Concussions: There's an App for That

Researchers at the University of Notre Dame, led by Christian Poellabauer and Patrick Flynn of the Department of Computer Science and Engineering, are in the process of field-testing an app that can diagnose a concussion simply by listening to someone talk. Poellabauer and Flynn are part of a group of faculty at the University of Notre Dame that are affiliated with Advanced Diagnostics and Therapeutics, an initiative that focuses on cross-disciplinary research areas such as advanced imaging, disease diagnostics, personal diagnostics, environmental diagnostics, and targeted drug delivery. The concussion app being developed at Notre Dame determines whether an athlete has sustained a concussion by analyzing the athlete's speech and vocal patterns.

*Why are concussions a big deal?*
In the last year, the media has followed the unfolding drama of concussions in professional football and professional hockey. Former players are suing their former associations for not addressing the serious risks involved with not just concussions, but repeated concussions. Some players with repeated injuries can't remember their kids' names or where they live. Some have even committed suicide due to the injury-induced depression.

Professional athletes are not the only ones to suffer the effects of concussions. While professional athletes have access to the latest equipment and diagnostic tools, high school athletes often practice and play in out-of-date, handed-down gear. Soldiers serving in active duty suffer one of the highest rates of concussions and mTBIs (mild traumatic brain injuries). The constant threat of explosives, IEDs, and general combat injuries greatly increase soldier’s chances for multiple concussions.
Because the brain is the neurological center of the body, any injury to it must be taken seriously and acted upon quickly. “Re-injuring” a concussed brain can have disastrous and deadly consequences. A phenomenon known as “second-impact syndrome” occurs when the brain swells so quickly that the person dies. This swelling is induced by a person suffering a second concussion before an initial concussion has completely healed. Because young athletes and soldiers can suffer more undiagnosed concussions, they are at a greater risk for serious or deadly effects from multiple concussions. These concussions must be diagnosed immediately so that treatment may be administered and further injury prevented.

**What are the current diagnostic hindrances?**
There are many reasons concussions go undiagnosed. First, “on-field” administered tests can be inaccurate and are often “cheated.” Players can too easily convince a coach or medical staffer that they are “fine” and should go back into the game. More precise diagnostic tools involve expensive machinery that is not available on the playing field or in the field of action. Diagnosing a concussion may also involve hospital or doctor’s office visits, often hours or days after the injury has occurred. Also, if players don’t experience any immediate adverse symptoms, they may delay concussion testing altogether, prolonging their recovery time needed as well as their risk for second-impact injuries.

**How can this app help?**
The concussion app from researches at Notre Dame addresses the diagnostic issues of accuracy, cost, and portability. The app analyzes vocal disparities in athletes before and after a potentially traumatic event. Athletes speak a series of words into the app before an event, giving researchers a baseline reading for comparison. Athletes then read the same words into the app after an event or suspected injury. The app compares vocal frequencies, vowel sounds, pitch variance, and speed to determine whether an athlete has suffered a concussion. Because the faculty of speech draws on every area of the brain in some way, a diagnostic tool testing for speech variances ensures a high degree of accuracy. Also, with the app accessible on a mobile device such as a tablet, it is readily available and portable for a very low cost.

**Where is the app in the development process?**
The app has already been tested on over 100 student athletes at the University of Notre Dame. Researchers are now working with speech pathology specialists from Notre Dame and Purdue University to develop better baseline readings for detecting vocal variances. The app will then be tested on youth athletes in the high school community surrounding Notre Dame. The hope is to fine-tune the app’s analyses through this next round of testing to ensure 100% accuracy every time. The app will then be available via the commercial marketplace through a start-up company called Contect.

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**Developing alliances with health practitioners to outline healthcare's greatest unmet needs**
New to the Team

AD&T would like to welcome Mridul Kanti Mandal. Dr. Mandal joined the Go Research Group in the Spring of 2014 as a postdoctoral scholar working with Dr. Go and his collaborators, Dr. Matt Champion and Prof. Marya Lieberman, on developing surface acoustic wave nebulization (SAWN) ionization technologies for mass spectrometry. Mandal most recently worked at the Clean Energy Research Center at the University of Yamanashi, Japan. Mandal’s research interests include the development of ambient and non-ambient mass spectrometry based methods for single-cell analysis, mass spectrometry based applications for imaging, and ultra-performance liquid chromatography. Current research includes mass spectrometry, ambient mass spectrometry, electrospray ionization, and hybrid systems of thermal desorption, electrospray ionization, atmospheric pressure chemical ionization, and dielectric barrier discharge.

Also new to the AD&T team is Melissa Endres, the administrative assistant for Advanced Diagnostics & Therapeutics. Melissa recently worked for HealthWorks! Kids’ Museum downtown as a Replication Evaluation Specialist and Curriculum Developer, where she wrote and edited children’s health curricula. Melissa has a BA in English from Bob Jones University and has started an MA in English Literature. Melissa’s husband is a South Bend native, so she married into the Notre Dame lifestyle before joining the team here at the university. Melissa will be helping with various aspects in AD&T, including website content, quarterly newsletters, scheduling, and office administration.

AD&T Spring News

Kevin Bowyer Receives the IEEE Computer Society Technical Achievement Award

Congratulations to Kevin Bowyer, Schubmehl-Prein Professor and Chair of the Department of computer Science and Engineering, who received the 2014 Institute of Electrical and Electronics Computer Society's Technical Achievement Award. The award was given in recognition of Bowyer’s “pioneering contributions to the science and engineering of biometrics,” specifically in the field of iris recognition. Bowyer has led many innovative projects researching image-based biometrics and multibiometrics. He currently directs the biometrics research group with Patrick Flynn and is an affiliated faculty member of AD&T. Bowyer will be honored at the IEEE Awards Ceremony in Seattle in June and will also serve as general chair for the 2015 IEEE International Conference on Automatic Face and Gesture Recognition.

NanDio Wins First Place in the 2014 Brown-Forman Cardinal Challenge at the University of Louisville College of Business

Congratulations to NanDio, a team of students who won first place in the 2014 Brown-Forman Cardinal Challenge at the University of Louisville College of Business. Students competing in the Cardinal Challenge developed business plans based on their own research ideas and technologies or those developed by someone else. Judging was based on a team’s written plan, their professionalism during presentation, and the practicality of their business venture. The business venture of the NanDio team is an in-office HPV oral cancer screening device marketed to dentists. The plan includes initial testing of saliva samples in routine dentist visits. Samples will then be sent to a lab to test the new screening process for detecting early signs of HPV. After a trial period, the chip used for screenings will then become available, through a start-up company, for in-office use at dentist offices. Patients can then be screened and have results ready by the time their teeth cleanings are complete. The NanDio device’s simplicity of use, speed of test results, and accuracy of the test as an early detector gave the team a first-
As the winner, NanDio received $15,000; an invitation to the 2014 Global Venture Lab Investment Competition in Austin, Texas; and a more than $125,000 “Launch in Louisville” package, which requires the winning team to locate and operate its business in Louisville within one year of receiving the award as well as an advertising package, $25,000 design and technical architecture services, logo development, a $10,000 cash economic incentive, website development, office space for a year and more.

The NanDio team consists of graduate students Ben Miller, an MBA student in the Mendoza College of Business; Patrick Rice, a student in the Engineering, Science & Technology Entrepreneurship Excellence (ESTEEM) master’s program; Marcy Kreimier, who is pursuing her master’s in patent law at Notre Dame; Daniel Miller, an M.D. and Ph.D. predoctoral fellow at the University of Missouri School of Medicine; and faculty adviser Gaylene Anderson, senior commercialization officer at the Cleveland Clinic.

Researchers for the project include several AD&T affiliated faculty members. The biomarkers were developed at the Mike and Josie Harper Cancer Research Institute by graduate student Ben Miller and M. Sharon Stack, the Ann F. Dunne and Elizabeth Riley Director of the Harper Institute and professor of chemistry and biochemistry at Notre Dame. The membrane sensor was developed by Zdenek Slouka, a postdoctoral associate in the Center for Microfluidics and Medical Diagnostics (CMMD); Satyajyoti Senapati, a research professor in the Department of Chemical and Biomolecular Engineering; and Hsueh-Chia Chang, the Bayer Professor of Chemical and Biomolecular Engineering and director of the CMMD. The research was supported by a Walther Cancer Foundation grant to professors Chang and Stack.

**AD&T Initiates First Inter-Collegiate Course: Bench-to-Bedside Technologies**

The spring semester of 2014 saw the launch of a new inter-collegiate course that focuses on topics related to measurement in the chemical sciences and interdisciplinary fields of science and engineering. Headed by Paul Bohn of AD&T and the Chemical Engineering department, Notre Dame partnered with professors at Indiana University and Purdue University for weekly classes. Classes are being held online via videoconference, with students meeting in a lecture room one night a week and in smaller research groups on a second night. Weekly classes are hosted by speakers from each of the three universities.

The focus of the course centers on developing proposals to solve real-world problems through collaborations with other university students. Each research group is comprised of students from all three participating universities. The “Bench-to-Bedside” title emphasized developing technologies that support individual as well as community health settings. Students are encouraged to develop ideas for field-deployable chemical instrumentation—technologies that can be used in low-resource environments for measuring data and developing analyses of various health issues.

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