

Research and Development

Who is Looking at Speech?

Study Finds Two Distinct Types of Corporate Technological Positions in the Speech Industry

By Konstantinos Koumpis

In the early stages Automatic Speech Recognition (ASR) and Natural Language Processing (NLP) technologies were approached by firms through extensive exploration and experimentation rather than through targeted development. This fast growing industry so far has been analyzed by several vendors and consultants using mainly qualitative data. In this article we present a different approach [1] exploiting *quantitative* data. Corporate goals and changes in the technological environment are better figured by patenting and publishing performances which are reported here, along with the results of an Internet based survey designed for executives and researchers.

The patent data were collected using the Bibliographic Database, which contains all US patents issued from 1976 onwards. We assume companies are competent in the given technical field when they are granted five or more patents between 1976 and 1997.

Firms' policy to publish selectively has been used in order to evaluate their level of activity in the field, as well as the level of collaboration with other research centers or universities. The research paper's data were collected mainly using the BIDS ISI Service for six journals and the IEEE ICASSP conference from 1982 onwards.

All major companies were informed about the survey via email, while it was announced repeatedly over a time period of three months in the most closely related electronic newsgroups.

Speech Industry Profile

There were 53 industrial participants in the survey from 51 different firms. 55% of them were senior researchers or developers, 30% presidents, directors or VPs of R&D and 15% product/marketing managers. The responses showed that, apart from the corporate decision to get involved in this area of research, 14% of companies began their lives as university spin-offs and 20% began as specialized in ASR&NLP firms.

The survey showed that, although 40% of the responses indicate very small companies or exploratory activity, departments with over ten researchers might be developing real life

applications. Interestingly, the survey showed that 65% of the companies managed to deliver their first complete product to market during the past five years, while 18% of them are currently conducting research without having any product in mind yet.

Tacit knowledge in ASR&NLP is a very important factor, as executives and researchers explained their success to be based on the quality and commitment of their employees. A speech technologies department has in average 27 Computer Engineers, 6 Linguistics Scientists and 2 Psychologists / Cognitive Scientists.

Although two thirds of companies work in English language systems, they have started transferring their applications into other languages seeking new markets. Reaching global markets will require applications customized for many languages.

The survey participants recognized other companies as major competitors in the following sequence: IBM, L&H, Dragon, AT&T/Lucent, Philips, ALTech, Nuance, VCS, PureSpeech, Microsoft, Sony, Apple and NEC.

National and Regional Patterns

Analysing the patenting data in ASR&NLP from a geographical perspective, the US dominance in the field was clearly confirmed with 43% of all patents granted. Japanese firms have the 34% of patents, while the third country (UK) has only 2%. Germany has 1.11%, Canada 0.63%, Netherlands 0.48%, France and Sweden 0.32% and all the rest countries 17.46%. Although the performance of Japanese giants (Hitachi, Toshiba, NEC, etc.) in patenting is very high, any related market penetration has not detected either from survey participants or from industry newsletters. Research activities in Japan are concentrated more on hardware than on software development.

Inside the USA, New York, New Jersey, California, Massachusetts and Texas are the regions with the highest patenting rates in ASR&NLP. Their high performance (with the exception of California and Massachusetts) is explained by the proximity of the American IT giants, such as IBM, AT&T, or TI (figure 1). 65% of patents in New York State belong to IBM, 73% in New Jersey to AT&T, 50% in Texas to TI and 100% in Illinois to Motorola.

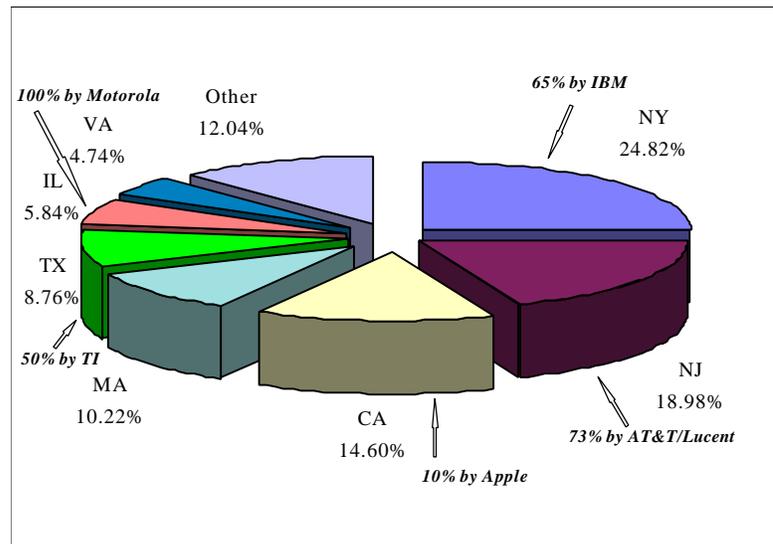


Figure 1 Regional Patenting Patterns within the US and the respective Contribution of Large Firms

In California and Massachusetts the pattern is different. Most of the top ranking small firms are located there, as funding from the ARPA program gave a boost to academic entrepreneurship. Consequently, the emergence of successful specialized firms depends heavily on the strength of universities and public research institutes in the related sciences, and less on large firms found in the same region.

The Coexistence of Very Large and Small Firms

Applying the classification method proposed in [2] technological competencies of the firms in such a new industry result to the pattern shown in the figure 2. Along the Y-axis is the percentage share of ASR&NLP in the total patenting of the firm, reflecting the relative importance of the field in the firm's technological portfolio. Along the X-axis is the firm's revealed technology advantage index, which is defined as the firm's share in ASR&NLP patenting, divided by the firm's share of total patenting in all fields.

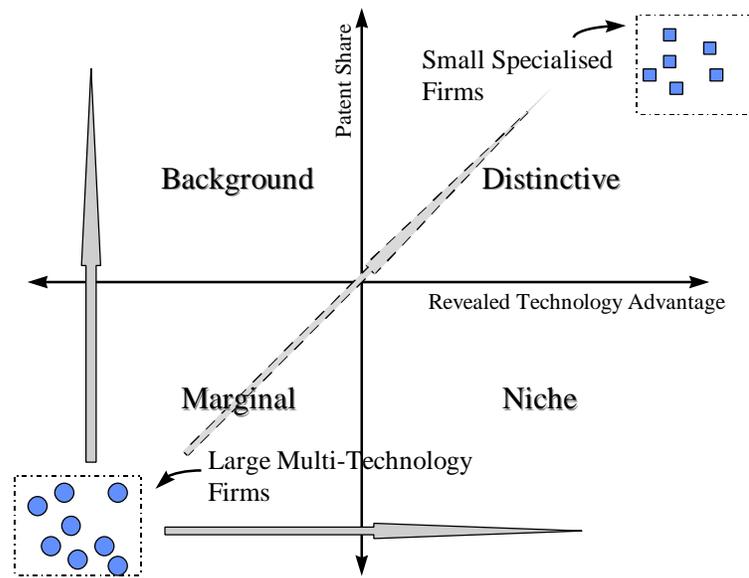


Figure 2 Technological Profiles of Large and Small Firms in ASR&NLP

There are two clusters of firms exist in this industry. For large firms in *marginal* quadrant, ASR&NLP consumes only a small proportion of corporate technological resources (at least so far). Eight out of top ten US patent recipients in all sectors (apart from Eastman Kodak and General Electric) during the period 1990-95 are also top ranked in ASR&NLP patents. For some of these firms ASR&NLP may emerge as a major opportunity for the future. They will have to decide whether they will move to either background or niche quadrants.

To move into the *background* quadrant firms will need to be able to co-ordinate and benefit from technical opportunities in the field, by combining them with their own competencies. Firms can move into the *niche* quadrant if they obtain a competitive position in a niche market with a relatively small share of corporate technological resources. This is because it will be impossible in the foreseeable future for large firms to move from their positions technological diversity to the *distinctive* quadrant for ASR&NLP.

They will therefore have two options, depending on the rate of progress in these technologies (especially NLP): 1.) if it is high, substantial investments (including those in complementary technologies) could open up massive market opportunities and 2.) if it is low, modest investments will allow them to exploit niche markets.

Companies such as Dragon Systems, L&H (Kurzweil), Threshold Technology, VCS Systems, Dialogue Systems and Emerson & Stem are classified in the distinctive quadrant. These are companies who are investing a high percentage (from 56% up to 100%) of their research portfolio in ASR&NLP.

These two clusters of firms can also be recognized in figure 3 where they have been classified according to their contribution in ASR&NLP and the importance of these technologies for the firm. Interestingly, all firms are found in a very narrow band (up to 7%), and none of them dominates the field. Among the technological leaders are automobile and consumer electronics companies. This reflects the recently acquired and rapidly growing technological competencies in ASR&NLP in non-IT sectors, which may give them a competitive advantage in both improved operations and products. In terms of the importance of ASR&NLP to the firm, figure 3 again shows us the split between the large, multi-technology firms, for whom speech represents 1.25% or less of their patents and small specialised firms for whom speech represents more than 50% of their patents.

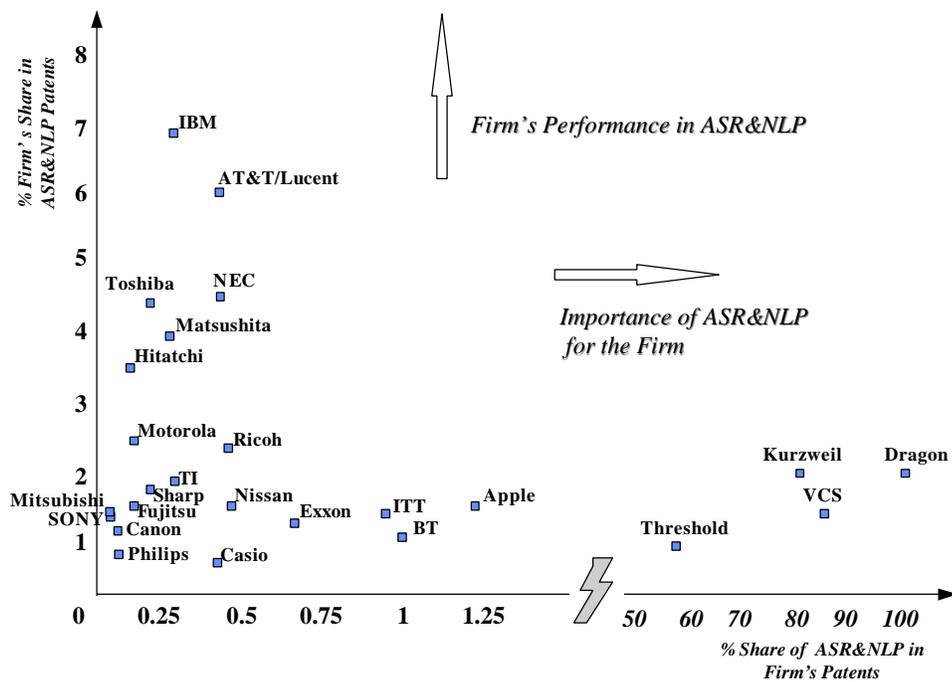


Figure 3 The Coexistence of Very Large and Small Firms in ASR&NLP

Considering the framework in [3], we conclude that many large corporations are currently committing relatively modest R&D expenditures in ASR&NLP to seek opportunities for profitable investments in the future. Many companies have established programs for the *knowledge building* stage, which requires relatively inexpensive research for developing and maintaining expertise in fields of potential future advantage. Fewer companies have moved to the *strategic positioning* stage, which involves applied R&D and feasibility demonstration, and is concerned with reducing technical uncertainties, identifying potential markets and building in-house competencies. Finally, even much fewer companies have moved to the stage of *business*

investment, where they are able to develop and distribute new and better products and have positive revenues from their R&D expenditures.

The progress in ASR has been spectacular, while NLP poses very difficult problems for researchers. The entire cognition process and other fundamental problems can not be solved simply by providing higher volumes of resources (e.g. as computing power in ASR). In NLP there is a high diversity among firms, especially in publications. The research task is profoundly difficult in terms of semantic understanding and contextual dependencies that are troublesome to integrate. However, the specialization of companies and universities in either ASR or NLP clearly indicates they are not recognizing how interdependent both technologies are.

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