb11056182.htm

[19] H. Liu, S. Chen, & N. Kubota, Intelligent Video Systems and Analytics: A Survey, 2013.

[20]A. W. Senior, L. Brown, A. Hampapur, C. F. Shu, Y. Zhai, R. S. Feris, et al., Video analytics for retail, *Advanced Video and Signal Based Surveillance* (2007), IEEE Conference, 423-428.

[21]https://aimsuite.intel.com/resources/knowledge-base

[22]M. De Mooij, *Global marketing and advertising: Understanding cultural paradoxes*, Sage, 2009.

[23]T. Macer, Development Impacts of Smart Technology, *International Journal of Market Research*, **54(4)** (2012).