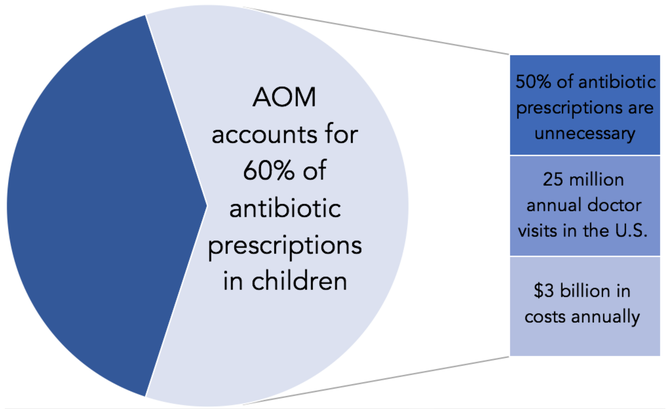
Improving Bacterial Ear Infection Diagnostics with an Image Classification Algorithm

Nick Lamb, Wanying Li, Crystal Mejia, Tiffany Tuedor, Adil Tyeb
Columbia University, Department of Biomedical Engineering, New York, NY

PROBLEM

- Acute otitis media (AOM), or ear infection, is the most common childhood infection.



- Misdiagnosis and prolonged treatment time causes a child to experience the buildup of ear pain and discomfort, and increases the likelihood of developing antimicrobial resistance.
- The use of an otoscope is the primary but inaccurate method for bacterial AOM diagnosis.

NEED

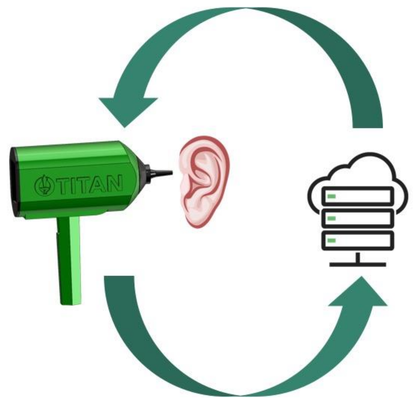
A **rapid**, **painless**, and **effective** method to detect whether an ear infection is caused by bacteria

DESIGN INPUTS

Functional Requirements	Specifications
Determine whether or not an ear infection is bacterial and inform the physician	Accuracy > 85% Sensitivity > 85% Specificity > 95%
Constraints	
Fast diagnosis <10 minutes	Easy to use for pediatricians/physicians
Lightweight <0.06 kg	Portable
Affordable $35-100	Safe/Non-invasive

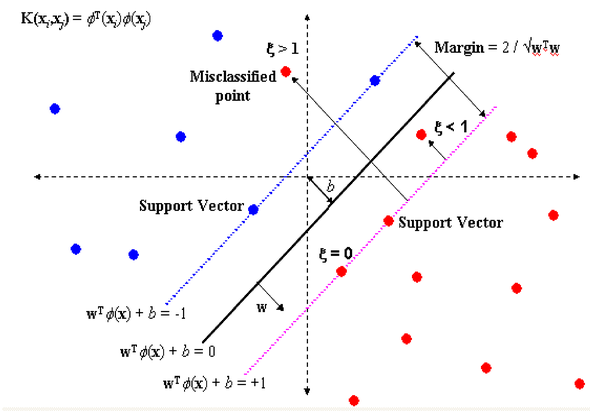
THE SOLUTION - AURI™

The presence of eardrum bulging is highly correlated with bacterial ear infections. Auri, our device, allows a doctor to view a patient's eardrum and accurately detect bulging, within 3.7 seconds.

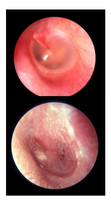


AURI captures an image of the eardrum, using our camera system, sends the image to an external server, inputs the image into an eardrum classification algorithm on a server, then returns the results back to the device. Together, they will be used in place of the otoscope.

The algorithm uses a classifier called Support Vector Machine (SVM). The classifier is defined by the hyperplane that separates the categories. Support vectors are points closest to the hyperplane. SVM assigns new points to one category based on its relation to the hyperplane.



PROTOTYPE & TESTING OUTCOMES



It is difficult to differentiate between a normal (top) and a mildly infected (bottom) eardrum using eyes alone.

	Medical Residents	ENT Doctors	AURI Algorithm
Accuracy	61%	77%	99%

Table 1. The accuracy of AURI's algorithm is much higher compared to that of residents and ENT doctors.

The computational time of the AURI algorithm is 3.7 ± 0.4 secs, which means the doctor can rapidly obtain the results.

	Targeted Specs	AURI Algorithm
Accuracy	>85%	99%
Sensitivity	>85%	86%
Specificity	>95%	99%
Precision	>85%	99%
Negative Predictive Value	>85%	99%

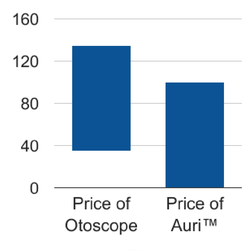
Table 2. The performance of the AURI algorithm is above the targeted specs

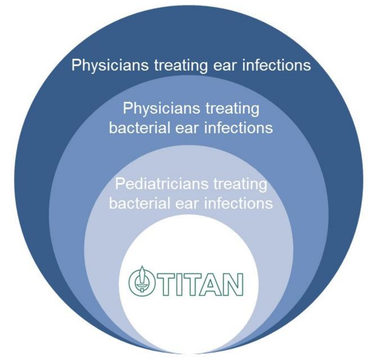
CONCLUSIONS

AURI is a **rapid** and **painless** diagnostic device that detects eardrum bulging through a machine learning algorithm, thereby providing doctors with a more **accurate** method of diagnosing bacterial ear infections.

BUSINESS MODEL

OTITAN will follow the reusable medical device business model, where the device will be used in clinics and physicians' offices. Our product will be used on different patients and will have a rechargeable battery.





10% Profit Marginx`

FUTURE WORK

- Continue to expand our image library by partnering with pediatricians, other specialists, and researchers.
- Miniaturize the product and move away from the limitations of the Raspberry Pi controller.
- Develop an iPhone part to improve user interface

ACKNOWLEDGEMENTS

We would like to give a special thanks to Tal Danino, Aaron Kyle, Dr. Naazneen Iqbal, Arthur Autz, Stefan Busheski, Josh Hughes, Columbia Health Services, and Columbia MakerSpace.

COLUMBIA ENGINEERING FOR HUMANITY