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Two heads are better than one

The Bronstein twins' facial-recognition technology promises to provide maximum precision and instant response - at a low cost. In the post-9/11 world, their product could be the next big thing in security systems

By Merav Sarig

Michael (left) and Alex Bronstein. "We've always done everything together since we were young, so it's hard for us to imagine it any other way." (Photo: Yaron Kaminsky)

The Bronstein brothers are a familiar and eye-catching sight around Haifa's Technion - Israel Institute of Technology. Identical twins Alex (the elder) and Michael, 22, have astoundingly similar mannerisms, share the same interests, study in the same department (electrical engineering), always take the same courses and earn virtually the same grades (within a tenth of a percentage point). One fellow Technion student says they're hard to miss as they stroll down the school's hallways: Dressed in matching gray vests, ties and sweaters, they clutch identical briefcases and are often laughing together over some private joke.

Under the direction of computer science Prof. Ron Kimmel, the Bronsteins have developed a 3D face-recognition system accurate enough to tell identical twins apart - the first system with such a capability. Most facial-recognition technology is based on two-dimensional photography and can be easily deceived by changes in lighting or head position. The Bronsteins' technology solves most of the problems of the existing technology and promises to provide maximum precision and instant response - and at a low cost, to boot. In the post-September 11 world, their product could be the next big thing in security systems.

But the tale of the Bronsteins is not just about genius; it's also an immigration success story. The Bronstein brothers and their parents came to Israel from Russia 12 years ago. Their father is a sailor and frequently away from home, and their mother, Olga, is an English teacher.

"We didn't make aliyah for Zionist reasons," says Olga. "Russia after Perestroika was a shattered country. You couldn't know what would happen the next day. We were afraid that because of the situation, people would be looking for a scapegoat and end up accusing the Jews, so we left."

To the boys, who were just 10 at the time, it was all a big adventure. "We were innocent kids who didn't really understand what was in store for us," says Michael, the more gregarious of the two. The family started out at an absorption center in Jerusalem, moved on to Kiryat Haim and finally to

Haifa. "We weren't aware of the difficulties involved in such a drastic change. You could say that we were immune to the hardships of making aliyah. We were happy to come here and now, looking back, I'd say it was one of the strongest and best experiences of our lives. And since we work in the sciences, there's even the advantage of working in a small country like Israel, where it's easier to stand out."

Things that blow up

Not that they weren't sent to music lessons (Alex: "We really love music, but we couldn't get the hang of playing any instrument"); or to classes in ballroom dancing (Olga: "I wanted them to be good dancers." Alex: "We were total failures at that, too"), but they became hooked on science at an early age.

At six, they constructed "this little robot that could move," recalls Michael. Then they became fascinated with anatomy. "We filled the house with models of human organs that we built ourselves from clay." Olga: "I'd come home from work and they'd be waiting for me with more models to bake in the oven."

The twins moved on from there to minerals. "We collected rocks and we had some fairly uncommon minerals," says Michael. "But when we made aliyah, we had to leave behind our rock collection."

After settling into life in Israel, they got interested in chemistry, says their mother. "Actually, we were interested in anything that blows up and we started to build things," says Michael. Their "armaments" were constructed of matches and gunpowder extracted from an M-16 bullet. "Our lab was an isolated field in Kiryat Haim."

"One night, I was home alone with the boys and I went into their room to see if they were sleeping," recounts Olga. "They were wide awake. I asked what the problem was and they said: `There's a bomb on the balcony and we're afraid it's going to blow up.' I didn't know what to do. I was alone, they'd made this thing and suddenly realized that it could be dangerous. We were very frightened. I called their grandfather, who was a chemistry professor in Moscow and I asked him how to neutralize the thing."

Alex: "That night, we swore that we'd stop the chemistry projects and instead we got an aquarium with fish."

At 15, they turned their attention to computers. "Before there was a refrigerator in the house, there was a computer for the kids," Olga says proudly. The Bronsteins had learned the BASIC programming language from books while still in Russia and worked out programs in the pages of a notebook without even having any way to run them. Their first computer was "very primitive - an XT-88 model. We tried out all our theoretical knowledge on it right away and it worked for the most part."

Apart from a three-month period in elementary school, Alex and Michael were always in the same class at school. They confess that, in high school, "We were lousy students. We were very lazy until our math teacher told us that if we kept it up, he would demote us to a lower group."

Fearing such a terrible fate, we finally started studying. We ended up completing a five-unit matriculation exam in mathematics when we were in the 11th grade."

After high school, they were accepted to the electrical engineering program at the Technion as atuda'im (youth who pursue academic studies before army recruitment), and they were awarded scholarships for academic excellence. While working on their bachelor's degrees, which they earned

with honors, they also began master's-level work in electrical engineering. As third-year undergraduate students, they received permission to supervise other students on their projects. The student quoted at the beginning of this article says that the courses taught by the Bronsteins are considered especially hard and few students are bold enough to enroll in them.

They have already published several articles in scientific journals, including an article on biometric technology in the prestigious journal Nature, and they have presented their work at scientific conferences and won prizes for it. The Technion has offered them the option of continuing directly onto the doctoral track.

Why is it so important to you to be together all the time?

Michael: "It's not a matter of principle, but we've always done everything together since we were young, so it's hard for us to imagine it any other way."

What is the meaning of this togetherness?

"It's hard for me to say something objective about this, but our professor at the Technion says that we understand each other very well - that if one of us starts to speak, the other always picks up at exactly the right point, even if he left the room and came back a few minutes later."

They usually submit homework assignments and projects together. Even when they do so separately, their work looks almost exactly the same, as do the grades they receive. Professors who normally insist on individual work have long ago conceded this point when it comes to the Bronsteins and have allowed them to submit work together. "They know that it's a lost cause with us," says Alex.

A teacher once asked them to solve a problem at home, each on his own, and if possible to do so in different ways. "So together we thought about how to solve the problem in different ways. Even on the psychometric exam, we ended up with practically the same grade - 750-something, with a difference of just four points."

The longest they have ever been apart was for a month, "when we went to England to improve our English," relates Michael. "They were afraid that if we stayed together, we wouldn't learn, so they separated us."

Have you ever exploited the fact that you're so indistinguishable?

Alex: "Once - Michael passed his driving test and got a driver's license and I didn't at first. So for a while I drove with his license. People give us all sorts of ideas on how we could exploit it more - like paying for just one membership to the pool. But we always go there together and besides, at the Technion, the pool is free. Another suggestion was about a way to cut the time in half for getting our degrees: Each one of us would do half of the courses and take the tests twice - as Michael during the first testing session and as Alex the second time."

Is there competition between you?

"Not at all."

The invention

At home, the room Alex and Michael share is furnished with two twin beds, two desks and two computers. The walls are adorned with photos of the two; a young woman appears in some of them. Michael hastens to explain:

"That's Alex's girlfriend, Suzy." He says that he doesn't have a steady girlfriend, but has been dating less seriously. The only other apparent difference between them is that Michael doesn't like corn and string beans and Alex does. Alex says that he met his girlfriend two years ago "via all the communications options available to modern man" - i.e., e-mail and the Internet. She is Italian and he travels to Italy to see her several times a year. "I was there in September and I'm going back in February," he says.

Before Alex fell in love, both brothers studied Italian ("We love opera and we wanted to be able to understand it in the original language"). They won a prize in the general studies department at the Technion for their Italian translations of some Shakespeare sonnets.

When they're not translating sonnets, they spend their free time going to movies or watching movies on DVD. "We don't go to pubs or nightclubs, but we read a lot," says Alex. Their reading includes Israeli literature, particularly A. B. Yehoshua. "We read him in high school and were especially impressed. I read `The Lover' in Italian not long ago and it was a lot of fun to compare the translation with the original."

The September 11 terror attacks prompted them to put the sonnets aside and to concentrate on developing a facial-recognition system. Alex says that the whole project started off as a joke: "One semester before finishing our degrees, we took a course with the intimidating name of `Computational Geometry.' For our final project, Prof. Kimmel asked us to use this idea that he and a former student (Assi Elad) had started to develop, and as a joke, he said to us: Let's see if you can develop a system that can tell the two of you apart. The joke turned into something very serious."

As soon as their system was ready, they registered for a patent with the United States Patent Authority (Prof. Kimmel and the Technion are also listed on the patent). Then the Ministry of Science contacted the Bronsteins and asked them to present their project at a science exhibition in Jerusalem last September.

Alex: "In four days, we scanned over 1,000 people, including Matan Vilnai, who was the science minister then. (The database of photos taken at the event is being used solely for scientific purposes to test the technology's performance.) People were very skeptical. They asked if we had any connections to the defense establishment. I have to admit that the model was quite scary because it looked like a guillotine and people were afraid to place their heads in it."

How is your system different from existing programs?

Alex: "In its sophisticated use of 3D. Most of the commercial programs use 2D. After September 11, it was shown that the two-dimensional programs are basically worthless. Tests done on those kinds of systems showed a lot of failures. One report on facial-recognition systems installed at airports said that the two-dimensional systems were as reliable as a coin toss. It's something that gives completely random results.

"People started talking indirectly about 3D systems back in 1995 when face recognition was done with a regular photograph and a profile shot, but the problem is that the face isn't something rigid. It can be significantly distorted, evidently because we are the mammals with the most highly developed facial expressions. When a person smiles, his facial surfaces look totally different than when his expression is serious."

But the Bronsteins' program is able to recognize a face even when its expressions are very different. The technology they developed is based on the creation of a three-dimensional picture and comparison of geometric variables of the face, represented as flexible surfaces. The idea is to render

the facial surface as a "canonical" or permanent form, in which the distances between various points are maintained, and thus are unaffected by changes in movement or expression (see box).

The Bronsteins are well aware of the economic potential of their invention, but for them, getting rich is not the main objective. "We're a lot more interested in the scientific questions raised by this patent, questions that we haven't been able to solve yet," says Alex. "Like the problem of `invariant representation' of isometric transformations. We discovered something surprising about the accuracy of the representation as a function of the density of the surface sample."

Explanation: "Our device doesn't actually photograph the face. It samples it at many points and the representation of the face is produced by the compilation of these points. But the space in which this representation is produced is limited by the amount of data that can be put into it without error. Intuitively, you might think that the more points you have, the less accurate a representation you'll get, because the data is crowded into a limited space and this causes distortion in the calculation. But from working with our system, we found that if you increase the density of the sample (by sampling more points), the degree of accuracy remains virtually the same - so a limited quantity of sampling points within a `low-dimension' representational space is sufficient.

"It's like the `sampling theorem,' without which you couldn't record music on a CD, for example. Digital recording on a CD is based on the same idea - that you don't need all the data, because that won't reduce the margin of error. This was proved in terms of one-dimensional signals like sound signals and so it was applied in music, but not with the kind of signals that we're dealing with, which are more complex.

"It's a mathematical-scientific problem that arose from our patent and which we still haven't been able to solve. Something similar was proved by John Nash, but it's not what he was awarded the Nobel Prize for. The problem doesn't have to do with the performance of the system and doesn't affect it, but it produces a theorem that is a challenge to prove. That's how it is with technology: Something works without mathematical proof, and sometimes it's not even mathematically correct, but you still want to try to prove the theorem."

So what you're saying is that there may be professors out there who at this very moment are struggling to prove the Bronstein theorem?

Michael: "We've talked about it with a lot of professors at the Technion and they've talked with other professors all over the world, but so far, no one has managed to prove these theorems."

Alex: "It may not be such a big deal to formulate a theorem, but it can be a lot harder to prove one. Let's say that we'd be very happy if someone would solve it."

`Loftier goal'

The Bronsteins certainly understand the enthusiasm their facial-recognition system has aroused, but they're even more excited about the first patent they were involved in - for a medical imaging device. Together with Dr. Michael Zibulevsky and Prof. Yehoshua Ze'evi of the Technion, they developed and patented a device for the detection of cancerous growths at a very early stage. The innovative instrumentation is meant to provide a more accurate and less costly alternative to existing medical imaging technology, which is based on high-energy ionizing radiation.

Michael: "This device could save lives. It can also reduce the cost of the

existing positron emission tomography (PET) technology, which is very expensive. In Israel, there are four such instruments in use at the main hospitals and, of course, [their use] not covered in the health basket. Doctors use [the instruments] only in rare cases and we hope that our method will not only make it possible to reduce a person's exposure to radiation, but also significantly reduce the cost of using the instruments so that more hospitals will use them. It may sound less impressive than the facial-recognition technology, but it has a loftier goal."

General Electric, one of the world's largest manufacturers of medical instrumentation, has expressed an interest in the product through its Haifa subsidiary, GE Medical Systems.

What kind of money are we talking about?

Alex: "That depends what stage we sell it at. If it's only at the conceptual stage, then it could be a number with five zeroes, but if we sell it at a more advanced stage, when we have a prototype, then it could be a lot more - a very, very big number, because their development budget is about equal to the budget of a small country."

Who is handling the contacts with GE?

"We're involved in all the discussions, with our advisers, of course."

So you'll be rich one day.

"We wouldn't mind."

Do you two always talk in the plural? Is there any "I" in your lives?

Michael: "Sometimes it sounds weird to people to hear one person talking in the plural. But it's become a natural thing. You could say that there's a nonlinear phenomenon between us. When we're together - which is practically all the time - one plus one equals three."

Maybe you're really clones!

Michael, as usual, has a scientific answer ready: "That's right - after all, we are the same genetically."

How it works

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