Profiling China's AI Unicorns:
Megvii Technology Limited

Summary

Megvii Technology is a leading Chinese developer of artificial intelligence algorithms for facial recognition. Founded in 2012 by Yin Qi and two other students at Tsinghua University, Megvii developed the "**Face++**" application that has become the basis for popular mobile facial recognition apps as well as city surveillance and management systems. Megvii claims that 70 percent of Android apps in China have adopted its face-scanning technology. Although operating at a loss, Megvii has been attractive to Chinese and foreign investors and has a current valuation of perhaps two billion dollars. This report profiles the development of Megvii as a company, the facial recognition services that it provides and who uses them, and Megvii's plans for developing AI-enabled systems for new categories of enterprises.

Megvii's business model for Face++ is to make its application programming interfaces (API's) available for free while licensing software kits to developers to build apps to access the API's. Face++ services include face detection in an image, comparing faces for a match, mapping facial landmarks, emotion recognition, gaze direction estimation, and 3D face model construction. Megvii's products are used by major Chinese software companies such as **Alipay**, which uses Face++ for identity verification in its online payment system. Other companies use it for identity in computer login, dating apps, and ride sharing, and it is also used in photo editing and video sharing apps. Megvii claimed in 2017 that police use of its technology had resulted in the arrest of 5,000 wanted criminals.

Megvii made its way onto the radar of the U.S. government in 2019 due to its rumored support to face-scanning software used by police to track the Muslim Uyghur minority, an activity denounced by human rights activists. The White House placed Megvii on the Department of Commerce Entities List in October 2019, so that Megvii has lost access to American components, including chips from Nvidia.

Megvii is now building on its success with Face++ to develop AI applications for the sectors it calls the City Internet of Things (City IoT) and Supply Chain IoT. Megvii's City IoT is a network of software, sensors, and cameras to create a city management complex for traffic management, fire response, crime prevention, and potentially the monitoring of all citizens. Supply Chain IoT uses AI to help manage large networks of robots to support complex warehousing tasks and to optimize merchandise planning by analyzing customer behavior. These efforts have made Megvii a key component of China's pursuit of dominance in several high-technology fields.

Sources

This report is drawn primarily from materials provided on the Megvii Technology websites (megvii.com, faceid.com, faceplusplus.com) and from the "Application Proof of Megvii Technology Limited," the prospectus submitted in August 2019 with Megvii's application for its IPO on the Hong Kong Stock Exchange. This has been supplemented by information from mainland Chinese and international media news coverage, profiles, interviews, and financial reports.

China's Facial Recognition Field

Chinese analysis of the facial recognition market showed that it grew at an annual rate of 30 percent between 2010 and 2018. A 2018 worldwide facial recognition market research report identified China as the biggest consumer of facial recognition equipment, being about 30 percent of the world market. That share was projected to grow to about 45 percent by 2023.

As of early 2020, the leading Chinese facial recognition giants were SenseTime and Megvii. The chart below is one Chinese ranking published in January 2020 of the top ten companies in China in this field.

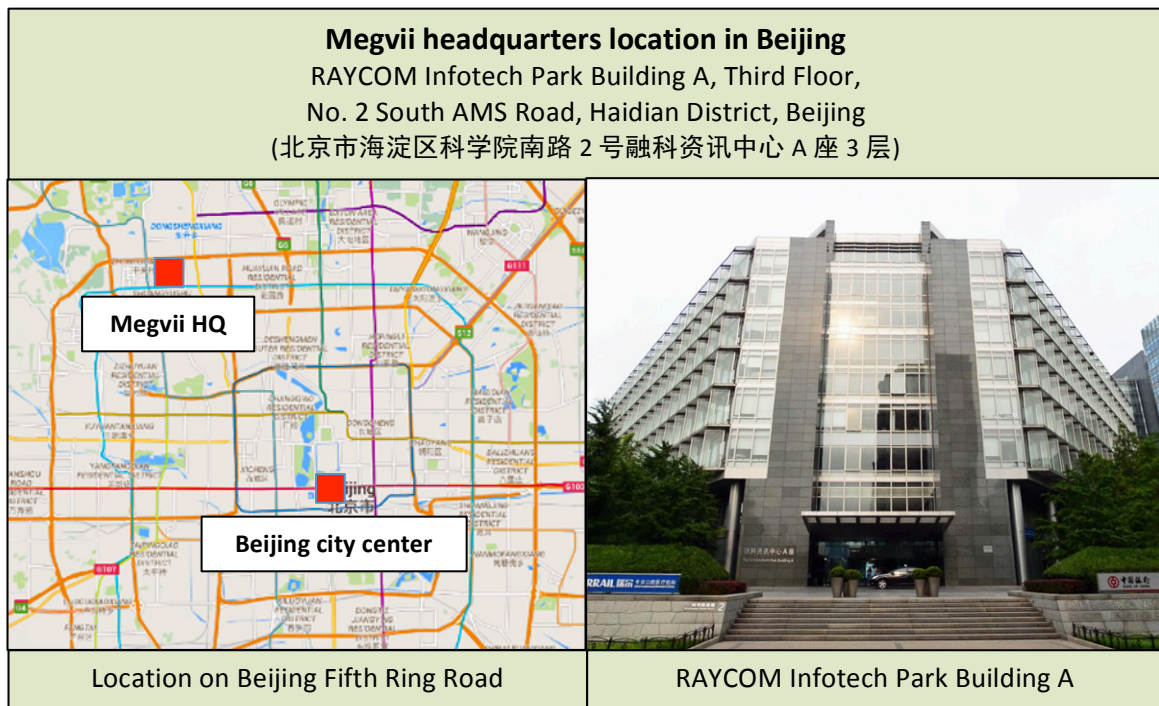| 2020 ranking of Chinese facial recognition technology companies	
1. SENSETIME TECHNOLOGY (商汤科技)	6. HIKVISION (海康威视)
2. MEGVII TECHNOLOGY (旷视科技)	7. YITU TECHNOLOGY (依图科技)
3. BAIDU INTELLIGENT CLOUD (百度智能云)	8. WARMNUT TECHNOLOGY (暖果科技)
4. ALIYUN [ALIBABA CLOUD] (阿里云)	9. CLOUDWALK TECHNOLOGY (云从科技)
5. TENCENT CLOUD (腾讯云)	10. HANWANG TECHNOLOGY (汉王科技)

Company Summary

The full name of the company is **Megvii Technology Limited**. The name "Megvii" is an adaptation by the founders of the English words "mega" and "vision." In Chinese it is written as "旷视," "kuang shi," meaning "wide vision."

While Megvii is known for being a facial recognition technology developer, it describes itself primarily as an AI company with a core competency in deep learning. Facial recognition capabilities are themselves the products of machine learning using a very large volume of face images. Megvii calls the system that they developed from scratch to perform this training "Brain++." They identify themselves as one of very few companies in the world that have developed a proprietary deep learning framework. This core has been the mechanism for developing the advanced AI algorithms that perform facial recognition functions, but Megvii uses Brain++ not just for facial recognition but for their three key verticals: Personal IoT, City IoT and

Supply Chain IoT. Personal IoT generally equates to their facial recognition services. City IoT and Supply Chain IoT are the broader AI-enabled services that Megvii is now developing.

Analysis in The Economist points out that some of Megvii's strength in facial recognition comes not only from elegant algorithms but from the image volume they have processed and the data labeling that Megvii has contracted. Megvii claims they have spent about $30 million for labeling services since 2016.

Megvii now claims more than 2,300 employees including 1,400 computer scientists, algorithm engineers and product developers. Its headquarters is in northwest Beijing just inside the Fifth Ring Road (see below). It is unclear how many of the employees are in the headquarters, since Megvii apparently has a suite of offices on the third floor and does not own the whole building. It has branch offices in the Chinese cities Chengdu, Hangzhou, Nanjing, Ningbo, Qingdao, Shanghai, Shenzhen, Wuhan, Xiamen and Xuzhou. It also claims to have a research team based in Seattle.

Megvii headquarters location in Beijing
RAYCOM Infotech Park Building A, Third Floor,
No. 2 South AMS Road, Haidian District, Beijing
(北京市海淀区科学院南路 2 号融科资讯中心 A 座 3 层)

Location on Beijing Fifth Ring Road	RAYCOM Infotech Park Building A

Sources: timeoutbeijing.com, baidu.com

The Evolution Of Megvii

Megvii got its start in the collaboration of three students at Tsinghua University: **Yin Qi** (印奇), **Tang Wenbin** (唐文斌), and **Yang Mu** (杨沐). Yin Qi, aged 31, obtained his bachelor's degree in computer science from Tsinghua University in 2010 and a master's degree in computer science from Columbia University in 2013. Tang Wenbin, aged 32, was a classmate of Yin Qi's and also graduated in 2010, then

received his master's degree in computer science at Tsinghua in 2013. Yang Mu, aged 30, was a year behind, graduating with his bachelor's degree in computer science from Tsinghua University in 2011 and his master's degree in engineering from Tsinghua in 2016. All three were part of a pilot program known as the Andrew Yao Qizhi Experimental Class in computer science. Professor Yao Qizhi (Andrew Yao) is a famous computer scientist who was himself educated at Harvard and is the only Chinese winner of the Turing Award.

Yin Qi and Tang Wenbin also worked as interns at the Microsoft Research Asia lab, Yin on image search technology and Tang on facial recognition. Tang was a gold medalist in the National Olympiad in Informatics in 2005 and served as the head coach of China's national team from 2007 to 2013. Yang Mu was a gold medalist in the International Olympiad in Informatics in 2007.

Megvii Technology's founders and current leadership team
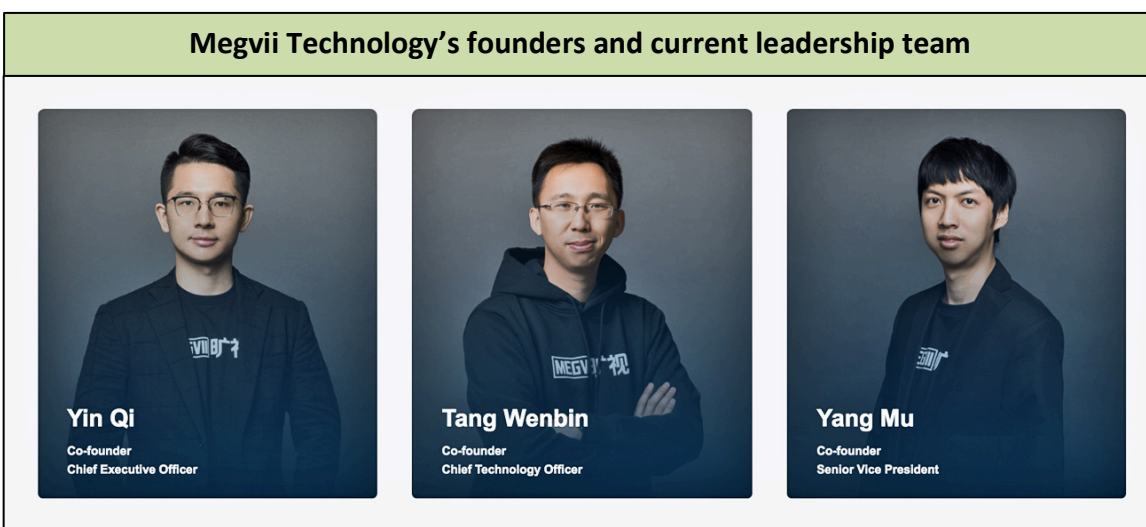
Source: megvii.com

Megvii Technology was formed in 2011 and Face++ was started by these three while they were still at the university. After graduating, Yin Qi went to the United States in 2011 to work on a doctorate in 3D imagery, studying part time and working on Face++ business from abroad. While there, he was reportedly motivated to put Face++ online by the investments he saw Google, Facebook, and others were making in facial recognition technology. (In 2013 Yin Qi had completed a master's degree at Columbia but quit his PhD program and returned home to work full time on Face++.)

In 2012 the team did put Face++ online and made its API's publicly available for free. By allowing developers free access to their service, they were able to build the large data sets necessary to refine their algorithms and also work out in which business sectors they could add value. Soon, Meitupic (image editing software), Jiayuan and Baihe (both dating sites), Kuaishou (video sharing app), and others were all using Face++e technology and providing feedback that helped refine its

functions. This assisted in working out what direction Megvii should be taking their technology.

A big break for Megvii came in 2014 as Alipay was looking for a solution for remote verification of identity and Face++ caught its eye. This started a major collaboration that was a turning point for their business. It also helped them see that the finance field could be truly profitable area to focus on.

Source: megvii.com

Face++ got another big boost in March 2015 at the CeBIT 2015 expo in Hannover, Germany, where Ma Yun (Jack Ma), co-founder and Executive Chairman of Alibaba Group, demonstrated the AliPay face-scan payment system whose underpinning was Face++. This was the biggest public exposure of this technology to the world at large, and it particularly fired the imagination of the Chinese financial sector. Soon Pingan Bank, CITIC Bank, Bank of Jiangsu, Xiaomi, Yirendai, China Telecom's Bestpay, and many other financial institutions became customers for face-scanning identity verification services.

Megvii was also making inroads into government security by providing intelligent decision-making systems based on vision to government departments including intelligence, command, and other internal entities. This included Megvii systems support to the 2016 G20 summit in Hangzhou and the 2017 BRICS Summit in Xiamen. Tang Wenbin further claimed in 2017 that Megvii-provided technology and products assisted police in the arrests of more than 5,000 escaped criminals.

Face++ Services

Throughout this period, Megvii built its reputation on the development of their facial recognition application called Face++. The business model for facial recognition services has been to make AI-enabled application programming interfaces (API's) available to developers for free, and to sell licenses for software development kits (SDK's) for customers to build applications to access the API's. The range of Face++ services offered, as Megvii describes them on their website (see below), goes well beyond identification of a face on the street and includes the following:

Source: megvii.com

- **Face Detection:** detect and locate human faces within an image and return high-precision face bounding boxes.

- **Face Comparing:** check the likelihood that two faces belong to the same person, returning a match probability.

- **Face Searching:** find similar-looking faces to a new face, from a given collection of faces.

- **Face Landmarks:** locate and return keypoints of face components including face contour, eye, eyebrow, lip, and nose contour.

- **Dense Facial Landmarks:** accurately locate facial features and facial contours, returning 1000 facial key points.

- **Face Attributes:** analyze a series of face-related attributes including age, gender, head pose, emotion, eye gaze, and ethnicity.

- **Emotion Recognition:** analyze and identify emotion of detected faces, producing confidence scores for several kinds of emotions.

- **Beauty Score:** compute beauty scores for detected faces from both a male and female perspective.

- **Gaze Estimation:** estimate eye-gaze direction, computing and returning precision eye center positions and eye-gaze direction vectors.

- **Facial Skin Status Analysis:** accurate analysis of skin status such as skin color, type, dark circles, wrinkles, acne, and skin spots.

- **3D Face Model Reconstruction:** based on 8,000 3D facial key points technology, a 3D face model can be reconstructed by using a single RGB image; the face surface information can be clearly described, and the real 3D model can be quickly output.

Sample specs for a Face++ API

Face Compare API (Version 3.0)
Compare two faces and decide whether they are from the same person. You can upload image file or use face_token for face comparing. For image upload, the biggest face by the size of bounding box within the image will be used. For face_token, you shall get it by using Detect API.

Image Requirements
Format : JPG (JPEG), PNG
Size : between 48*48 and 4096*4096 (pixels)
File size : no larger than 2MB
Minimal size of face : the bounding box of a detected face is a square. The minimal side length of a square should be no less than 150 pixels.

FaceID is a specific set of Megvii software solutions for the tasks of face verification and "liveness detection," the AI enabled practice of ensuring that the face being scanned is on a live human and is not a mask or image. Megvii claims that FaceID returns its answers within a few seconds and has a failure (false acceptance) rate of less than one in a million attempts. FaceID also performs ID card recognition, scanning both the face on the card and the textual identification data. Megvii claimed that by 2019 they provided Face ID solutions to over 1,100 business customers and were processing a daily average of 2.4 million Face ID verification requests.

Principal Customers

Megvii currently lists the following as major clients:

- **Alipay**: the leading online payment platform founded in China uses Face++ authentication technology.

- **Camera 360:** a popular photo editing and filter app that uses Face++ precision face detection and landmarks algorithms to help users edit face images.

- **UCAR**: an Uber-like ride-sharing service that uses facial recognition service by Face++ to smooth transactions and combat fraud and cheating.

- **Meitu**: popular photo editing application producer; uses Face++ on its smartphone MeituKiss and Meiyan Camera apps for facial enhancement.

- **Jiayuan.com**: China's largest dating website with more than 90 million users; the face searching technology provided by Face++ enables Jiayuan to help single persons find "faces they are fond of."

- **Lenovo:** computer manufacturer that turned to Face++ for a biological identification solution; with Face++, Lenovo's users can smile into their computers and directly log in.

- **Kuaishou:** the leading video sharing social platform in China; uses Face++'s high-precision facial landmarks and video beautifying technology for enhancing user videos.

In addition, Megvii counts **Ant Financial**, **Vivo** (smartphones), and **Didi Chuxing** (ride-sharing) as customers for the Face++ application. Megvii also claims that 70 percent of **Android apps** in China have adopted its face-scanning technologies.

Indicators of Megvii Expertise

Insights into the true nature of the company can come from a variety of sources. Their technological progress can be seen in part from the processes they have patented. Chinese media reported in January 2020 that Megvii has accumulated more than 1,100 patents of which 79 percent were inventions and 85 percent were based on their own in-house research. The strength of this work in the field was highlighted by reported citations of Megvii patents in the patent work of others including Qualcomm, Baidu Online Technology Corporation, Fudan University, and the China Academy of Sciences Institute of Automation Research.

The nature of their work can also be inferred from the work positions they advertise. In January 2020 Megvii was seeking talent to fill more than five hundred technical positions. The types of engineer and technical manager positions advertised at that time reflect the work specializations that are part of the Megvii operation.

Recent Megvii Positions Advertised	
Engineer Positions	**Technical Manager Positions**
3D Development	AI Appliances
Android Development	AI Traffic Control Products
CIS Back-End Technical Design	Deep Learning Platform Product Operations
CIS Component Design	Education Product Line
City Brain Solutions	Facial Recognition Entry Control Products
Deep Learning Systems Architecture	Higher-Education Cooperative Projects
Logistics Automation Systems	Industrial Park/Industry Projects
Embedded Algorithm SDK Development	Informatics Technology
Embedded Drive Software Development	Intelligent Logistics And Automation
Full Stack Lead	Logistics Automation Projects
Full Stack Development	Robotics Marketing
Hi-Res Mapping Algorithms	
Image Search Algorithms	
Informatics Architecture	
Logistics Simulation	
Optical Systems Design	
Screen Fingerprint Systems	
Visual Perception	

Megvii's Financial Status

Megvii has experienced explosive growth since its inception and is now categorized as one of China's primary AI "unicorns," start-ups that are valued at more than $1 billion. Although their services are popular and they have attracted many investors, they have been operating at a loss up to the present time.

The prospectus prepared for the 2019 Megvii IPO (now delayed) showed rapid growth in income over the previous three years from about $10 million (2016), to $45 million (2017), and to $200 million (2018). The prospectus also showed ballooning losses over this same period. Despite its status as a successful provider of AI solutions, it has consistently lost large sums of money every year. While they took in $200 million in 2018, their losses, also growing year by year, had reached $480 million for 2018. Megvii leadership explains this away by saying this was caused partly because of changes in the value of preferred shares. They claimed by eliminating impact of items that "our management does not consider to be indicative of our operating performance," they claimed an adjusted net profit of $5 million in 2018.

Megvii's valuation is based largely on large investments made in the company over the last four years. The principal funding rounds shown at right indicate the growing attraction of Megvii to financial players.

Megvii funding rounds		
Jul 1, 2014	Series B	$22M
Aug 1, 2015	Series B	$25M
Dec 31, 2016	Series C	$100M
Nov 1, 2017	Series C	$460M
May 8, 2019	Series D	$750M

Investors in the early years were mainland Chinese, but they have expanded their financing sources to include entities in Taiwan, Russia, Australia, and the Emirates. At present, Ant Financial and Alibaba Group (both Chinese) are listed as the primary outside investors with 15 and 14 percent of the company, respectively. The three founders retain partial ownership: Yin Qi holds 8 percent of stock, Tang Wenbin 6 percent, and Yang Mu 3 percent.

The actual current valuation of Megvii is unclear but has been given as at least $2 billion. One source listed its valuation as $3.3 billion even prior to the 2019 round of investments.

Known Megvii investors in chronological order of involvement	
Sinovation Ventures	Russia-China Investment Fund
Comet Labs	China Reform Holdings Corporation
Qiming Venture Partners	Ant Financial
Duane Kuang	Boyu Capital
Foxteq Holdings	Alibaba Group
Foxconn Technology Group	Macquarie Group
CCB International	ICBC Asset Management
Sunshine Insurance Group	Bank of China Group Investment
SK Group	Abu Dhabi Investment Authority

The U.S.-China Conflict and Megvii IPO

Conflict between China and the United States on trade and other issues has the potential for negative impact on Megvii's growth. In early 2019, Human Rights Watch (HRW) reported that Face++ technology was being used by a Public Security Bureau app in Xinjiang Province to verify identities in the Uyghur minority. This brought Megvii to the attention of the U.S. government which considered putting Megvii on the Department of Commerce Entity List. HRW later assessed that Megvii and Face++ were not part of the app or Public Security operations in Xinjiang.

Despite the changed position by HRW, the U.S. administration blacklisted Megvii and seven other Chinese tech companies in October 2019, accusing them of involvement in human rights violations against Muslim minorities in Xinjiang. Being on the Entity List means that Megvii has lost access to crucial American components, including chips from Nvidia. Megvii called the blacklisting "unsubstantiated" and Yin Qi told his company that he would fight against the US designation.

Despite these troubles, Megvii filed in August 2019 to list on the Hong Kong Stock Exchange and planned to raise $500 million in its initial stock offering. As of January 2020, Megvii had preliminary clearance from the Stock Exchange to move ahead with its IPO plans. Clearance was granted based on a recent change in Exchange rules that allowed a company operating at a loss to be listed. In its prospectus, Megvii does acknowledge the risks associated with investing in its company, including the U.S.-China set of conflicts and negative publicity about facial recognition technology in general.

In the midst of this turmoil, Chinese media still evaluates Megvii as a good bet. Commentary from January 2020 included a statement that:

> "Megvii Technology is a model investment, index AAA as a hard science investment. Megvii possesses a relatively strong capability for innovation, has a relatively strong technical team and a complete research and development system. Its capabilities in tech innovation have gained the approval of national and government organizations. Its reserve of patented assets is solid, its quality is high, operations are dynamic, and it has a very strong competitiveness in the market."

Megvii's Growth Vector: The AI-Powered Internet of Things

Megvii is in the process of transforming itself from a facial recognition algorithm provider into an artificial intelligence of things (AIoT) service provider. Chinese media quoted Yin Qi in 2018 as saying, "in two or three years, IoT could become production's core force, and AI could become a genuinely essential tool." His intentions were reflected in his purchase that year of Ares Robotics for supply chain AIoT development, a move that Forbes reported cost Megvii over $290 million.

Megvii has explained their move as an answer to the question of where they could add value: "Internally, we have considered many options. There are millions of things to we could do. However, in supply chain IoT the scale of associated business is big enough. Second, we have the ability to create value in this enterprise. In addition, the current conditions in this market aren't very good, so there's a lot of room for technical improvement."

Their vision is reflected in the categories of services now offered on their home website. Facial recognition technology is now called Personal IoT, and the other two categories show the direction of their mission expansion:

- **"Personal IoT.** We provide Personal IoT solutions to improve user experience on personal devices by empowering cameras with AI. Our Personal IoT solutions encompass algorithms and software. Our device authentication solutions allow users to conveniently unlock their devices or authorize online payments using facial recognition technology; and our computational photography and video processing solutions allow consumers to use their smart personal devices to take pictures or videos with quality comparable to those taken using professional cameras."

- **"City IoT.** We provide City IoT solutions to make cities and communities safer and more efficient by digitizing the urban space. Our City IoT solutions encompass algorithms, software, and AI-empowered sensors. Our smart city management solutions allow government agencies to enhance public safety, optimize traffic management and improve urban resource planning. Our smart community management solutions enable businesses to enhance the security of their properties and improve the experience of occupants and visitors."

- **"Supply Chain IoT.** We provide Supply Chain IoT solutions to make the supply chain more efficient through AI-empowered robots and sensors. Our Supply Chain IoT solutions encompass algorithms, software, and AI-empowered robotics. Our smart logistics solutions enable logistics companies and manufacturers to efficiently deploy and manage a large network of robots to support complex warehousing tasks. Our smart retail solutions enable offline retailers to improve service quality and optimize merchandise planning by analyzing customer behavior."

Recent Hong Kong media reports highlight the progress that Megvii claims it is making in each of these fields:

- **Personal IoT: "**Megvii's algorithms are used in 70 percent of the mainland China Android market and account for over 3.5 billion instances of facial identification and payments processes every day."

- **City IoT:** "Megvii services are used in more than 100 Chinese cities and 15 other countries and areas. Megvii enables 100 million instances of facial identification every day at entrances to residential communities."

- **Supply Chain IoT:** "Megvii AI-enabled the on-time delivery of over 1.5 million packages during a recent peak Chinese shopping day with the help of 400 robots."

Illustration of a Hangzhou "City Brain" display for firefighting responses

Source: Aliyun

One of Megvii's most successful relationship now is with **Alibaba**. Megvii leadership has stated that their vision is to become the artificial intelligence that powers China's smart cities. Face++ is integrated into Alibaba's City Brain platform, and Megvii claims it is being used to analyze the CCTV network in cities where it is deployed to optimize traffic flows and "see" incidents that require police or medical attention. Alibaba claims that the system has improved traffic speed by 15-20% in Hangzhou. Megvii also supports Alibaba's supply chain with its Hetu (River Map) system of 500 robots in the Alibaba Tmall warehouse, focused on reduction of human sorters' workload.

Comments

Megvii Technology is emblematic of a set of new Chinese companies that are focused on high-tech niches and are developing their own solutions. The three founders

started while still in university, reportedly honing their coder skills writing computer games. They leveraged a good education in artificial intelligence into a start-up business that soon gained a foothold in the Chinese market. Their growth has been rapid and even while operating at a loss they have become a major presence in the Chinese and international markets for AI-enabled systems.

While a relatively new company, Megvii seems to be rapidly pushing into development of a broader set of AI systems: City IoT and Supply Chain IoT. Their position in these markets is less clear, but they are actively advertising solutions in these areas. The Chinese appetite for these systems appears more than sufficient for Megvii to develop into a robust provider with a broad customer base inside China. Their claim to be doing business in 15 other countries is harder to verify, but given their experience in AI it is possible that Megvii could successfully penetrate the international market as well.

The Chinese government identified artificial intelligence as one of the key technologies is which they plan to foster development, attempting to make China the world leader in this field by 2025. It is unclear if Megvii has been the beneficiary of any "Made in China 2025" research funding, but it is certainly one of the leaders in Chinese AI development highlighted by that plan. In any event, its success in this discipline undoubtedly has made Megvii a valued resource in the view of Chinese leadership as they pursue dominance in high technology.