

Analysing the Innovation Growth of Robotic Pets Through Patent Data Mining

Teo Kiah Hwee, Mohan Rajesh Elara, Ricardo Sosa and Ning Tan

Abstract This study aims to illustrate the importance of patent data mining as a tool to analyse the innovation growth of robotic pets across time, countries and patent types. Such an approach differs very much from the traditional academic strategies which often technology centric focusing on validating incremental technical contributions with respect to a pet robotic system. To conduct this study, patents of robotic pets were retrieved and analysed. A period of 5 years, from 2009 to 2014, was defined as the time of reference to which the patents were extracted from the relevant patents database for analysis. The patent office of which the patents are registered and patent types were also used as indicators to further segregate the patents found in the database. The search gave a total return of 82 patents that were documented. Analysis done found that distribution trends indicates an overall increase in technology advancement made by companies, academic institutions and individuals from various countries to robotic pets. The results summarized in this paper is set to greatly benefit the policy makers in government agencies, and entrepreneurs to effectively manage the growth of this emerging market of robotic pet products.

Keywords Patent data mining · Pet robot · Robotic pet · Technology advancement · Assisted therapy · Growth

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1 Introduction

Animal Assisted Therapy (AAT) is a form of therapy that is deployed to help patient improve their social, emotional and/or cognitive functions. This is especially so in an aging population. However there are various difficulties when deploying such a therapy to a patient. As living animals are used in this therapy, certain issues such as safety of patient, maintenance for the animal and allergies to the animal's fur hinders the success of such a therapy. Therefore, in order to remove the difficulties and still be able to achieve the same success, the Artificial Animal Assisted Therapy (AAAT) was introduced. Thus this is also where robotic pets comes into play as they are designed and built to behave like the animal that it is supposed to represent.

Over the years many robotic pets have been developed [1, 2] and placed into the market [3, 4]. The different varieties and features allow users to choose the type that suits their purpose. However, in AAAT, one of the main purpose of the use of robotic pets is to provide companionship. Through companionship, it hopes to achieve the goal of the therapy. In order to come up with more variations of robotic pets and to have improved features on existing ones, innovation is one main ingredient that can't be missed. There are many firms in the world that deals with the creation of robotics. All of these firms compete to show that their technology in robotics are more superior to the rest.

If innovation is an important element of the success and future of robotic pets, it is imperative that studies must be done to reflect the importance of innovation to senior management of robotics firms that being innovative is one of the main aspect to ensure success in robotic pets. Such an effort towards mapping innovation growth through patent analysis has yielded positive results in other industries [5]. In order to show that innovation is an important fact, this paper will provide a study by gathering patent data related to robotic pets to depict how patent data mining can be used to explain the importance of innovation in the robotic pets industry and to show what does the future holds for the industry.

2 Study Methodology

To conduct the study in this paper, patent data were collected from the Google Patent database. Patents were gathered from different countries between the period of 2009 and 2013. Multiple keywords were also used, such as, pet robot, robotic pet, companion pet and companion pet robot, to gather relevant data on robotic pets. Manual analysis will then be done to make sure that the patent results are relevant to the subject matter and are within the scope of study. After doing individual searches on each keyword, the results show that a total of 82 patents that were filed and published over a period of 5 years from 2009 to 2013 and were relevant to robotic pets.

3 Results and Discussions

3.1 General Overview of Robotic Pet and Tools Derived from Global Patent Information

The results of 82 patents from the patent data search were compiled into a summary dataset and is illustrated in Table 1.

From the dataset, we can see that a total of 222 patents were filed and/or published during the period of 2009–2013. 28 patents were filed in 2010, which make it the year with the most patents being filed. The general overview of the whole dataset shows that there is a good spread of patent activities that span across the 5 years. This also indicated that the technology growth of robotic pet is on a steady pace.

3.2 Annual Patenting Activities

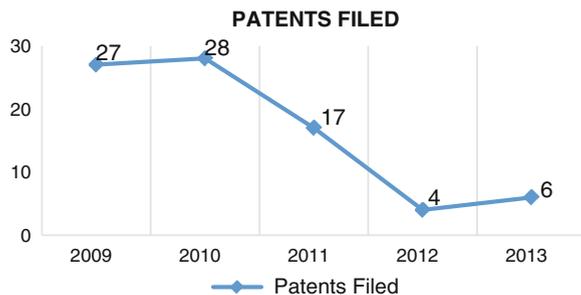
Using the results obtained from the search, an analysis was done based on the patents filing dates and publish dates. The two analysis were plotted in a graphical illustration to show the distribution of patents being filed and patents published over the 5 years. This analysis will provide the study with a better understanding of patent activities that occurred during the 5 year period.

From Fig. 1, we can observed that there was a steady number of patents being filed in the year 2009, with 27 patents and year 2010, with 28 patents. From this we

Table 1 Summary of dataset found on robotic pets

Time frame	2009–2013
Number of patents filed and published	82
Peak year	2010 (28 patents)
Top country	Japan
Patent offices	6
Years	5

Fig. 1 Distribution of patent filed over time

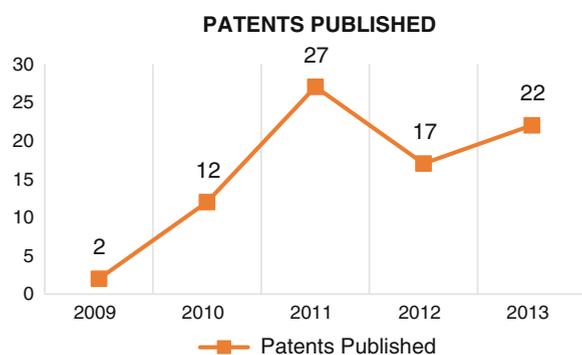


can infer that the innovation of robotic pet technology has been explored even before 2009 and 2010. The filing dates of a patent are only an indication of when the patent application was submitted. It doesn't indicate that the technology was invented and explored then. Therefore, we know that inventive activities of robotic pets came about way earlier than the 5 year period of study. Despite the fact the study only covers a period of 5 years, it is sufficient for us to say that from the year 2009 onwards, the technology of robotic pet have showed great progress. Although according to Fig. 1 there is a rather steep decline in patent applications from 2011 onwards till 2012 and only slightly pick up on 2013, it doesn't mean that there was a decline in overall patent activities and technology growth decline. If we look at Fig. 2, it is observed that there was a peak in patents being published in the year 2011 and followed by a steady spread in 2012 and 2013 as well. Therefore, we can infer that there is no sign of a decline of patent activities from 2010 onwards. In fact, we can say that the two charts correspond to each other as from the manual analysis done on the search results, we observed that most of the patents filed during the peak period of 2009 and 2010, were then published in 2011 onwards.

In both Figs. 1 and 2, it can be observed that there was a pick-up of patent activities in 2013 for both patents filing and patents publishing. From this, it can be inferred that such growth in patent activities could only mean that companies are looking into bringing robotic pet technologies to a greater height, exploring new means to of improving existing robotic pet technologies. To support this claim, a search was done on the current market trend on robotics in general. From the search results, it was observed that researchers believed that there will be an influx of robotics product over the next 10 years and robotic pets such as the SONY AIBO dog will be more visible as well.

In this modern era where new technologies are surfacing at a very fast pace, many technology companies will want to have their creation and invention protected so as to avoid technology infringement from other companies. Therefore, companies put up patents for their technologies to acquire the protection that patents provide. All these are part of the Intellectual Property Rights (IPR). An increase in patent activities also means that companies are more aware of the IPR and are more afraid of their technologies being copied. With their technology

Fig. 2 Distribution of patents published over time



protected, they have every right to the technology and will be ready to file a law suit with any companies that are deemed to have infringed on the patented technology. A very good example of IPR at play would be on two of the largest smart phone companies, Apple Inc. and Samsung, where they have sued each other on multiple occasions on patent infringements. However, it is not an easy task to determine if a patented technology has been infringed as two different technologies could be very similar to a staggering point but at the same time are distinct in their own ways [6].

The increase in patent activities could mean that there is a higher demand in robotic pets by the market. Existing robotic pets would also need to improve to provide better features to accommodate to the demands of consumers. Many consumers are seeking robotic pets for features far more advance than before. Robotic pets that are currently in the market have features that far surpass those in the past. Robotic pet can now be used on different fields like therapeutic, companionship or military applications. Robotic pets like PARO the seal developed by the National Institute of Advance Industrial Science and Technology (AIST) is an example of a therapeutic robotic pet that administer animal therapy to patients in different environment [7].

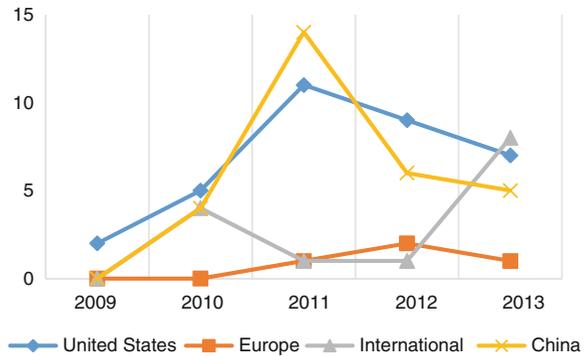
3.3 Geographical Distribution of Patents

The understanding of the geographical spread of the patents activities will provide a better observation on the trends of companies acquiring patent protections on their technology to give a better insight of where their products would likely be marketed. Therefore, a graphical illustration was drawn to plot the geographical spread of patent activities in 6 different patent offices over the 5 years. Through the graph plotted, it will be able to show which patent office has the most number of patents filed in each of the 5 years.

Figure 3 illustrates the patent activities of different patent offices over the period of 5 years based on the publication date. The 4 trends were based on 6 choices available on Google Patent, of which, two patent offices, Germany and Canada were not shown on the graph because no patents were filed under the 2 patent offices. Also, International is not a patent office by itself. Patents results found under the International tab are formed by patents filed under patent office such as Japan or South Korea patent offices that has a much smaller patent database that is not an available choice in Google Patent.

From Fig. 3 we can observed that patents filed under the Europe patent office has remained at a steady pace over the 5 years. In the case of United States and China, it can be observed that patent activities started increasing from 2010 onwards, reaching a peak in 2011, then followed by a gradual decrease in 2012 onwards. However, for the case of International, where patents are filed and published in patent offices from Japan, Taiwan and Korea, with Japan having the most patents published. It can be observed that the trend was on a steady pace throughout the first 4 years and then followed by a steep increase in 2013.

Fig. 3 Geographical distribution of patent activities



One reason for the different trends to show such a behavior is because, most companies, even those that are not of US origins used to file their patent applications with the United States patent office making them US or patents. This shows that the robotic pets market were dominant in the United States. However, the decline in US patents and increase in Japanese or Korean patents indicate that companies of these countries are slowly moving the market back into their own countries as well, allowing growth not just in United States, but within their own countries as well. From this, it can also be observed that quite a number technology companies have origins from Asian countries like Japan and Korea. For the case of China, the observation made was that there was a rather steep decline on patent activities in 2012 after its peak at 2011 with the highest number of patent activities recorded. Chinese technology companies have always been trying to develop their own inventions, trying to compete with foreign markets. This would explain the peak in patent activities in 2011. The decline in patent activities could mean that China is slowly moving its R&D focus out of robotic pets and more on other form of technology like smart phones. Thus, lesser patents activities were recorded in recent years.

Each patent office has their own patent system and each system provide different types of patents. Typically, a patent office will provide three types of patents, design patents, plant patents and utility model patents. Design and plant patents are available in every patent system in the world, whereas utility model patents are available in 77 countries with extensive usage in some European countries, Japan, China and South Korea. It is therefore, important to consider the available patent system in these patent offices when analysing their patent activities.

Utility model patents are usually more sought after because of the protection it provides for the utility and functionality of the invention. Most companies will want to prevent their competitors from coming up with a product that differs in their own design, but has the same functions. This type of patent is especially suited for small and medium enterprises (SME). To many SMEs, acquiring patent protection for their technology is a very stringent and costly process. However, they are not able to do away with patent protection for their technology. This is where utility model patents becomes a suitable choice for SMEs. The process to acquire a utility model

patent is much less stringent as compare to other forms of patents. The cost of filing for such patents are also significantly lower. A utility model patent can be obtained 6–8 months upon application. This is well suited for SMEs who makes “minor” improvements and adaptations to existing products, who may not have met the inventive step requirement of a patent [8].

3.4 Comparative Analysis of Patent Output

3.4.1 Patents Filed in United States

Out of the 36 patents filed in the United States patent office from 2009 to 2013, only 19 % of the patents filed were by domestic assignees or applicants. The majority of patents filed in the United States patent offices were of foreign origins. Among the foreign applicants, Netherlands, Israel and China filed 3 % of the total patents, Hong Kong with 8 %, both South Korea and Taiwan filed 14 % and Japan who file the biggest percentage of patents at 36 %. Further segregation of the patents based on the type of applicants also indicated that 81 % of total patents filed are by commercial manufacturers, and 19 % are filed by individual inventors. Figure 4 illustrates the distribution in the United States patent office.

3.4.2 Patents Filed in Europe

All of the 4 patents filed in the Europe patent office over the 5 years are all of foreign origins. Of which 3 (75 %) patents are filed by commercial manufacturers, only 1 (25 %) patent is filed by an individual inventor.

Fig. 4 Distribution of patent activities in United States patent office

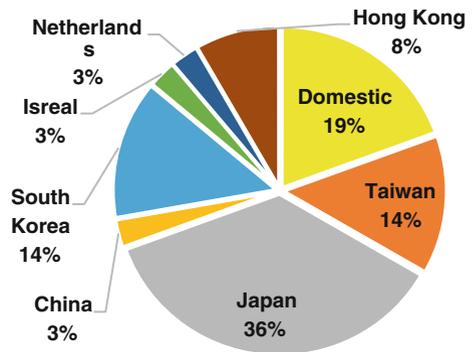
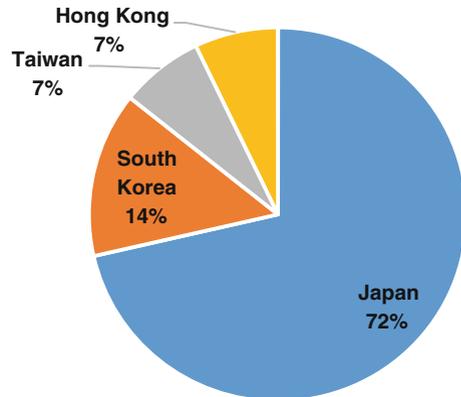


Fig. 5 Distribution of patents filed internationally



3.4.3 Patents Filed Internationally

Of the 14 patents that are filed internationally, 72 % of patents are filed in the Japanese patent office. 14 % of the patents are filed in the South Korean patent office. Both Taiwan and Hong Kong patent offices have 7 % each of the total patents filed internationally. 79 % of the total patents filed internationally are filed by commercial manufacturers, 21 % are by individual inventors. Figure 5 will illustrate the distribution of patents that are filed internationally.

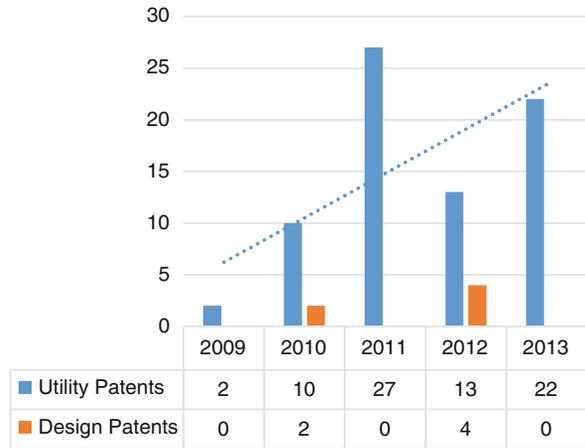
3.4.4 Patents Filed in China

The total number of patents filed in China patent office 29. Of which, 20 (69 %) patents were filed by commercial manufacturers which included foreign applicants mainly from Japan. The remaining 9 (31 %) patents were filed by domestic inventors.

3.5 Technology Analysis

By understanding what kind of technology relevant to robotic pets are being patented, it will allow the study to better understand the direction of technology advancement for robotic pets. To understand this, technology analysis is done using the type of patents being filed in the different patent offices. 76 out of the 82 patents found were listed as patent of inventions, which according to United States Patent and Trademark Office (USPTO) is also referred to as the utility patent [9]. The remaining 6 patents are listed as design patents. Figure 6 illustrate the distribution of the patents based on their patent types.

Fig. 6 Distribution of patents based on patent types



From this, it can be observed that over the given time frame of 5 years from 2009 to 2013, there are more utility patents filed as compared to design patents. The difference between the two is quite significant. The most number of utility patents filed were made in 2011. Through this observation, it can be said that technology advancement have been increasing steadily every year. Although there was a drop in 2012, it quickly pick up in 2013. This shows that technologies companies are constantly exploring into new technology advancements of robotic pets.

4 Conclusion

In conclusion, we can observe that the overall patent activities related to robotic pets have generally increased over the given time frame of 5 years from 2009 to 2013. There are a few factors behind the increase in patent activities over the years. One of the main factors that causes the increase of patent activities could be that there is an increase in demand for robotic pets by consumers. With the advent of computing, sensing and miniaturized electronics hardware, there is an increasing trend to accommodate more features into robotic pets and extend to new innovative application scenarios. From the patent analysis, we could validate that trend as the application domain seems to have shifted from purely entertainment to elderly companionship and therapeutic scenarios. Also, it can be witnessed that a vast majority of pet robot related innovations arise from Japan and/or Japanese companies. Patents activities made by Japan in the United States patent office alone took up 36 % of the total patent activities made throughout the 5 years, let alone the number of patents filed by them in other patent offices.

This paper presents our results from patent data mining experiences to analyze innovation growth of robotic pets over time, countries, and patent types. The work presented here is novel and differs entirely from the traditional technology centric

validation studies in core robotics domain. With large number of national level initiatives across several developed countries towards developing robotics market aimed at handling aging societies, the results presented in this paper is expected to be highly useful for policy makers and entrepreneurs in managing this new market segment of robotic pet products. Future work would include deeper analysis of core technology orientation of considered countries, their commonalities and difference over years. Another possibility of future work would include study of correlation between the preferred morphological form and cultural orientation of the nations considered.

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