TwitterViz: A Robotics System for Remote Data Visualization

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Abstract

We demonstrate a portable and functional Internet-connected robotics system called TwitterViz, which visualizes real-time Twitter data on a kinetic sculpture. The purpose of our project is to explore how robotics can 'understand' and visualize remote data streams. We have constructed an overall system architecture with custom hardware and software that drives a robotic sculpture in real-time. Our system monitors Twitter data from the public API feed, analyzes the Tweets, and then converts the Tweets to motion on a kinetic robot. Our live demonstration of the TwitterViz robotics system fits onto a desktop, and includes the functioning kinetic robot, mini-ITX server, display for raw Tweets, and 4G connectivity to communicate with the Twitter API.

Introduction

Advances in robotics may be entering an exponential phase of growth. In 1965, Gordon Moore correctly predicted that a long-term trend of computing power growth was underway, based on his observation that microchip transistor densities were regularly doubling every 2 years. Robotics is now capitalizing on modern-day exponential trends such as Internet Bandwidth, Networked Sensors, Digital Storage, and Machine Learning. Our project explores how robotics can use these trends to analyze and visualize data streams, whether analytical or social.

Our demonstration consists of a custom-built robotics system we call TwitterViz, which lets us download and store real-time Twitter data from the public API data feed. We then process and animate the Tweets on a robotic kinetic sculpture using microcontrollers and stepper motors. TwitterViz builds upon our previous robotics system called WeatherViz, which converted remote weather radar data into motion. Our current project analyzes social media data metrics instead.

TwitterViz Hardware

The main TwitterViz hardware components consist of (1) The robotic sculptures, (2) Omega stepper motor controllers, (3) Arduino microcontrollers, (4) a 4G connected Core 2 Duo mini-ITX computer with monitor.

The Robotic Sculptures: Prototype and Full-scale

During the course of our research, we built two robotic sculptures: one proof-of-concept desktop robot, and one large aesthetic robot suitable for art installations. The sculptures utilize stepper motors to provide a wide range of kinetic motion. Our base system can be adapted to most any remote data feed – in TwitterViz, we use robotics to visualize the Intensity and Sentiment components of information flowing over Twitter.

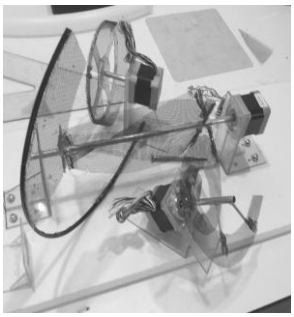

Figure 1. Prototype Robot

Figure 2. Full-scale Robot

Our robotic sculptures utilize color coded moving mesh components to represent changes in Twitter, where motion corresponds to changes in 'Intensity' (Tweet Volume) and 'Sentiment' (Tweet Emotional Content). A computer monitor simultaneously displays the actual Twitter data feed driving the robot. The robot's motors receive motion instructions from the micro-controllers and the computer, which in-turn receives the raw Tweet data from Internet via 4G. The computer maps real-time Twitter Intensity and Sentiment data from the Twitter stream to robot motion patterns, such as angular velocity and angular acceleration.

Arduino Microcontrollers and Stepper Motors

The Omega Stepper Motors in our robotic sculpture create the kinetic motion to represent Twitter metric changes over time. We drive our Omega stepper motors using an Omega 3540M driver unit. We utilize micro stepping in our application because it gives the aesthetically smoothest operation (2000 steps/rev). The Omega driver is controlled from an Arduino Microcontroller, which runs custom code written in Processing (Banzi, 2010), which sends RPM updates to the motor driver as they are received from the computer. The computer speaks to the Arduino via USB ports running the Firmata Protocol (Steiner, 2010).

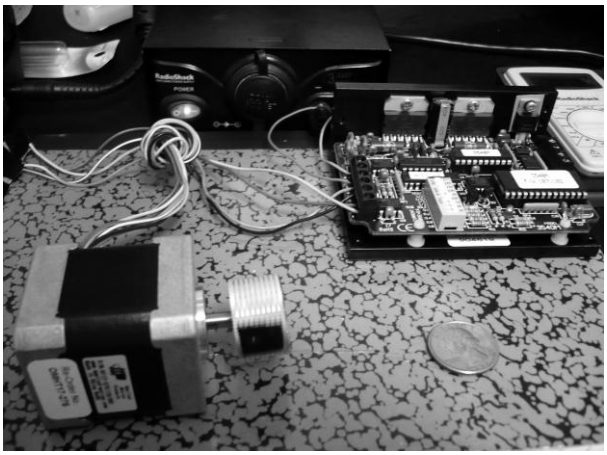

Figure 3. Omega Stepper Motor and 3540M

TwitterViz Software

The TwitterViz Software was adapted from our previous WeatherViz software, which was written in C#. TwitterViz includes a Python script which connects to the Twitter RESTful API using a developer key, and retrieves streaming information from both the current 'garden hose' (a total ~1% statistical sampling of all Tweets), as well as a sub-set of Tweets filtered by a user-specified keyword.

The software runs on a mini-ITX Core2 Duo computer, and consists of 1) an Internet-connected Twitter data scraper with statistical auto-analysis and SQL database, 2) an integrated GUI tool that drives the robot sculpture by letting the user select Tweet feed keywords, displaying raw Tweets and classified sentiment; and synchronizing the microcontroller interface to the current data stream, for parameters of Tweet Intensity and Tweet Sentiment.

TwitterVizNetwork Software

We have adapted our WeatherViz Network software for Twitter to download and store the Twitter JSON object data from the RESTful data feed in a mySQL database. The object metadata is timestamped and stored for analysis using our existing graphing and analytical tools written for our previous robotics visualization projects. The database of Tweets is stored on a large terabyte archive partition utilizing key indexing. We make continuous updates to the SQL database as the Tweets flow in from the network. We also store associated metadata, which are included in the JSON objects provided by Twitter. Tweets include source username, time stamp, Twitter message content, user information, and optional geolocation data.

TwitterVizWorkbench Software

We have adapted our WeatherViz software to conduct analysis on Twitter feeds, in order to produce two parameters with which to drive our robotic sculpture – 1) That of 'Intensity', which represents the overall Twitter data flow rate (Tweets/second) in real-time -- which is converted to kinetic motion. The second parameters is that of 'Sentiment', for which we use open-source sentiment analysis tools to classify Tweets as to their linguistic sentiment (positive emotion or negative emotion), which then effects the motion of the sculpture (and underlying stepper motors) accordingly.

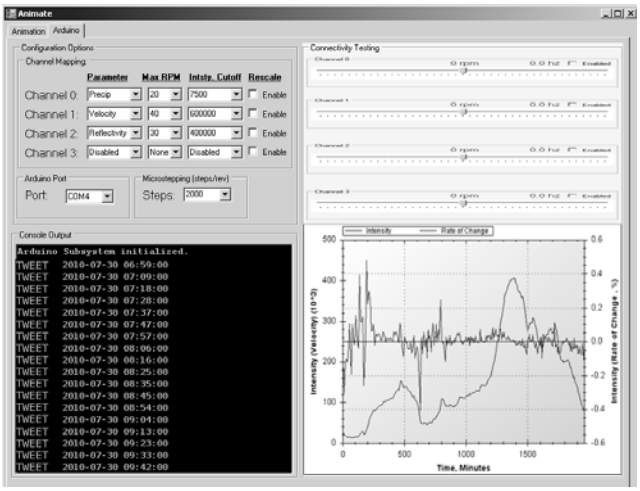

Figure 4. TwitterVizWorkbench Software

The software displays the statistical information analyzed and derived from Twitter, as it drives the TwitterViz robot's Arduino microcontrollers and stepper motors with the underling Tweet data – Twitter Intensity and Tweet Sentiment. The robot's kinetic motion patterns are time-synchronized with the Twitter data displayed on the screen. The software is fully configurable, to include robot motions for particular Twitter data metrics.

References

Fry, B. 2010. Processing [computer software]. http://processing.org

Steiner, H. 2010. Firmata [computer software]. http://firmata.org