Acoustic localisation in a compressed granular medium

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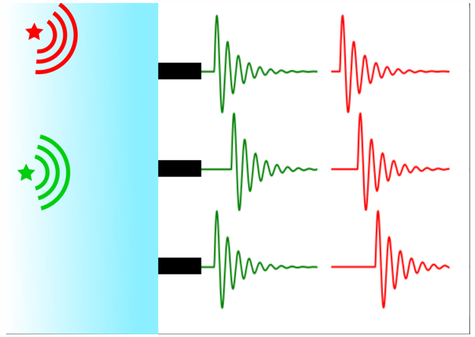
General Idea



Hyperbolic location

Potential sources — Observed TDoA

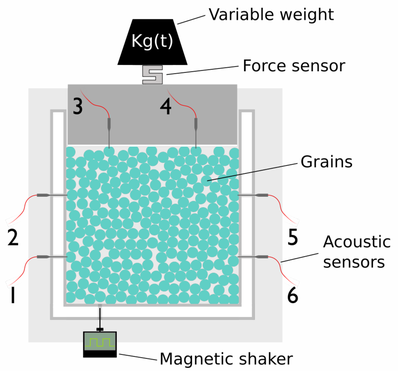
$$H = \{P : ||PF_2| - |PF_1|| = 2a\}$$

Travel time to sensor 1 & 2

Different acoustic sensors will pick up an acoustic wave at different times. We can then measure **time difference of arrival (TDoA)** between pairs of sensors.

The pattern of **time difference of arrival depends on the acoustic source location.**

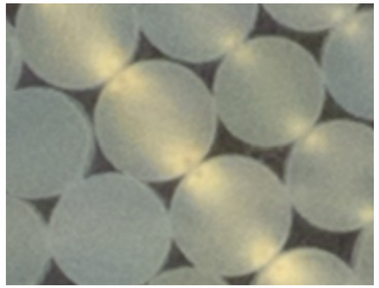
Experimental Setup



Controlled acoustic waves are emitted at the bottom of the granular pile, and then recorded by an array of 6 piezo-electric sensors. Using 6 sensors, we can measure **3 independant TDoA**.

By **modeling the acoustic propagation** and comparing with observed time differences of arrival, we can **look for points with matching TDoA.**

Propagation Modeling



Granulars are **not continuous** *(gaps between grains)* **nor isotopic** *(chain forces)*

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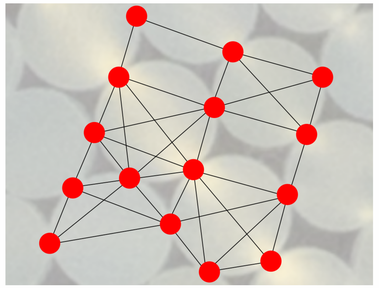
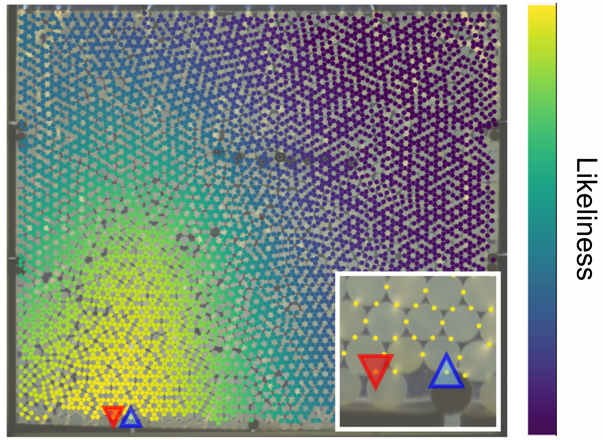
Need for a model addressing this

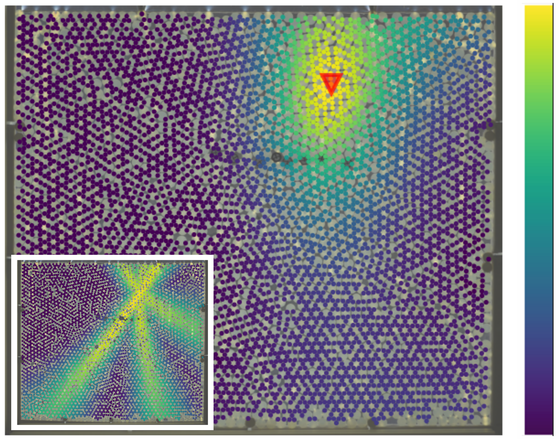


Network model with:
- **contact points** as nodes
- **edges** between nodes within a grain
- **propagation speed** along an edge depends on its stress level

Results & Performance



On controlled impacts, the **predicted source** is very close to the **ground truth.**



Spontaneous emission can also be **located** as well. While there is no ground truth for comparison, the agreement between the 3 sensor pairs lends weight to the prediction.