INTERVIEW SPOTLIGHT

Dr. Qiyin Fang

SHINING LIGHT ON BIOMEDICINE

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DR. QIYIN FANG IS AN ASSOCIATE PROFESSOR OF ENGINEERING PHYSICS, MEMBER OF THE MCMASTER SCHOOL OF BIOMEDICAL ENGINEERING, AND AN ASSOCIATE MEMBER OF THE DEPARTMENT OF ELECTRICAL AND COMPUTER ENGINEERING AT MCMASTER UNIVERSITY. HE ALSO HOLDS THE COMMENDABLE POSITION OF CANADA RESEARCH CHAIR IN BIOPHOTONICS. HIS OTHER TITLES AND ACCOLADES INCLUDE BEING A SENIOR MEMBER OF THE INTERNATIONAL SOCIETY FOR OPTICAL ENGINEERING (SPIE), THE OPTICAL SOCIETY OF AMERICA (OSA), AND THE INSTITUTE OF ELECTRICAL AND ELECTRONICS ENGINEERS (IEEE). DR. FANG'S CURRENT RESEARCH INTERESTS INCLUDE STEADY-STATE AND TIME-RESOLVED FLUORESCENCE SPECTROSCOPY/IMAGING WITH BIOMEDICAL APPLICATIONS.

PRIOR TO TEACHING AT MCMASTER UNIVERSITY, DR. FANG WORKED AS A PIONEERING RESEARCH SCIENTIST IN THE MINIMALLY INVASIVE SURGICAL TECHNOLOGY INSTITUTE AT THE CEDARS-SINAI MEDICAL CENTER IN LOS ANGELES. HE OBTAINED HIS UNDERGRADUATE DEGREE FROM NANKAI UNIVERISTY AND BOTH OF HIS GRADUATE DEGREES FROM EAST CAROLINA UNIVERSITY, WHERE HE STUDIED THE INTERACTION BETWEEN NANOSECOND LASER PULSE AND SOFT BIOLOGICAL TISSUE.

THANK YOU SO MUCH FOR MEETING WITH US, DR. FANG. FIRST OF ALL, CAN YOU TELL US A BIT ABOUT YOUR EDUCATIONAL BACKGROUND AND YOUR INSPIRATION FOR JOINING MCMASTER UNIVERSITY?

Thank you for giving me the opportunity to talk about our research. I did my undergrad in physics and then my thesis work in optics. Around that time, I started becoming more interested in [the medical applications of] optics because I have close family ties with medicine. As a result, I decided to pursue my graduate career in the field of biomedical optics, which, at the time, was a relatively new discipline. I did my Masters and PhD. in optics at East Carolina University and then worked at the Cedars-Sinai Medical Centre in Los Angeles for a few years. There, we focused primarily on clinical applications of optics, [specifically] on cardiovascular applications. And then about ten years ago, I decided to switch directions, so that's when I finally came to McMaster.

YOUR RESEARCH FOCUS IS BIO-PHOTONICS. CAN YOU TELL US A BIT ABOUT THIS AND WHAT INSPIRED YOU TO RESEARCH THIS FIELD?

Biophotonics is a made-up word by people in our field. It is essentially the biomedical application of optics or photonics engineering. As biophotonics is an interdisciplinary research area, most of our projects are a result of a multi-disciplinary team of engineers and clinicians. In particular, our team uses a specialized technique called time-resolved fluorescence or time-resolved optical imaging to look at diagnostic applications. Recently, we have been looking at applications at the time scale of a few nanoseconds to picoseconds [and] femtoseconds. So that's quite a fast instrumentation technique.

ONE OF YOUR RECENT RESEARCH FIELDS INCLUDE MULTI-MODALITY OPTICAL BIOPSY TECHNIQUES. CAN YOU TELL US MORE ABOUT THIS AND WHAT IT ENTAILS FOR CLINICAL DIAGNOSIS AND GUIDED THERAPY?

This is one of the projects I started as soon as I got here. We basically tried to look at non-invasive or minimally invasive magnets for in-vivo clinical diagnosis applications. Optical biopsy is a relatively new trend compared to traditional biopsy. In traditional biopsy, you take a piece of tissue from the patient, process it using histopathology, and look at the pathology changes in surface and sub-surface features to make a diagnosis. This is a pretty standard technique for many diseases, but one of the problems with it is the associated possibility for sampling error. It is an invasive procedure so you can only take so many [samples], and as a result there are a limited number of data points or samples for analysis. Another drawback of traditional biopsy is that it is not real-time. Typically, a process called frozen biopsy is used, which allows you to analyze frozen test tissue for about fifteen to twenty minutes. Typically, it is used in skin cancer diagnosis during surgery or, in our case, in brain tumour surgery cases. This is the fastest way you can do it, but imagine the actual biopsy of a patient – you have viewpoints and you have weight, so it is not very practical. In fact, I think Hamilton Health Sciences has foregone the use of this process precisely because of this reason. Only a very few centres, such as the Cedars-Sinai Medical Centre, are still doing that. In the case of optical biopsy, we shine light on a target. In our specific case of brain tumours, we examined the cavity for residual tumours after the main bulk tumour had been removed. In those cases, we shone UV light into the cavity and based on the fluorescence light from that target [area], we were able to determine whether or not residual tumours were present. Obviously, the goal would be to remove as much of the tumour as possible. This optical fluorescence technique allowed us to sample the whole cavity without damaging it, and subsequently further probe the questionable regions with biopsy. This is what we call optical biopsy. For the multimodality part, we combined two techniques in optics – one being time-resolved fluorescence, and the other, diffuse reflectance. These two techniques are complementary so they allowed us to gain more information and cross-calibrate. This is an in-vivo technique so you see that many of the measurements are determined very quickly and so real-time calibration is very necessary.

SO IS THIS APPLICABLE TO ALL TYPES OF TISSUE OR ONLY BRAIN TISSUE?

"IN THE CASE OF OPTICAL BIOPSY, WE SHINE LIGHT ON A TARGET. IN OUR SPECIFIC CASE OF BRAIN TUMOURS, WE EXAMINED THE CAVITY FOR RESIDUAL TUMOURS AFTER THE MAIN BULK TUMOUR HAD BEEN REMOVED."

Optical biopsy has broader applications that are not necessarily limited to brain tissue. We are currently focusing on the brain and also working with teams from the GI unit to look at esophageal and stomach cancer cases. For example, we are looking at lesions in the esophagus to determine whether we can distinguish malignant tissue from the normal tissue. The goal, in this case, would be early detection, instead of guided interventions.

ANOTHER RECENT PUBLICATION OF YOUR'S IS "A 360 DEGREE SIDE VIEW ENDOSCOPE FOR LOWER GI TRACT MAPPING". CAN YOU TELL US SOME OF THE HIGHLIGHTS AND IMPLICATIONS OF YOUR RESEARCH?

That's a good question. For another lab, we are working with the same team in the GI division, which is led by Dr. Armstrong, chief of that division, and also Dr. Francis Xi. We are looking at the problem of colonoscopy screening in colorectal cancer. We essentially screen everyone over 50 years old. That's a large volume of patients to try to screen. One of the problems during this process is that the cameras mounted at the tip of the endoscope are forward-looking and they are wide-angled, quite wide-angled actually — almost 170 degrees. Nonetheless, they are still forward-looking. Now imagine that you are going through a tunnel, a narrow tunnel. Most of the interesting parts will be on the wall, right? If you actually look straight down in a forward view, the majority of what is seen will be down the tunnel, but the information we are interested in is on the sidewalls. We targeted this problem by developing a special optical system that can guide the endoscope forward by looking straight down, while creating a [lag part] of the image view, which can then be separated so that we look only at the side wall as the scope moves along. Eventually, this allows us to move the endoscope down the colon and recreate a 2-dimensional [view] of the colon [wall]. There are implications other than just improved imaging. Using this technology, we can actually skip the real-time diagnostic part because this is a very fast procedure. One of our goals is to incorporate this technology into a pill camera so that the camera can pass through the digestive tract. Thus, medical professionals can image the whole tract and receive an "unwrapped map." From there, we can use different methods to highlight specific regions before going back and repeating the procedure. Typically, that means that for 95% of the patients, we don't actually have to look again. Only with patients who have potential problems will we go back and look at those regions. This technique improves the efficiency of screening procedures significantly. Currently, we are working with the GI team and the MDA** robotics team from Brampton on this technology as they have developed similar technologies for mind surface mapping.

WHERE DO YOU SEE THE FIELD OF BIOPHOTONICS GOING IN THE NEXT 20 YEARS?

This is a rather new field. The term itself was conceived around the 90's, and although the usage of optics in biomedical applications has a very long history, this field is relatively new. In the last 20 years or so, many of the techniques have become commercialized. So far, the majority of applications in Biophotonics focuses on diagnosis. Most of them, especially those from the early 90's, are so-called laser medicine applications such as laser-based angioplasty and laser eye surgery… But I think that the direction in which we're headed will integrate diagnostic and therapeutic applications.

DO YOU HAVE ANY SUGGESTIONS OR ADVICE FOR STUDENTS ASPIRING TO BE RESEARCH SCIENTISTS?

Well, I think my advice would probably be to keep their interests broad. If they see something interesting, they should give it a try. And obviously, when they become serious about a particular topic or idea, they can start to focus… But the initial interest is most important.

ASIDE FROM YOUR ACADEMIC PURSUITS, WHAT OTHER INTERESTS OR PASSIONS DO YOU HAVE?

When I have the time, I play quite a bit of sports. I mean, I may not be very good at it, but mostly it's just interest.

WHAT TYPES OF SPORTS?

I think I play soccer the most –we have a soccer team where I live, so I play pretty regularly. Over the summer, I actually participate in softball. I also swim competitively, so that keeps me busy!

**MACDONALD, DETTWILER AND ASSOCIATES