Citizen Engineering: Crowdsourcing for Urgent Human Computing

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1. Motivation

Thousands of post-disaster photos need to be tag.
It takes small group of experts 1 month, too slow!
It takes thousands of citizen workers 2 days, great!

When natural or man-made disasters happen, efficient post-disaster responses could help save lives and accelerate disaster recovery. Field reconnaissance generates thousands of images, both aerial and street level, of damaged infrastructure and debris that must be examined. However, common problems like image filtering and classification cannot be easily solved by computers. It takes a PhD student years to design and optimize computer algorithms and takes experts weeks or even months to tag those huge amount of photos.

To solve this problem, we propose the concept of "Urgent Human Computing" and explore to achieve it by "crowdsourcing".

2. Introduction

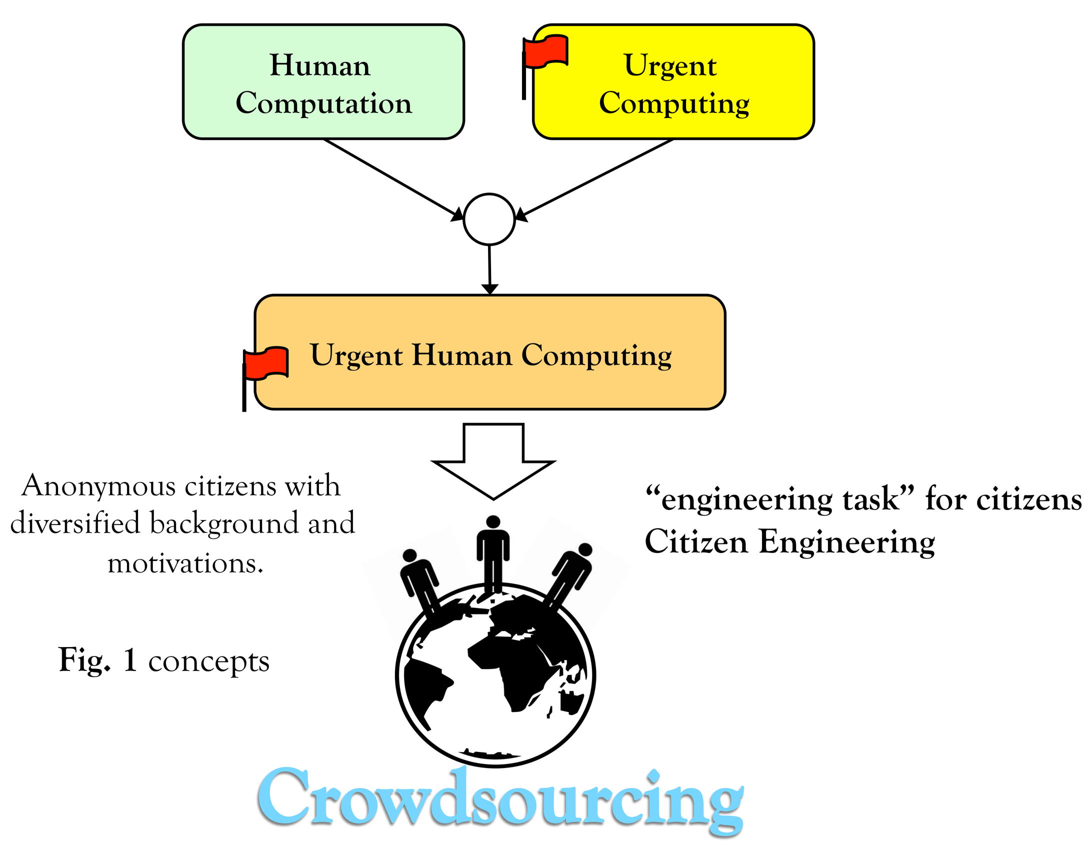

Fig. 1 concepts

- **"Urgent Computing"** means providing prioritized and immediate access to supercomputers and grids for emergency computations [1].
- **"Human Computation"** is "a paradigm for utilizing human processing power to solve problems that computers cannot yet solve."[2]
- **"Urgent Human Computing"** is an extension of "Urgent Computing" where supercomputers and grids are replaced by on-demand human workers.
- **"Crowdsourcing"** for Urgent Human Computing releasing tasks to an open community rather than a designated agent.
- **"Citizen Engineering"** is a general concept that refers to using a cohort of physically dispersed citizens connected by the Internet to solve real-world "engineering tasks" [3][5].

Research Problem

- How to get reliable results when we "crowdsource" challenging human computation tasks to unknown citizen workers?

3. Experiment on Mechanical Turk – Task Design

Overview

In this project, we explore both task design and algorithm design approaches to achieve reliable answers under time and cost limits. We are crowdsourcing a Haiti earthquake photo-tagging task – classifying damage patterns in post-disaster photos, to Mechanical Turk. The results are to be compared with previous experiments with college students and civil engineering graduates (experts) [3].

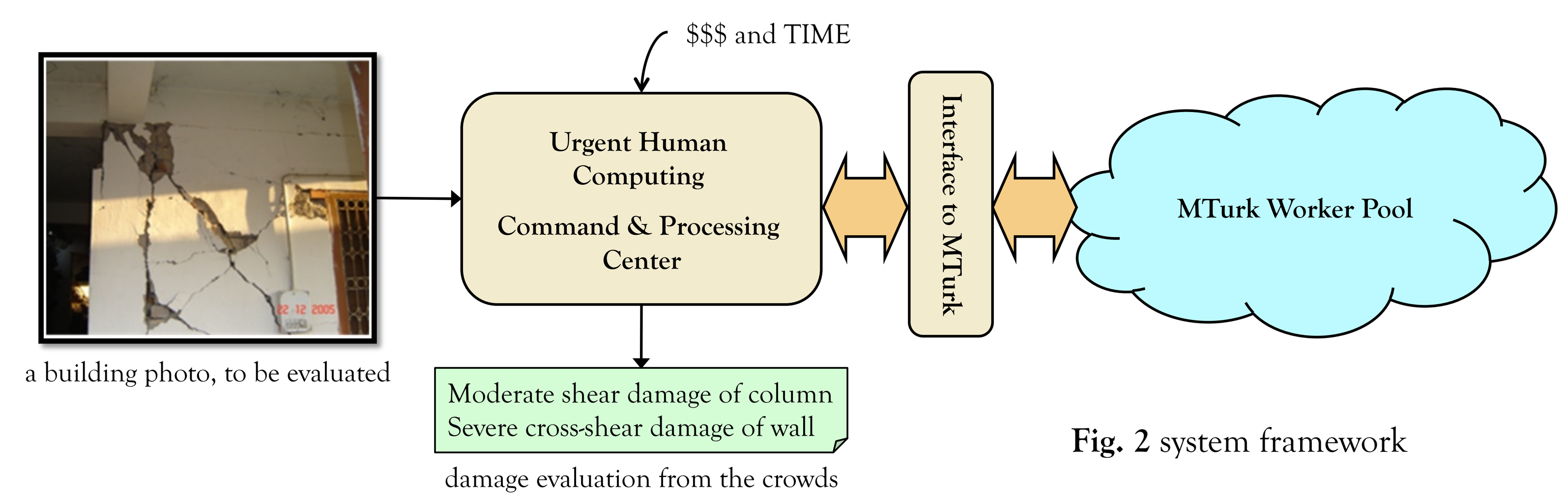

Fig. 2 system framework

Task Decomposition

We decompose the complex task into 3 small ones (i.e. 3 layers) that workers without civil engineering background are able to complete. Only after one layer is finished, do we go on to the next layer and in layer 3, four threads each for one building element are going on at the same time. This serial-parallel hybrid structure will help us get more reliable results since the decision of each layer is derived from the crowd-wisdom rather than an individual.

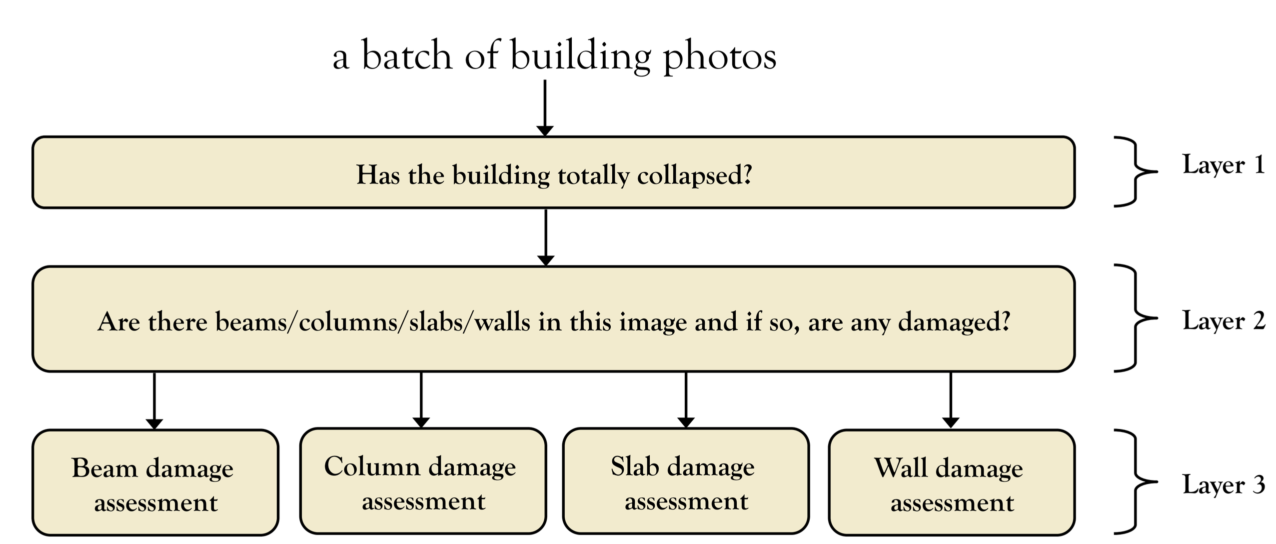

Fig. 3 task decomposed to a 3-layered structure.

Workflow Design

In order to filter out low quality workers and improve work quality, we designed a workflow with qualification tests and a bonus incentive. A qualification test includes a tutorial and several questions that are exactly the same as those in real tasks. For each layer, the worker has to pass the test for that layer to be "qualified" to work on the task. Workers are also told that they would receive a bonus if they perform well on the tasks. Bonus is given to workers according to the estimated correction rate of their answers.

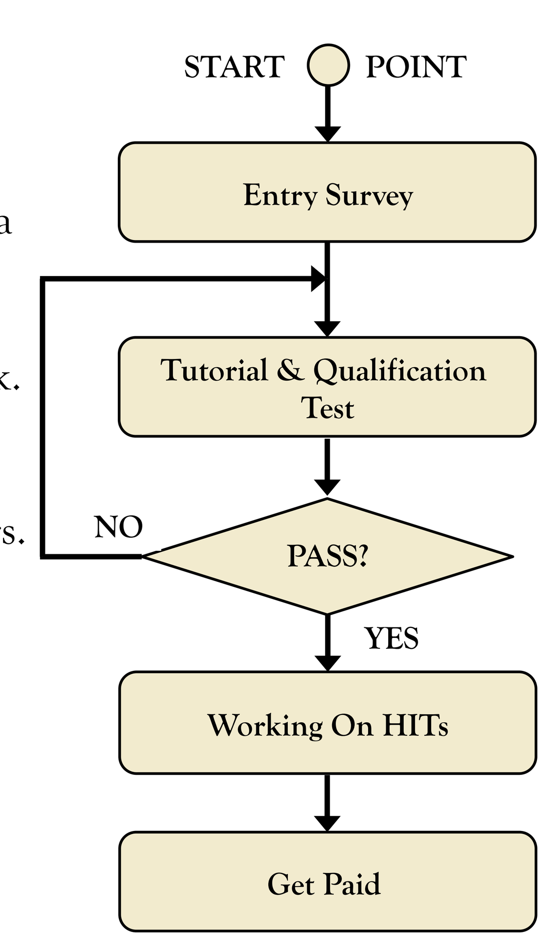

Fig. 4 workflow for Turk workers

Task Design Techniques

- 3-layered structure
- Entry survey & qualification test
- Bonus incentive

3. Experiment on Mechanical Turk – Algorithm Design

Quality Control Algorithm

Quality control algorithms are introduced to filter out "noisy" input, to grade workers and to improve overall work quality. The algorithm is running on a local computer and it is able to communicate with Mechanical Turk through API interface.

The first technique is to grade workers by estimated answers and then to select out the most possible answer through "weighted voting" (i.e. answer is more biased to highly graded workers). The estimated answer comes from crowd consensus. At first the answer is determined by the majority but we can iteratively grade workers and voting for answers to improve the reliability of answers [4].

The other technique is to outsource the problems to field experts (expert-sourcing) such as graduate students, professors and engineers and get authoritative answers, i.e. gold standard. We can use expert-sourcing to solve "difficult" tasks to which crowd workers don't have any consensus. Or we can use the experts' answers as grading reference, by looking at workers' performance on expert-sourced task, we can give more objective grades.

Algorithm Design Techniques

- Worker grading and weighted voting
- Expert-sourcing and gold standard

4. Contributions and Future Work

Contributions

- Design and Implementation: a system crowdsourcing "engineering task" to Mechanical Turk workers
- Exploration: difficulties and problems in the area of "Urgent Human Computing"

Future Work

- **EFFICIENCY-ECONOMY-QUALITY:** How to coordinate speed, economy and quality? Difference among experts, closed community and open community?
- **RECRUITING:** How to attract workers and reduce response time? Pushing task news, fair payment, long-term business relationship.
- **SIMULATION:** How to optimize parameters and validate design ideas? Is human computation simulation possible?

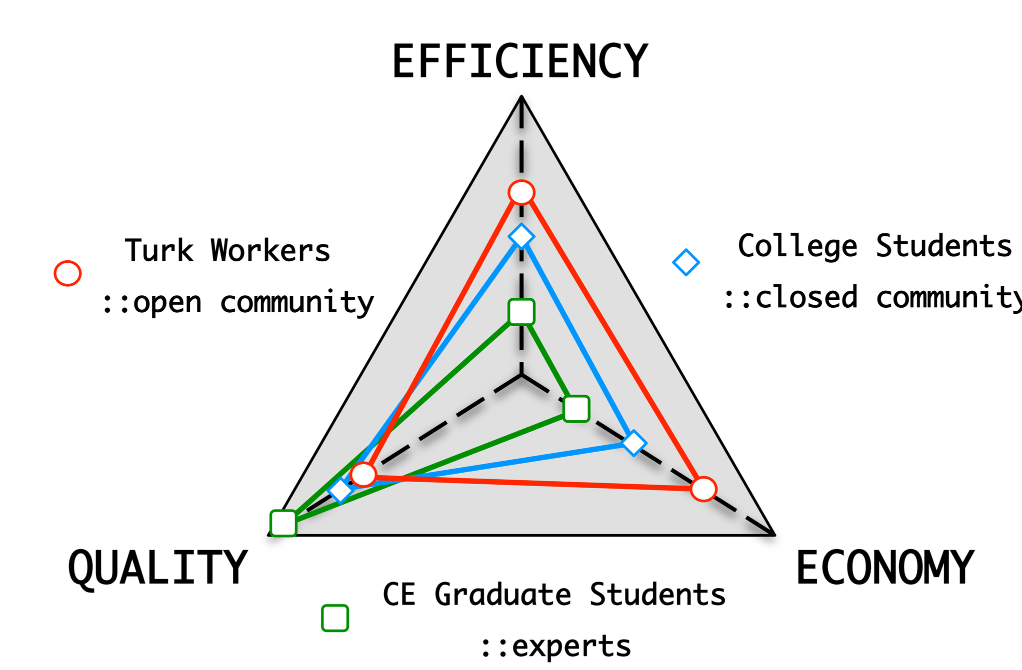

Fig. 5 efficiency-economy-quality triangle

Acknowledgements and References

Acknowledgements

The research presented in this paper was supported in part by the Notre Dame iSURE program and an award from the National Science Foundation, under Grant No. CBET-0941565 for a project entitled *Open Sourcing the Design of Civil Infrastructure (OSD-CI).*

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