Cloud Mediated Nature Observation

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I. Introduction

Scientific study of animals in situ requires vigilant observation of detailed animal behavior over weeks or months. When animals live in remote and/or inhospitable locations, observation can be an arduous, expensive, dangerous, and lonely experience for scientists. Emerging advances in cloud computing, robot cameras, long-range wireless networking, and distributed sensors make feasible a new class of portable robotic observatories that can allow groups of scientists, via the Internet, to remotely observe, record, and index detailed animal activity. One challenge is to develop a cloud mediated mathematical framework for collaborative observation. Collaborative observation includes (1) collaboration between humans of different backgrounds, skill sets, and authority/permission levels, (2) collaboration between humans and automated agents whose behavior arises from sensor inputs and/or computation, and (3) automatic detection of species and activities.

II. Cloud Mediate Nature Observation

Recently, Cloud Computing services like Amazon's EC2 elastic computing engine provide massively-parallel computation on demand [1]. Examples include Amazon Web Services [2] Elastic Compute Cloud, known as EC2 [3], Google Compute Engine [4], Microsoft Azure [5]. These rovide a large pool of computing resources that can be rented by the public for short-term computing tasks. These services were originally used primarily by web application developers, but have increasingly been used in scientific and technical high performance computing (HPC) applications [6]–[9]. Cloud computing is challenging when there are real-time constraints [10]; this is an active area of research. Real-time video and image analysis can be performed in the Cloud [11] [12] [13]. Image processing in the cloud has been used for assistive technology for the visually impaired [14] and for senior citizens [15].

Cloud computing provide a new platform for networked robots and an enabling platform for integrating humans, robots, and sensors to a cloud-mediated nature observation system. Fig. 1 illustrates an overall diagram of the cloud mediated nature observation system which includes the following topics that will be detailed in the talk:

This work is funded in part by National Science Foundation under 0534848/0535218, CAREER-0643298 and IIS-1318638, by Microsoft, Inc., and by Panasonic, Inc.

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- Collaborative Teleoperation: how can we cloud computing to allow multiple users to tele-operate one or multiple robotic devices [16]–[18].
- Robotic BioTelemetry: how to enable automatic observation by developing animal recognition algorithms that leverage computation resource and database in the cloud [19]–[22].
- Crowd Sourcing: how can we combine machine diligence and human intelligence for sustainable nature observation [23]–[26].

I will summarize our years' development of algorithms, systems, lessons learned, and results of field experiments. More information of the projects can be found at `http://telerobot.cs.tamu.edu/projects.shtml`.

Acknowledgment

The project is a collaborative contribution of a large research team incluing Ken Goldberg (UC Berkeley), Ni Qin, Yiliang Xu, Wen Li, and Chang Young Kim (Texas A&M University), Jingtai Liu and Hongpeng Wang (Nankai University, China), Ron Rohrbach and John Fitzpatrick (Cornell Lab of Ornithology), David Luneau (University of Arkansas at Little Rock), John Rappole (Smithsonian), and Selma Glasscock (Welder Wildlife Foundation). We would like to thank Y. Lu, M. Hielsberg, J. Lee, Z. Gui, S. Jacob, P. Peelen, and X. Wang for their inputs on this work and contributions to the Networked Robots Lab at Texas A&M University.

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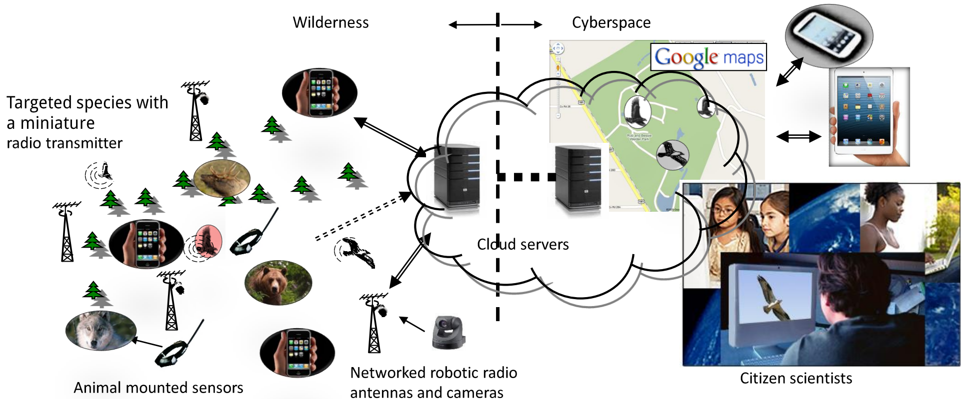

Fig. 1: System architecture for cloud-mediated nature observation.

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