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# Tangible Cryptocurrency

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## **Abstract**

This paper describes an information visualization system with an embedded computing object that functions independently and as a tangible in a TUI (tangible user interface). Current and historical prices for Bitcoin are collected and analyzed for changes in value over time. The amount and direction of change in these values over the past day is communicated through object's light levels and color values. When the object is used as a tangible, the TUI surface displays graphics, connected to the object, that indicate Bitcoin values and changes for the previous week.

## **Author Keywords**

Tangible computing, industrial design, interaction design, digital currency, cryptocurrency, embedded computing, ambient user interface, information decoration, information design.

## **ACM Classification Keywords**

• **Human-centered computing~Information visualization** • *Human-centered computing~User interface design* • *Human-centered computing~Interface design prototyping* • *Human-centered computing~Ubiquitous computing*

## **Introduction**

*History of Money*

Beginning ten thousand years ago, civilizations and societies used some form of physical property or

material for the purpose of exchanging goods. In Mesopotamia, a barter system incorporating livestock, property, weapons, and other items of value evolved into organized exchanges where grains were traded and tokens were created to signify transactions. In western and central Asia, precious metals along with other items including beads, stones, and animal skins were used to in trade during the seventh millennium BC. The first coins were created in the ancient kingdom of Lydia, located on what is now the western coast of Turkey during the same time period. [1] Coins and paper currency have been used for financial transactions to the present day. Currently, transactions can be performed as an exchange of information through credit cards and online banking. At the same time, we continue to use physical currency as money.

#### *Cryptocurrency*

First described in 1998, and realized in 2009, Bitcoin (BTC) became the first open-source digital, or cryptocurrency. Cryptocurrencies are not are not part of on an established currency market with the support of a government monetary system. They are created through a network of users and developers. A public ledger, a block chain, keeps track of all transactions and verifies their authenticity through confirmations by a number of digital signatures around the world. [2] Currently, there are twenty cryptocurrencies listed on the Poloniex Exchange, an online exchange. [3] The values of many cryptocurrencies have increased greatly over the past five years. In the past year, the increase in value for Bitcoin has been tremendous, [4] creating much publicity. For example, the music artist Bjork gave AudioCoins, a digital currency connected directly to Bitcoin, to buyers of her latest album. [5] The value of Bitcoin fluctuates, often in great amounts, from day

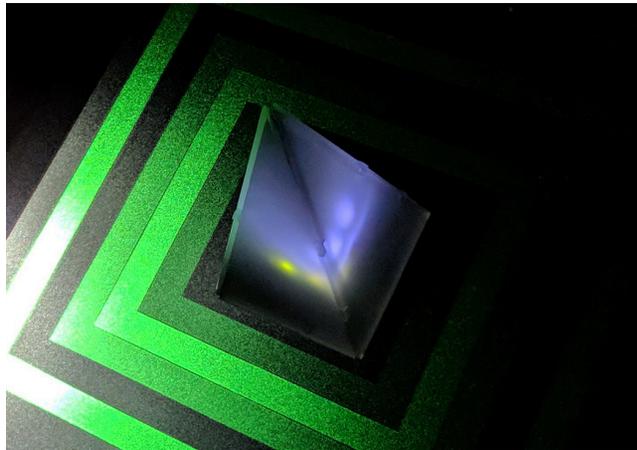
to day. [6] Bitcoin is currently in a period of mixed acceptance by financial institutions and governments, creating uncertainty for the future. [7] The value of Bitcoin remains volatile. [8]

#### *Tangible Cryptocurrency*

In this project, the change in value, for one week, for Bitcoin, is represented in an embedded computing object and TUI. The object communicates the change in BTC value from yesterday to today. The TUI adds information for an additional week of value changes. The object is a pyramid form with a microprocessor and LEDs (Light Emitting Diodes). The pyramid contains white, green, and red LEDs. The microprocessor is programmed to periodically collect and compare the current value of Bitcoin and the value of the closing value from the previous day using a web api (application programming interface). The amount of change in the two values is translated into brightness values for the white LEDs in the object. The greater the change, the brighter the white light. The direction of the change is communicated by turning green (positive) and red (negative) lights on and off. By communicating information through the transmission of light color and value, the pyramid is an AUI (ambient user interface). [9] Because this object can be placed in an environment where the user monitors it in a peripheral manner, it is also an implementation of information decoration. [10]

When the pyramid signals information that is of interest, it can be moved and placed on a TUI surface where it acts as a tangible object. Graphics are displayed on the surface and registered to the object's position. In the TUI, graphics are generated by software that queries the same Bitcoin data api used by

the pyramid's microprocessor. Squares of a consistent scale factor are displayed outward from the pyramid tangible. The color of each square, green or red, indicates a positive or negative change from the closing market value for Bitcoin from one day to the next. The saturation value of color is a reflection of the amount of change in that time period. The greater the saturation value, the greater the change.



**Figure 1:** TUI - pyramid object, BTC value changes for week.

## **Background**

### *Project Goals*

This project is an exploration and implementation of information design for cryptocurrencies. Bitcoin is used as a specific example. Because Bitcoin is a virtual currency, there are no design constraints for a material equivalent. Design concepts and experiments exist, based on traditional representations of currency, [11] but, there is no official BTC coin or paper currency. In this project, design is not based on the familiar

representations of currency. The embedded object communicates information through the transmission of light color and value. Information at the micro level, is shown for the change in one day of information. When the pyramid object is placed on the TUI surface, it is connected to a graphic design that, as whole, displays the changes in each day for one week, creating a micro and macro level information design. [12] The pyramid object (3 x 3 x 6.5 inches) is designed for use in a social space (4 to 12 feet). When it is used as a tangible in the TUI, it is manipulated and experienced in an intimate space (under 1.5 feet). [13]

### *Comparison with Existing Tools*

There are several websites and smart phone apps that provide current and historical data for Bitcoin and other digital currencies. [14] These information sources present data for values within time periods determined by the viewer. In this project, information is communicated through an object and surface display. The information design does not contain text or numbers. It is an experiment in ubiquitous computing design for transmitting data by objects that are part of an environment peripherally. Placing the object on a TUI surface, it serves a tangible object, activating contextual displays of information.

## **Related Work**

There have been experiments in the design of physical currency for Bitcoin. Block Bills, [15] is an artistic visualization of BTC paper currency. Casascius Bitcoins include a digital wallet inside coins to make them functional as money. [16] These examples are designs based on expectations for physical currency. Scrip is a design concept for a hand-held device with a surface that changes to provide tactile feedback for

## Pyramid Object

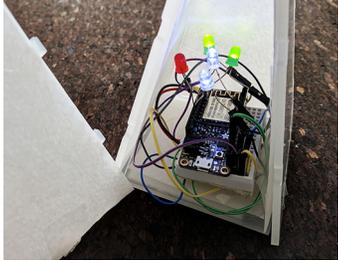


Figure 2: Interior – components.

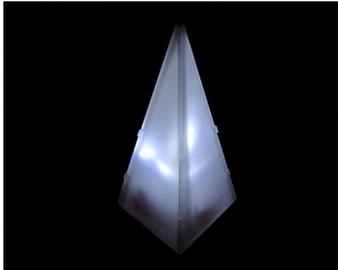


Figure 3: Exterior - white light.



Figure 4: Base - fiducial marker.

transactions for digital currencies. [17] In Proverbial Wallets, a research project, wallets are designed with the ability to provide tangible feedback for financial information and transactions. [18] Datafountain, is an implementation of information decoration. Relative currency rates are displayed using water fountain levels. [19]

## System Design

### Information Design

Initial concepts for design included design for representations of digital wallets and decorative animations based on current and historical currency values. In the pyramid object, information is transmitted through light value and color. The brightness of white light is connected to the change in BTC value for the previous day. Green light is an indication of a positive change. Red light is an indication of a negative change. This correlation between colors, color value, and meaning is consistent with color choices and saturation values in the graphics displayed in the TUI.

### Embedded Computing Object Design

This component is an exploration of ubiquitous computing design with industrial design and the use of light to transmit information. The object is to be placed in an environment where it can be monitored peripherally. Using the ESP8266 microprocessor, with Arduino software, current and historical BTC value data is gathered from the coindesk.com api by WiFi. Data is evaluated and used to control the LEDs. The design of the object, using a pyramid form, semi-transparent acrylic, and shoji (fiberglass) paper is influenced by the work of Thomas Wilfred (1889 – 1968), who used light in 'lumia' performances and stand-alone artworks. [20]

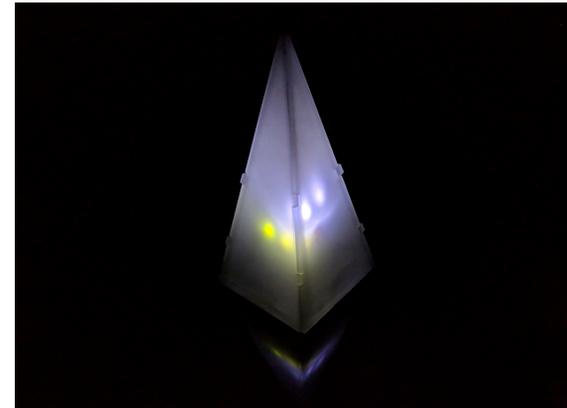


Figure 5: Pyramid indicating BTC value change, one day.

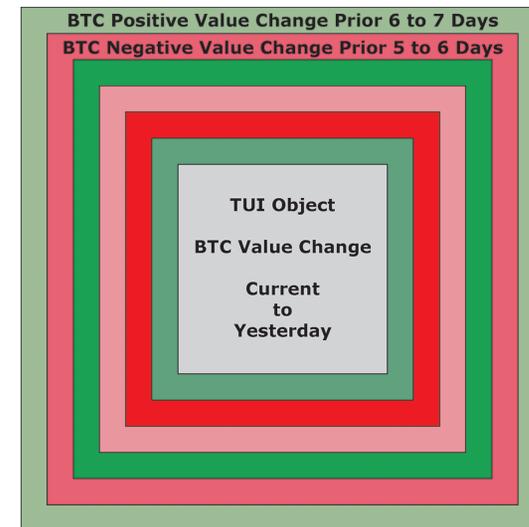
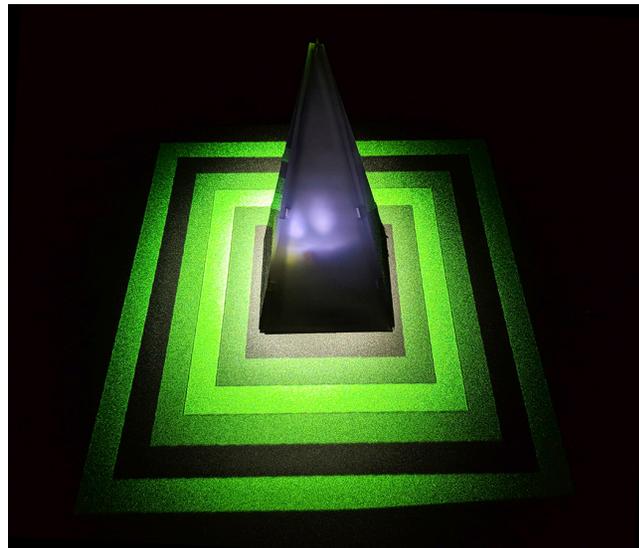


Figure 6: TUI information design. BTC changes, one week.

### *Tangible User Interface Design*

The pyramid object is lightweight with a fiducial marker on the base for recognition by reactIVision. By placing the object on the TUI surface, graphics generated from Processing software are displayed. Squares representing changes in value are displayed from the base of the tangible outwards. Seven days of data are shown. Current and historical BTC value data is gathered from the coindesk.com api. Each square, communicates the amount of change in value for one day, and, indicates a positive negative change. Moving the pyramid object updates the position of the graphics as well. The entire information design remains connected as shown in figure 7.



**Figure 7:** Pyramid as tangible on TUI surface with graphics.

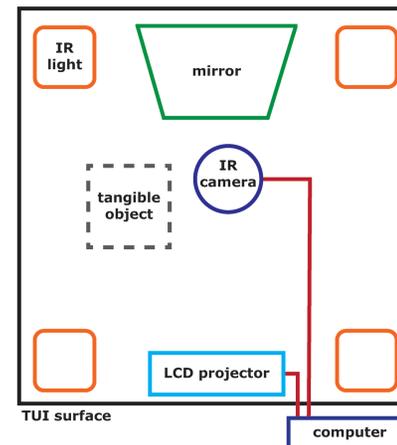
### **Technical Implementation**

#### *Pyramid Embedded Object*

- Laser-cut semi-transparent acrylic
- LEDs
- ESP8266 with WiFi, lithium ion battery
- Arduino 1.8.5

#### *Tangible User Interface*

- Computer, Apple MacBook Pro, OS 10.11
- reactIVision 1.5.1
- Processing 2.2.1
- InFocus IN1100 projector
- Apple iSight camera modified for IR (infrared)
- Four sets of IR lights
- One mirror
- Surface, acrylic sheet, matte finish, 24" square



**Figure 8:** TUI components – top view.

## Evaluation and Discussion

There was no user testing for this project. Future implementations will benefit from input for user experience. The pyramid object is of a dimension that makes it usable as a tangible object, but it would be good to gather information on the experience of users at different ages and abilities. The setting for the TUI is not determined. The project is an exploration of design for an embedded computing object that is used in a TUI, but the exact user scenario for the TUI is not established. Possible implementations include, exhibition design, and education design.

## Conclusions and Future Work

This is one concept and implementation for a physical representation of one digital currency. More designs for information visualizations are possible. The project could include the ability to have different modes of functionality in the TUI. Early concepts included the ability to rotate the tangible to cause the interface capabilities to change. The incorporation of cryptocurrency transactions including displays of information for digital wallets, along with other visualizations of digital currency information would be interesting to include. Future implementations might include more than one digital currency. Several embedded computing objects, each displaying information for one cryptocurrency, could be added. The TUI would recognize more than one digital currency object and information can be displayed that allows for comparisons of data between several currencies at one time. The ability to interact with the display of information in a TUI system has been found to support cognition and enable creative immersion in information. [21] In future implementations, there could be displays

and designs for interactions with cryptocurrency data that utilize this aspect of TUI systems.

## Acknowledgements

[Names, affiliations]

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## Tags

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