Motivating Urban Cycling Through a Blockchain-Based Financial Incentives System

Caroline Jaffe, Cristina Mata, Sepandar Kamvar
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MIT Media Lab

Overview

As cities become increasingly dense, they must use novel technologies to address new mobility challenges. **50% of trips in the U.S. are less than 3 miles**, and could be replaced by a more sustainable and space-efficient mode of transportation, such as bicycling, if effective policies and incentives were implemented.

This poster presents a **blockchain-based financial incentives system to encourage urban cycling**. The system allows cyclists to receive financial compensation from organizations, such as city governments or local businesses, that would like to sponsor cycling. Using bicycle-powered sensors, cyclists collect and redeem activity data through smart contracts stored and executed on an Ethereum blockchain.

This project envisions **expanding this data platform to include additional bicycle-based sensors** that cyclists can use to collect and sell data, monetizing their commuting habits, and **building a scalable and stable solution for encouraging sustainable transportation in cities**.

Motivation
- Build a framework that allows organizations to internalize the positive externalities of urban cycling
- Provide strong incentives to both cyclists and organizations
- Increase the proportion of cyclists in cities in a way that is self-sustaining and engaging

Background

Positive Externalities of Urban Cycling
- Zero-emissions transportation
- Reduces congestion
- Improves public health
- Increases worker productivity
- Equitable and accessible form of transportation

Related Efforts
- Nudge behavioral studies
- Grassroots and data-based transportation advocacy
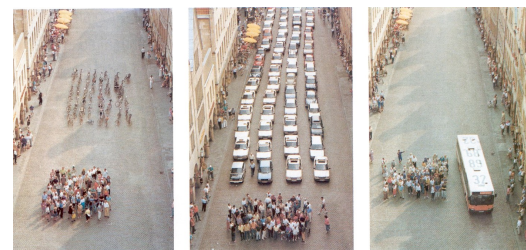- Government-led financial incentives programs (direct or tax-based)

Figure 1: Space requirements of different modes of travel

Technical Implementation

Our **proof-of-concept system deployment** consisted of a network of bicycle-mounted sensor devices and traditional desktop hardware that shared an Ethereum blockchain database and interfaced via smart contracts running on that blockchain network.

Blockchain Database & Smart Contracts
- Ethereum blockchain provides a mechanism to execute logic and manage node interactions via smart contracts
- Embedded devices (e.g. bicycle GPS sensors) run power- and space-efficient light clients
- Desktop hardware operated by organizations run full clients
- Nodes share a blockchain database and communicate over blockchain network

Sensor Device
- A single-board computer that runs an Ethereum light client and interfaces with a GPS/ GSM module
- Collects cyclists' activity data and connects to the blockchain network over a cellular connection
- Raspberry Pi and Adafruit FONA (SIM808 GPS/ GSM module)

Power Supply & Data Validation
- Sensor is powered by regulated Lithium Ion batteries
- A generator affixed to the bicycle wheel recharges the batteries when the bicycle is moving
- The ability to detect when the bicycle is in motion (e.g. when it is generating power) allows us to validate the activity data the sensor collects
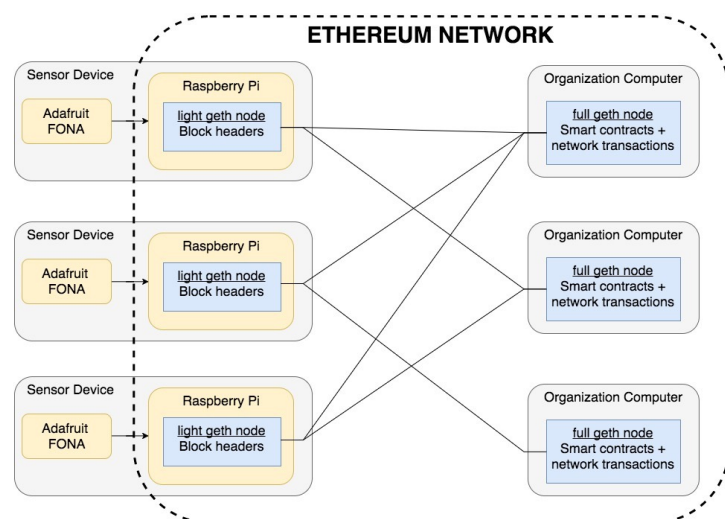

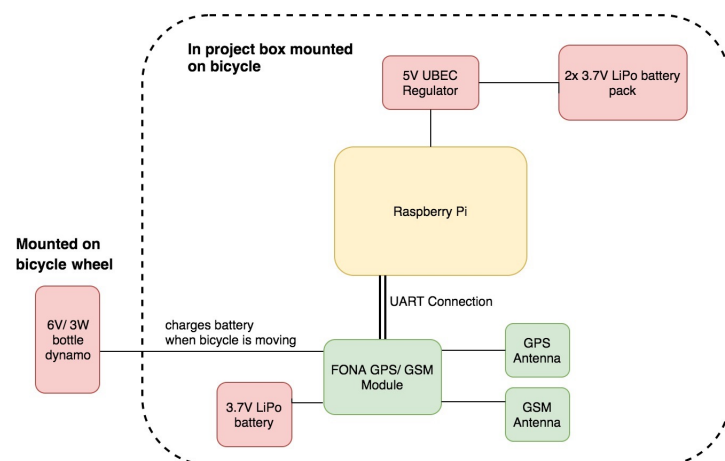**Figure 2:** High-level system architecture design diagram

Figure 3: Hardware architecture diagram

Evaluation & Contribution

We built and deployed an end-to-end proof-of-concept version of our system that allowed us to **evaluate the project's technical architecture and overall concept.**

We see this work as a building block for a **new paradigm around monetizing urban data**, and as a powerful tool for rewarding and incentivizing sustainable behavior.

Contributions
- Design a blockchain protocol that supports a financial incentives system for cyclists
- Build and deploy a proof-of-concept implementation of the GPS sensor device and blockchain application
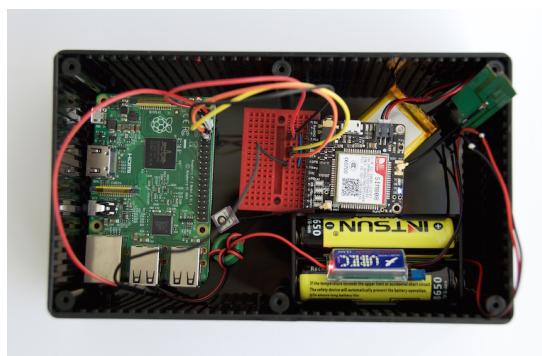- Technical evaluation of system protocol

Figure 4: Sensor device in electronics box

We assembled a sensor device that was programmed to initialize a blockchain node and connect to the blockchain network. The sensor's hard-coded configuration settings allowed it to distinguish and identify itself on the network.
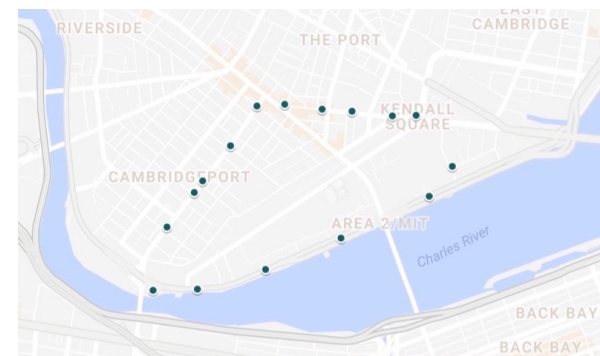

Figure 5: Cyclist's GPS data points from test deployment

On a 3 mile ride, the cyclist in our test was able to earn 0.0203 Ether, or $1.75. This test deployment verified the system's core technical components, including the ability to run a blockchain node and to send and receive behavior-based financial rewards.