SYSTEMS AND METHODS FOR BRAIN-MACHINE-INTERFACE-AIDED FEDERATED TRAINING OF SCENT DETECTION ANIMALS

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] This applications claims the benefit of and priority to U.S. Provisional Application No. 63/220,361, filed on July 9, 2021, the contents of which are incorporated by reference in its entirety.

TECHNICAL FIELD

[0002] The present disclosure relates generally to the field of scent, odor, and chemical detection. More particularly, the present disclosure relates to efficient federated training of multiple agents, which can include service animals equipped with a neural interface.

BACKGROUND

[0003] Service animals can be used for scent detection and scent tracking across a variety of sectors and industries. Examples include police canine (K9) units used by border protection agencies across the globe, by drug enforcement agencies, or by search-and-rescue teams, Gambian rats trained to sniff out buried land mines, or truffle hunting pigs. The animals in these examples can have two things in common: (1) they remain in use in the 21st century because their exquisite sense of smell is superior to and more versatile than any portable man-made chemical sensor developed to-date, and (2) they require lengthy and expensive individual training to report the presence of a small sub-set of highly specialized odors through behavioral report. Scent detection training currently constitutes a costly and laborious investment that is only good for the working life of an individual service animal.

SUMMARY

[0004] Aspects and advantages of examples of the present disclosure will be set forth in part in the following description, or can be learned through practice of the examples.

[0005] The systems and methods of the present disclosure, in some examples, relate to an odor training and detection system. The odor training and detection system can include multiple service animals, each provided with a means by which neural activity can be read from the olfactory system, and each associated with an edge computing device containing an

updateable local database and enabled with wireless communication. The odor training and detection system can include one or multiple cloud-based servers and databases. Further, the systems and methods of the present disclosure, in some examples, relate to a family of anchor odor sets and computational methods that enable the alignment of olfactory maps across individual animals into a common coordinate framework. Additionally, the systems and methods of the present disclosure, in some examples, relate to a means of computing and communicating (in a privacy-preserving manner if desirable) federated updates to olfactory decoding models between the local databases on the "edge" and the cloud database(s).

[0005a] In one aspect, the present disclosure refers to a scent detection system for detecting volatile chemical compounds comprising, a plurality of animals equipped with, a means of recording neural activity from an olfactory system or portion thereof, an edge computing device equipped with a local database and wireless communication, and one or multiple server-side databases in a cloud.

[0005b] In another aspect, the present disclosure refers to a method comprising, providing a family of anchor odor panels, and aligning individual animal's olfactory neural signatures into a common coordinate framework.

[0005c] In yet another aspect, the present disclosure refers to a method of federated improvement of cloud-based scent decoding machine learning models, the method comprising, computing scent model weight updates on an edge device in common coordinate framework coordinates, communicating encrypted scent model updates to a cloud, and incorporating scent model updates into cloud-based model in cryptographic space.

[0006] These and other features, aspects, and advantages of various examples of the present disclosure will become better understood with reference to the following description and appended claims. The accompanying drawings, which are incorporated in and constitute a part of this specification, illustrate examples of the present disclosure and, together with the description, serve to explain the related principles.

BRIEF DESCRIPTION OF THE DRAWINGS

[0007] The details of one or more implementations of the subject matter described in this specification are set forth in the accompanying drawings and the description below. Other

features, aspects, and advantages of the subject matter will become apparent from the description, the drawings, and the claims.

[0008] FIG. 1 illustrates a schematic of a scent detection system, according to an embodiment.

[0009] FIG. 2 illustrates a method of aligning neural signatures, according to an embodiment.

[0010] FIG. 3 illustrates a method of federated improvement of cloud-based scent decoding machine learning models, according to an embodiment.

[0011] Like reference numbers and designations in the various drawings indicate like elements.

DETAILED DESCRIPTION

[0012] This disclosure relates generally to animal-based odor detection systems and methods for the federated training thereof. Federated training (e.g., federated learning,