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# In-Home Surveillance Systems and Privacy Considerations for Malaysians: A Survey

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**Abstract**—Always-on cameras, microphones, and devices are increasingly intruding on private environments due to their promising applications in regard with the better quality of life. But they can also be exploit by adversaries as surveillance systems, introducing a matter of concern for privacy. Intruders can observe and record in-home activities for further malicious aims. Due to this vulnerability, it is important that privacy issue in this case, being addressed properly. Since perception of privacy varies among different cultures, privacy priorities of each culture should be investigated separately. In order to provide a better insight into Malaysians opinions about their highly private in-home activities for designers of visual smart household systems, we conducted an anonymous survey with 217 respondents. In this paper, we discuss the outcomes of our survey in order to provide a reference for engineers working for the Malaysian market.

**Keywords**—Privacy, camera, smart home, Malaysians, survey

## I. INTRODUCTION

Nowadays, surveillance systems (mainly CCTVs) have established their contribution to physical security [1], and they have been widely employed by both governments and private

companies to overcome challenges caused by lawbreakers [2]. Rapid advancement of enabler technologies of a surveillance system, such as digital cameras, batteries, data storage formats and capacity, image processing techniques, and wireless communication, along with significant reduction in overall cost and ease of use for almost everyone, have extended the applications of surveillance cameras beyond intrusion detection system (IDS). These in-home surveillance systems are playing an important role in the realization of a smart home in its modern definition [3]. A modern smart home is considered to be more than just an automated cyber-physical system. It supposed to observe, understand, make proper decisions, and act in the right time, to contribute to the enhancement of the residents' quality of life in a meaningful way. In-home cameras are among main building blocks of a smart home system, since they are doing much of the observation in a smart home. Currently, usage of in-home security cameras has been adopted to either monitor residents for safety of elderly, monitoring kids and pets [4-6], or for enabling visual gesture detection systems for human-computer interaction [7]. Fig. 1 shows a schematic diagram of an in-home cameras system. Aside from promising benefits offered by in-home cameras in order to improve in-

home safety and quality of life, privacy concerns among researchers and users is on the rise [8, 9]. In general, domestic security cameras are relying on wireless networks as a data communication infrastructure and due to a well-known drawback of wireless communication systems, transmitted signals can be eavesdropped by adversaries and reveal secret messages to unauthorized parties [10-12]. Considering the fact that the home is the location for most private activities, data leakage from a home network can cause privacy violations, which can end up as a disaster, depending on the sensitivity of exposed information. For example, adversaries can extract the daily schedule of residents and exploit it in their planning to implement their malicious aims or force their victims to follow their orders via sensitive data exposure threat. As discussed above, potential privacy issues caused by in-home cameras need to be addressed and managed properly due to their high risk. Privacy preventive design (or privacy by design) can be considered as a frontier stage to overcome privacy challenges [13, 14]. For this, engineers need to have clear insight about end users' privacy requirements. As a matter of fact, perception of privacy cannot be generalized because it varies throughout different cultures, and it is evolving asynchronously through time around the world. Thus, the circle of privacy for each nation has to be investigated individually. Understanding a target nation's point of view in regard to their privacy concerns concerning in-home activities provides an informative insight for designers and developers to adjust their essential considerations align with requirements of their cultural target group.

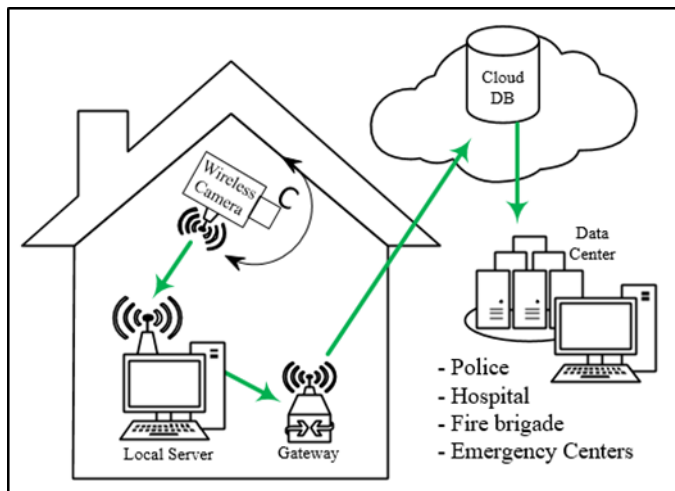


Fig. 1. Sample schematic of an in-home monitoring system

The key novelty of this research is that we conducted a survey among Malaysian citizens to investigate their privacy concerns in the presence of cameras in their private environment and to provide an empirical basis for researchers and designers. To the best knowledge of the authors of this article, our work is novel in sense of its investigated target group (Malaysian citizens). In the literature, there are two similar works, done only in scope of U.S. citizens [15, 16]. None of those works focused specifically on issues of in-home

cameras, instead, they considered all smart systems in a home to cover a broader scope. The rest of paper is structured as follows, Section II presents details about the content of survey, methodology and respondents. Results are discussed in the Section III. A comparison between the outcome of the survey among Americans and our results with Malaysians is provided in Section IV and conclusions are given in Section V.

## II. SURVEY

We used the manual approach to distribute our designed questionnaire among the target group. Sufficient time was given to each participant to answer anonymously. However, no compensation was paid, and all participants answered the questionnaire voluntarily. We considered the importance of variety in the distribution of respondents and tried to cover different ranges of Malaysians in terms of age, gender, race, education level, and income level.

### A. Recruiting Method

Around 400 questionnaires were distributed manually, mainly at Medini Iskandar, Johor. Participants were among various visitors to the shopping mall from all around Malaysia during a number of public events and visitors to the Imagineering Institute, a research lab, during events and visits. The surveys were distributed over four months. Also a subset of surveys were distributed at Universiti Teknologi Malaysia (UTM), Johor campus. We randomly invited Malaysians over 18 years old to participate in our survey to minimize focus of our research on a specific group (e.g. students only).

### B. Questionnaire Content

In the prepared questionnaire, we started with a declaration of terms and conditions to make sure all participants answered with awareness and consent. In the following section, we asked for demographic information, including gender, age, education level, job title, monthly income, race, and living status. Then, in order to aid respondents to imagine living situation in a smart home equipped with monitoring cameras, the following description was provided by us:

“Smart home, is a fully automated home enabled by artificial intelligence, to provide better in-home services. Embedded sensors will be everywhere to monitor almost everything. Collected data will be utilized for understanding residents' needs and lifestyle. However, possibility of data leakage cannot be neglected. Leaked data, can be misused for malicious purposes by adversaries. And it is a form of invasion of privacy.”

Finally, we continued by asking the question below:

“Imagine a future where you live in a smart home in which all your activities are monitored by cameras and

microphones; what are the top activities that you would not want to be recorded?"

Because we did not offer any compensation and participants had limited time, we kept our survey brief. Instead, we asked them to share their thoughts on the question above freely.

C. Respondents

In total, 235 surveys were collected from the respondents. After excluding invalid answers and responses which did not comply with the terms and conditions, 217 of surveys were considered valid.

The split of respondents on gender was 48.4% female and 51.6% male. In regard to race, 48.39% of respondents introduced themselves as Malay, 41.94% Chinese, 5.53% Indian, and 4.15% other race. Respondents in the range of 18 years old to 20 years old formed the most populated age group with 43.72%. The number of respondents reduced by age range increments as follows: 34.42% for ages between 20 and 30 years old, 17.67% for range of 30 to 40 years old, and 4.19% for elder than 40 years old. Job categories of respondents were as follows: student (43.43%), management-related (12%), academic (11.43%), business-related (9.71%), technology-related (9.14%), and artist (4.57%), followed by other occupations such as architect, housekeeper, and chef. In terms of income range, the majority declared their income somewhere between MYR5000 and MYR 10000, while the rest consists of 3.08% for income less than MYR 5000 and 9.74% for who earn more than MYR 10000 per month. In regards to education level, bachelor degree holders are on top with 61.06%, next is holders of postgraduate degrees (27.4%), and 11.54% were lower than bachelor degree. Fig. 2 presents the demographic information related to respondents.

III. RESULTS

A. Activity Categories

Based on activities that respondents claimed they do not want to be observed and recorded by cameras, we adopted 16 categories from a similar survey done among Americans [15]. Table I shows the breakdown of all categories formed from all mentioned in-home activities. In terms of privacy concerns, the top five categories are personal hygiene, sleep, all activities, self-appearance, and intimacy. And 82.67% of all expressed concerns fall into this group of categories. We discuss each category as follows:

*Personal Hygiene.* This category includes activities like taking bath, showering, grooming, and toileting. And it covers 34.06% of all expressed concerns by 50.69% of respondents. It is notable that, these activities were described frequently along with nudity related items.

*Sleep.* This category consists of activities such as sleeping, napping, laying on bed, or staying up late. 39.17% of respondents expressed their privacy concerns related to this category, and in total, it forms 26.32% of all concerns.

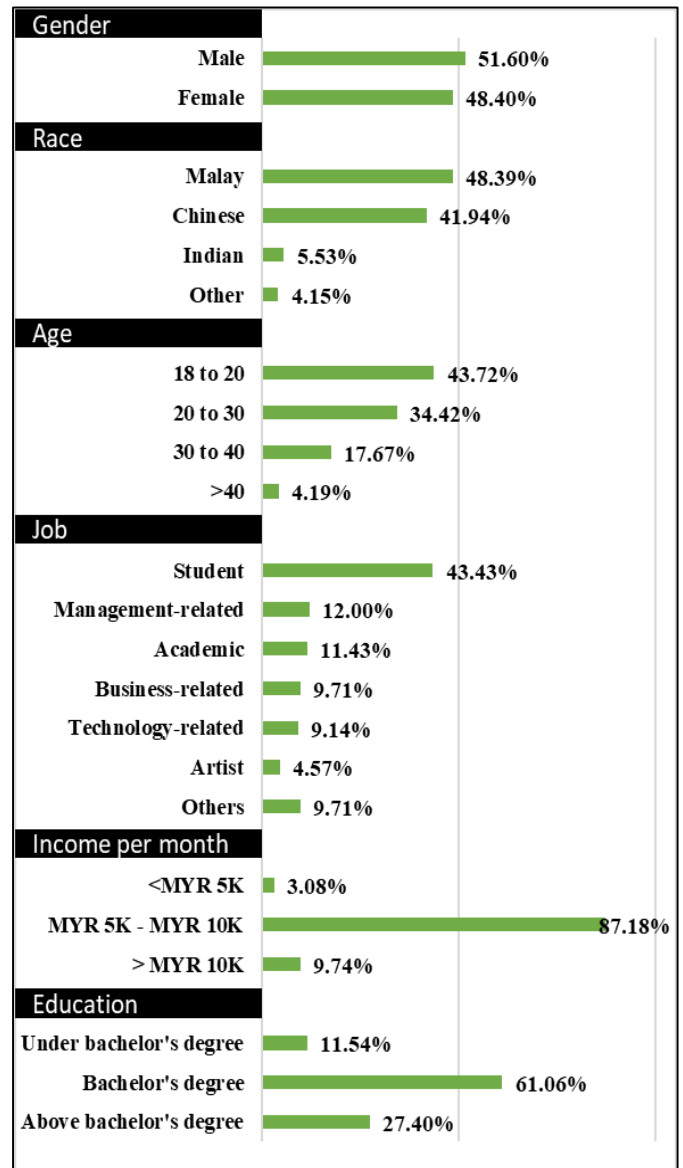


Fig. 2. Demographic information of participants

*All Activities.* 12.9% of respondents totally disagree with utilizing monitoring cameras in their living environment. They mentioned everything they do in their home is considered private for them and there should not be any recorded video about those activities.

*Self-appearance.* Example activities in this category are nudity, changing clothes, and wearing underwear, and its share is 7.12% of all concerns, mentioned by 10.6% of participants.

*Intimacy.* All activities similar to having sex, kissing, masturbating fall into this category and it has 6.5% shares of all concerns. 9.68% of respondents considered these kind of activities matter of concern.

Other categories in order are: oral expression (4.64%), cooking and eating (4.02%), media use (2.17%), working (2.17%), family activity (2.17%), physical activity (0.62%), guesting (0.62 %), spirituality (0.31%), contentious acts

(0.31%), and unwinding (0.31%). These categories all together have 17.33% shares of all concerns.

Here are few sample quotes from respondents on their own word:

“Why you want to make something no one have the privacy?”  
-20, female, student

“I need privacy. Outside security camera is enough!”  
-26, male, teacher

“Feel uncomfortable. Do not want to be monitored”  
-20, female, student

“It is a great improvement. But as a Muslim woman, we should cover ourselves all the time, it is disturbing” -20, female

“Can be convenient but not feel relax in everything being recorded” -40, female, admin

“Taking bath, my private activities, I am shy, shy!”  
-19, female, student

TABLE I. BREAKDOWN OF ACTIVITY CATEGORIES

Activity Category	Number of Mentions	Concerns (%)	Respondent (%)
Personal Hygiene	110	34.06	50.69
Sleep	85	26.32	39.17
All Activities	28	8.67	12.90
Self- appearance	23	7.12	10.60
Intimacy	21	6.50	9.68
Oral Expressions	15	4.64	6.91
Cooking & Eating	13	4.02	5.99
Media Use	7	2.17	3.23
Working	7	2.17	3.23
Family Activities	7	2.17	3.23
Physical Activity	2	0.62	0.92
Guesting	2	0.62	0.92
Spirituality	1	0.31	0.46
Contentious Acts	1	0.31	0.46
Unwinding	1	0.31	0.46
<b>Total</b>	<b>323</b>	<b>34.06</b>	<b>*</b>

\*Respondents were allowed to mention more than one concern.

B. Demographic and Activity Categories

Table II provides information related to three selected demographic data (sex, race and age) of respondents and the first five categories of sensitive activities. It is considerable that the number of respondents for each gender is almost equal (F: 48.38%, M: 51.61%), but the importance of preserving privacy for activities in self-appearance category is much higher for

females; their difference is 21.74%. On the other hand, males are more concerned about their intimacies; the difference is huge (71.42%). The reason behind this outcome might not be because females do not care about privacy of their intimacy activities, but it might be due their cultural or religious beliefs, not allowing them to express it in a survey, even anonymously.

TABLE II. TOP CONCERN CATEGORIES AND DEMOGRAPHIC

Categories		Personal Hygiene	Sleep	All Activities	Self-appearance	Intimacy
Total activities		110	85	28	23	21
Sex (%)	Male	50	45.88	46.43	39.13	85.71
	Female	50	54.12	53.57	60.87	14.29
Race (%)	Malay	54.21	51.76	32.14	60.87	61.9
	Chinese	41.12	42.35	64.29	34.78	28.57
	Indian	3.74	2.35	-	4.35	9.52
	Other	0.93	3.53	3.57	-	-
Age (%)	18~20	49.09	45.88	19.23	50	52.38
	20~30	30.91	23.53	61.54	33.33	28.57
	30~40	17.27	27.06	11.54	16.67	14.29
	>40	2.73	3.53	7.69	-	4.76

IV. DISCUSSION AND COMPARISON

As mentioned before, there is a similar work in the literature, with a scope limited to American citizens [15]. Since in this work, we are following the same structure of categorizing of activities, this similarity enables us to compare our results with theirs with clarity. Considering privacy matters, the top five categories of in-home activities that Malaysians do not want to be recorded are personal hygiene, sleep, all activities, self-appearance, and intimacy (total, 82.67%). The top five categories for Americans includes self-appearance, intimacy, cooking and eating, media use, and oral expressions (total, 66.4%). Table III shows the results of these two surveys.



TABLE III. TOP CONCERNS OF MALAYSIANS AND AMERICANS

Scope	Activity Category	Concerns (%)	Place in the Other Survey
Malaysians	1 Personal Hygiene	33.33	7
	2 Sleep	25.76	9
	3 All Activities	8.48	19
	4 Self- appearance	6.97	1
	5 Intimacy	6.36	2
Americans	1 Self-appearance	22.5	4
	2 Intimacy	18.3	5
	3 Cooking and Eating	9.3	7
	4 Media Use	8.3	8
	5 Oral Expressions	8.0	6

According to Table III, the two nations are common in only two categories: self- appearance and intimacy. However, it seems the level of importance is different, where these categories are on top of the list for Americans, their position for Malaysians are four and five. In contrast, the two top groups of concerns for Malaysians (personal hygiene and sleep) are not in the top five groups for Americans.

V. CONCLUSION

In this paper, we presented the results of a survey given to Malaysians to gauge their opinions on camera surveillance of in-home activities. The novelty of this work is gauging the opinions of Malaysians on privacy issues in smart homes as compared with a previous similar study with Americans. We analyzed the distribution of activities in terms of importance for respondents in association with their demographic status. Also, the outcomes were discussed based on activity categories. This work provides a better insight for smart home system designers about what Malaysians think about utilizing cameras in their homes when it comes to privacy matters, based on an empirical study.

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