AETA White Paper

Using big data & AI to forecast earthquakes

Beijing/ Shenzhen

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Contents

Introduction

The Acoustic Electromagnetic to AI (AETA) project is designed to combine big data and AI to forecast earthquakes several days before they occur. Each forecast reveals the yes/no probability of an earthquake, the epicentre, and the magnitude.

AETA originated from the Peking University by Professor Wang and Dr. Yong. Their research has led to the ability to perform earthquake forecasting through data gathering and machine learning-based algorithms with impressively accurate results.

The genesis of AETA's idea came shortly after the devastating 2008 and 2010 earthquakes that hit Sichuan, affecting the lives of over 400,000 people and causing over USD $150Bn worth of damage.

In 2018 AETA successfully forecasted two >5.0M earthquakes to the local government of the Chinese province of Sichuan. Since then, AETA provides weekly forecasts to local governments in China.

Problems

Across the globe, earthquakes cause a huge amount of structural damage, loss of life, and an unprecedented amount of repair costs.

The constant uncertainty that looms over governments and civilians is that earthquakes are "unpredictable" and difficult to foresee, leaving countries unable to act fast upon the occurrence of an earthquake's devastation.

The current preventive measures that have been developed over the years have been an improvement for mankind, however, they are still limited and are missing many important aspects.

Current systems include pre-alert companies that send an alert to civilians when an earthquake is occurring. Depending on the epicentre, the pre-alert apps send out a text message and generally give civilians between 30 and 90 seconds to prepare. If you are lucky enough to see the text message immediately, you have enough time to stop your activity and find cover.

An additional problem with alert systems is that the affected area's radius is roughly 50km, normally the earthquake would have passed the location when the alert is sent. But the people who receive the alert usually are far away from the epicentre and in many cases are actually safe from harm.

These systems are not sustainable enough to offer real support in the event of an earthquake, but rather minimize the death toll by only a small percentage. Combining the forecasting capability with existing early warning systems could greatly improve the overall effect and reduce the impact of devastating earthquakes.

The knowledge of when and where an earthquake will occur, and how strong that earthquake will be can bring the loss of life to almost zero. On top of that, it can also help governments save billions of dollars in damage. AETA's accuracy rate has achieved breakthroughs in forecasting. However, the algorithm will need constant improvements to reach an over 90% accuracy rate.

AETA's solution

AETA's solution is designed to forecast earthquakes similar to how we forecast the weather. The system is comprised of hardware & software to solve the forecasting issue.

We have deployed over 300+ sensory systems across the Sichuan and Yunnan provinces (China) and have been collecting 95 variants of seismic data.

This data is used to feed an algorithm that can identify particular anomalies before, during, and after an earthquake occurs. Artificial intelligence allows the algorithm to continuously improve and use all the collected insights to make accurate forecasts of future earthquakes.

The solution can forecast an earthquake several days before they happen, allowing countries to take the right precautions that will greatly minimize the devastation caused by the disasters.

The forecasts that are generated are imminent forecasts. In other words, when an earthquake is forecasted, we also define the precise location and magnitude of the expected earthquake.
AETA doesn't give probabilistic forecasts that gives a certain chance an earthquake might occur.

The sensors are deployed across earthquake-prone areas and, together with the algorithm, offer the government and rescue services days to prepare for an earthquake.

How the technology works

The technology is comprised of a 3-part sensory system (the hardware) and a machine-learning-based algorithm (the software). see figure 1.0.

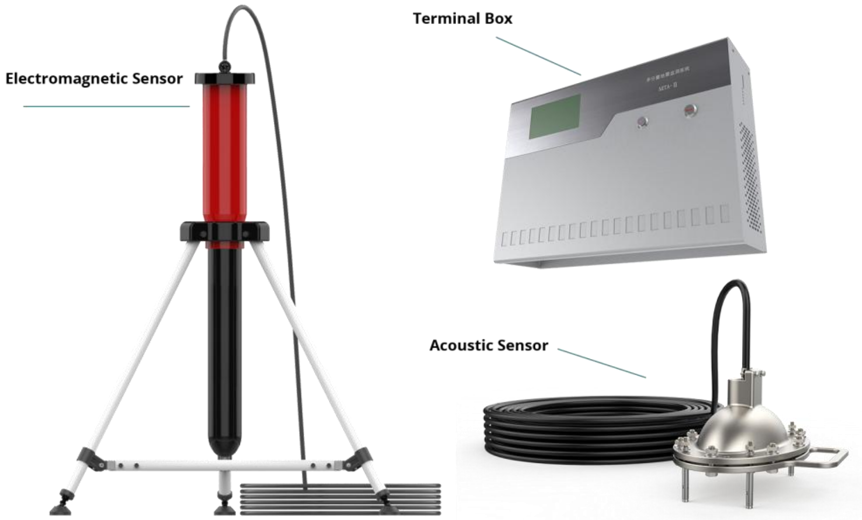

Figure 1.0

The sensory system collects over 95 variants of seismic data. Below is a description of each sensor's capabilities.

Electromagnetic Sensor

Frequency range: 0.1 Hz to 10 kHz;
Dynamic range of output: 0.1nT~1000nT;
Sensitivity: >20mV/nT@0.1Hz~10kHz;

Data resolution: 18bits.
Size: Diameter is 90mm,
height is 850mm,
length of cable is 40m.

Acoustic Sensor

Frequency range: 0.1 Hz to 10 kHz; Voltage **resolution:** 19.073uV;
Conformity error: ＜±5.5%(0.47dB);

Data resolution: 18bits.
Size: Diameter is 265mm,
height is 68mm,
length of cable is 40m.

Terminal Box

Multi-probe access data pre-processing, data packing & transfer to cloud sever, local storage remote operation and access ability

The electromagnetic and acoustic sensors are placed underground (2 meters in depth) beside one another. While the terminal box is placed above ground in a sheltered area no further than 40m from the sensors.

With the placement of numerous sensors deployed, data is then gathered within that region, and transferred to a data centre via each sensor's terminal box. See figure 2.0.

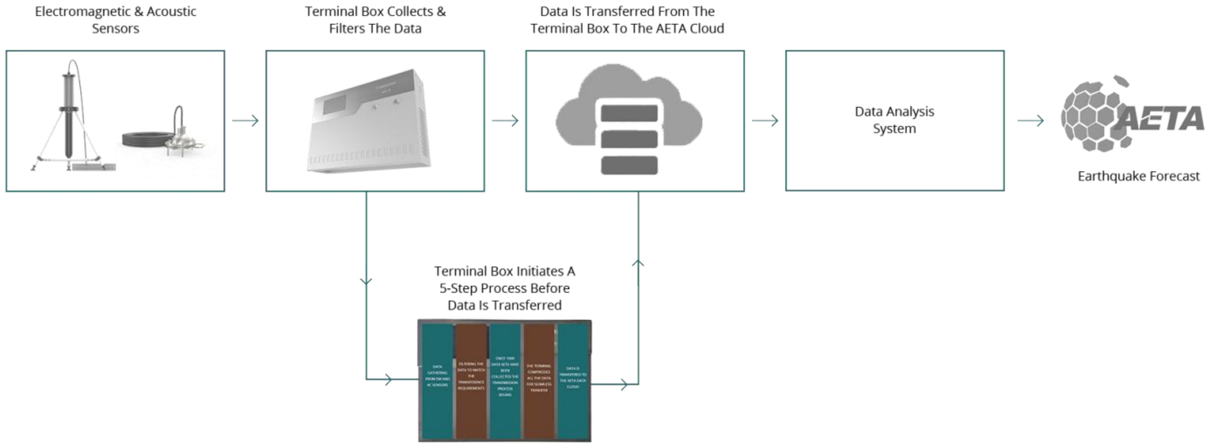

Figure 2.0

The ideal density of each 3-part sensor should be between 20km - 50Km. The higher the density between the sensors the more accurate the forecasts will be. See figure 3.0 of how the sensors are laid out.

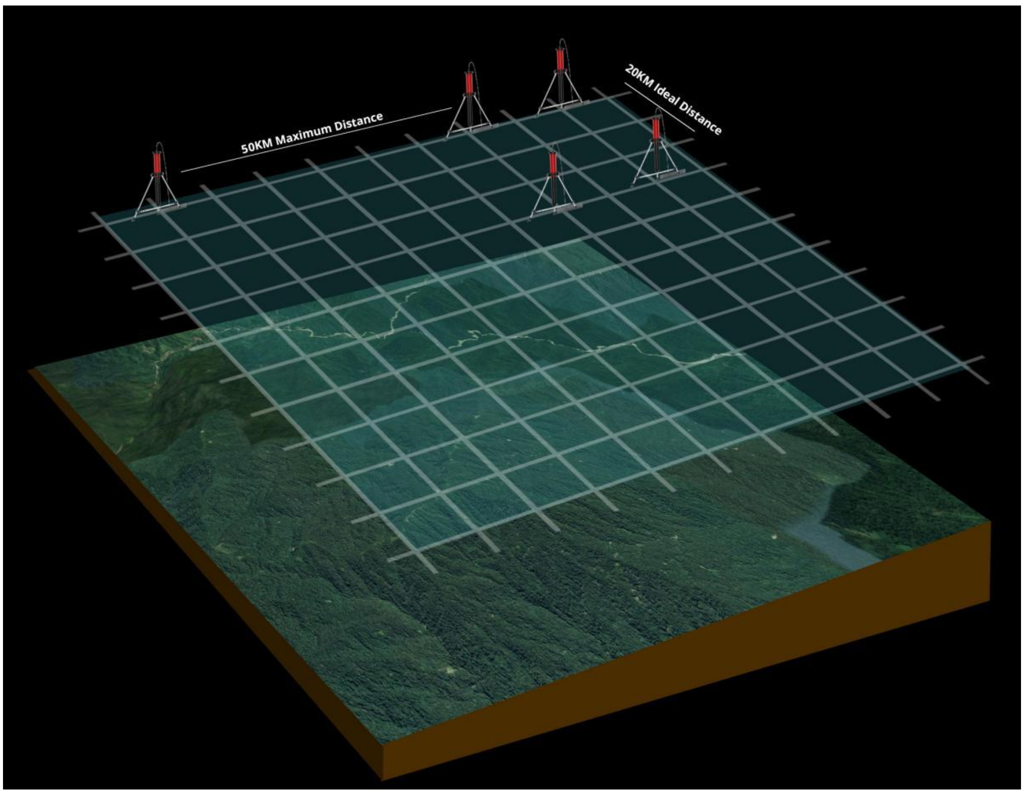

Figure 3.0

Each earthquake-prone region must be analysed before the deployment of the sensors. Our team will pre-plan strategic locations along/close by the region's fault lines, ensuring optimal data collection and thus a more accurate forecast.

Figure 4.0 illustrates how the sensor work in unison, collecting/transmitting data via their terminal boxes to AETA's data centre. All the data transmitted reveals anomalies that the AETA algorithm can use as precursory indicators of an earthquake's occurrence.

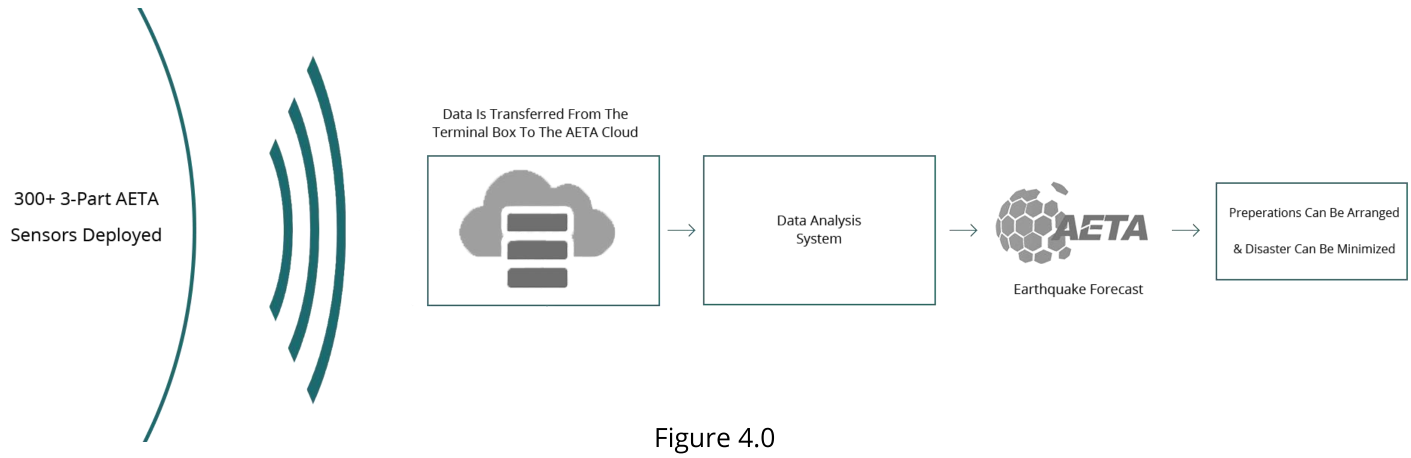

Figure 4.0

What has been done so far?

The AETA project was first initiated in 2010 and since then has gone onto achieve numerous milestones within the field of earthquake forecasting.

2010

Professor Wang Xin'an of Peking University Shenzhen Graduate School, and his team of doctors, began the research of the AETA program, after two violent earthquakes in China, affecting the lives of over 400,000 people.

2013

First lab validation prototype is finished in Peking University Shenzhen Graduate School.

2015

First batch of 20 validation samples were built and deployed in Sichuan, Yunnan, and Hebei. And proved earthquake relevance with geo-acoustic and electromagnetics.

2016

SVV became the hardware partner, by redesigning & improving the sensor's hardware reliability and consistency, and began mass deployment.

2018

Made two earthquake forecasts in Sichuan to the local authorities 3-7 days in advance.

2020

First earthquake prediction AI algorithm competition, with 183 teams, that revealed 10 winners, with average yes/no accuracy above 70%.

2021

Partner with Capgemini's AIE for the second competition to attract international talents and achieve the goal of earthquake forecasting.

AETA for governments

One of the major advantages of an earthquake forecasting system is designed to support the country's governments. When an earthquake strikes, it has a damaging impact, not only on the structural integrity of the region but also on the economy.

With a forecasting system in place, governments can place their specific regions into a 'safe mode' several days before the earthquake strikes. A safe mode will consist of the evacuation of the area, a safe shut down of highly sensitive locations such as nuclear power stations, electrical grids, gas lines, dams, transportation routes, etc...

Structural damage is unavoidable during an earthquake. However, the total cost of damage can be minimized using AETA's solution. A huge part of the total damage value comes from events that are following earthquakes e.g. fires, explosions, nuclear disasters, landslides,...

Governments can use AETA's forecasts to take design anticipatory policies that enable them to 'anticipate' before an earthquake strikes. This way, the humanitarian impact can be reduced as show in figure 5.0.

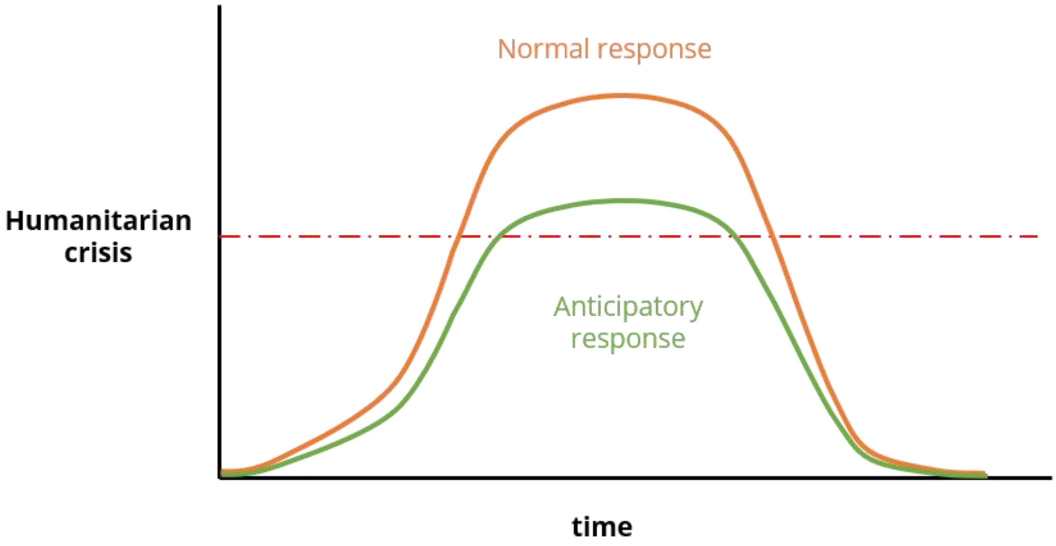

Figure 5.0

The AETA team believes that several days of preparation time are key to reduce damage to an absolute minimum. It will save a lot of money for the taxpayer, avoid loss of human life, and enable a country to rebuild faster.

AETA for the (re)insurance industry

Insurance and reinsurance companies are major stakeholders in natural disasters. There are insurance products for various natural disasters. Think about floods, hurricanes, droughts…. We have all seen the news reporting massive claims (re)insurers have to pay after a big hurricane hits the east coast of the USA or when European countries experience extreme flooding.

In order to reduce these claims, insurers invest billions in research to better understand these natural phenomena to better assess the risk per region and to know when the next natural disaster will happen.

The same can be said regarding earthquakes and the devastation they cause. However, they are harder to predict, and the impact can be extremely devastating compared to other natural disasters.

AETA can help better understand an impending earthquake risk by sharing the data the AETA sensory system collects. The mesh network of sensors can cover huge regions and continuously collect data before, during, and after an earthquake occurs. This data can be used to sharpen risk models, feed parametric insurances, conduct fault line behaviour analysis, and much more.

Furthermore, the earthquake forecasting capability can help (re)insurers make pricing of earthquake insurance variable according to the risk, to enable hedging and financial protection, or prepare the company for faster claims handling.

Additionally, the forecasting feature can also pave the way for new insurance product designs such as “predictive earthquake insurance”.

This kind of new insurance product can be used to cover the costs of the preventive measures a city is taking to reduce the overall damage of an impending earthquake.

If the earthquake happened as forecasted, then the overall impact should be lower due to the preventive measures. As a result, the value of the claims will also be lower.

On top of that, the insurance company can also give a discount on the premium if the region is monitored by AETA’s sensors. There are numerous opportunities for the (re)insurance industry to make earthquakes more insurable.

AETA for the drilling and mining industry

Corporations that are exploiting natural resources are also great beneficiaries of the AETA solution. Earthquakes can pose a safety risk for mining companies. When there is equipment or people in the mines, they are much more vulnerable when an earthquake occurs.

Usually, mines already have seismic sensors to capture dangerous seismic activity, but they are mostly too late when an earthquake suddenly hits. Having AETA sensors around the mining site could dramatically increase the safety of everyone in and around a mining site.

Pre-operational forecasts can be made to make sure the miners and equipment are kept safe, and damage is reduced to a minimum.
The same counts for oil & gas drilling companies.

As these companies are placed under more pressure due to increased (induced) seismicity, the forecasting technology would also be a great tool to pick up their corporate social responsibility. It allows companies to live in harmony with the neighbourhood and improved overall safety against seismic hazards in the region.

Future of AETA

Among experts, a hypothesis suggests that an earthquake/volcanic eruption in one location can influence another location across the globe. This has been difficult to prove as there has never been a global deployment of sensors designed specifically to collect this type of data.

Our vision is to deploy the sensors globally and collect/share this data with our partners and academics to continuously improve the algorithm but to also begin submitting accurate forecasts to the general public.

The implications of a global network will provide an immense amount of data to the world and perhaps unveil new insights into the earth's integrity. AETA has and will continue, to research other natural disasters, using the sensors as a base for research data

Partners & sponsors

Many companies, universities, and research centres partnered with AETA.

The more prominent companies are The Capgemini group and SVV.

Founders & Team

AETA was founded by professor Wang Xin’an and Dr. Yong Shanshan. See biography below.

Professor Wang Xin’an

Wang Xin'an, Ph.D, Professor and Doctoral supervisor at Peking University.Prof. Wang mainly engages in SoC and integrated microsystems, earthquake monitoring, and prediction technology. Prof. Wang has published 260+ papers and 3 Books. He has also applied for 190+ patents, 15 of which are international PCT patents, 60 of which are authorized.

Dr. Yong Shanshan

Yong Shanshan, Ph.D., senior engineer at Peking University Shenzhen Graduate School. Dr. Yong mainly engages in SoC and integrated microsystem and earthquake monitoring and prediction technology. Dr. Yong has published 32+ papers. She has also applied for 64+ patents, 16 of which are authorized.

Additional team members

Chadwick Xu

AETA Partner | Business Advisor

Frederick Bravey

Head of Marketing | Public Relations

Niels Heffinck

Business & partnership Development

Conclusion

Mankind has never successfully forecasted earthquakes before. Until AETA's solution has made the thought of forecasting possible.

With a global earthquake forecasting system, AETA can finally bring mankind into a new era of living in a smarter globe. The implications of this technology can save thousands of lives, reduce serious damage, and decrease the amount of relief packages by billions of dollars.

The AETA project is currently in a growth stage, whereby opportunities to invest in the project's global expansion is available. This can be done by using the contact information below to learn more.

Join us and change the world.

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