Making Sense of Air Quality Using Sensors

Ainoor.Peermohamed
@timesgroup.com

In cities, millions breathe in contaminated air containing particles many times higher than the prescribed safe limit. Finding innovative ways to monitor and predict air pollution, although not difficult, is proving to be expensive.

Entrepreneurs at tiny startups and researchers at premier institutions are, however, taking up the challenge. The bottleneck is primarily due to a lack of data, which in turn is chiefly due to the exorbitant cost of setting up sensors to gather air pollution data.

The highly accurate sensor arrays used in most countries cost around $150,000 apiece, and there is a huge shortage of such sensors in India.

According to the World Health Organisation, one air quality sensor should be installed for every one square kilometre. In a city like Bengaluru, which is spread over 700 sq km, that means at least 700 sensors have to be put in place. This means an investment of over ₹700 crore, without even considering high maintenance costs.

Solving the cost problem was the key issue for researchers working on this project at the Indian Institute of Technology in Bombay.

Professor Rajesh Zele from the department of electrical engineering put together a team of five students for project Satvam, which is developing a sensor array that costs just ₹20,000 and is able to do most of the things that a high-cost sensor can do currently.

Zele's team aims to put hundreds of low-cost sensors across cities, collecting data on air quality. Although they won't be as accurate as sensors available today, Zele, a chip designer by training, has a trick up his sleeve.

His team is building a machine learning model to average out error in readings, an effort ably supported by researchers at the Indian Institute of Science (IISc) in Bengaluru.

"If you take a bunch of sensors it will give you some readings, but you need a lot of data analytics along with it to improve the accuracy," says Zele. "What we're doing right now is putting our boxes within close proximity to a calibrated sensor and we're calibrating our sensors based on that."

If it works, Satvam will be rolled out across the IIT-Bombay and IIT-Kanpur campuses by year-end and maybe across an entire city once it proves effective. The project, funded by the Department of Science and Technology and Intel, is finding novel ways of enabling machine-to-machine communication to further bring down costs.

IIT-Bombay isn't the only one with the idea of building low-cost sensors.

Ambee, a Bengaluru-based startup that's looking to solve India's air quality monitoring problem, and Ahmedabad-based Oizom, are also in the race to install low-cost sensors across cities.

While Ambee has already installed 100 such sensors in Bengaluru, Oizom says it has over 250 sensors in India and eight other countries. "Mumbai has just two (government set-up sensors), Bengaluru has seven, of which three do not function," says Madhusudhan Anand, CTO of Ambee. While Ambee's solution is to use as few physical sensors as possible and instead rely on machine learning and data science models to build virtual sensors, Oizom is actually investing in setting up sensors on the ground.

Ambee's models are fed with sensor data, weather patterns, traffic data, ratio of diesel to petrol vehicles and even contextual data such as road repair, garbage burning and density of diesel generators. Armed with this information, it is able to predict street-level air pollution.

"Like what the Global Positioning System is to maps, we want to be for air quality monitoring," says Anand. Ambee, which is part of the US-based Techstars incubator, is engaging with health and fitness apps that use its data to inform customers of the best time for workouts. It is now hoping to sell the data to local authorities to take on-ground action on improving air quality.

Ambee is also in talks with an e-commerce company to sell air quality data that the firm will deploy to target customers with cosmetics, air purifiers and other related goods based on the air quality locally.

Oizom, on the other hand, offers information on co-location and calibrating of its sensors, which can be customised to local conditions. It is looking at building analytics and intelligence services on top of its hardware layer, although that will take a backseat for now.

"We are doing a lot of R&D in pollution prediction and monitoring, but that's still secondary for us, because for any machine learning model to work, you must have vast amounts of data," says Jainam Mehta, co-founder and CMO at Oizom.

If reports are to be believed, 1.2 million people died prematurely due to the adverse effects of air pollution in 2018, which the government denied.

"Once the problem is visible, we can't hide from it," Anand said.

WHAT POLLUTES OUR AIR

PM 2.5 and PM 10: Particulate matters in the atmosphere whose diameters are less than 2.5 micrometers & 10 micrometers respectively. The diameter of human hair in comparison is 50-70 micrometers. These particles can cause eye, nose, throat and lung irritation in the short term, while scientific studies have linked long-term exposure to increased respiratory and cardiovascular diseases and deaths.

CO: The biggest source of Carbon Monoxide in cities is vehicles burning fossil fuels. Inhaling CO reduces the amount of oxygen that can be carried by blood to organs and in high-enough concentrations can cause dizziness, confusion and unconsciousness.

NO2: Nitrogen dioxide reacts with oxygen, water and other chemicals in the atmosphere to create acid rain. Further, nitrate particles suspended in the air make it hazy, with the compound being one of the leading causes of smog.

Ozone: Ground-level ozone can trigger a variety of health problems including chest pain, coughing, throat irritation, and airway inflammation. Long-term exposure can cause reduced lung function and damage to lung tissues.