# Commuter Tracking Sensor Network

Weekly Report - August 31st, 2014

***Team Members:***

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Seth Hendrick (srh7240@rit.edu)

Jared Mistretta (jxm6666@rit.edu)

***Other Collaborators***:

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***Project Website:***

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## Updated Milestone Chart

| Milestone / Task | Team Member in Charge | Modified Completion Date | Original Completion Date | Comments |
|---|---|---|---|---|
| 5.1 Install software (Django, Apache, etc.) | Seth | 6/21/2014 | 6/17/2014 | Apache, Django, MariaDB are installed and ready to go. |
| 6.1 Disable root login test | Seth | 6/21/2014 | 6/16/2014 | Done automatically when Raspbian was updated |
| 6.2 Set the SSH port to a non-standard port test | Seth | 6/21/2014 | 6/17/2014 | SSH Port is set to 1315, not the default port of 22 |
| 7.1 Begin playing with Pixy Cam in USB tethered mode | Jared, Alex, Seth | 7/11/2014 | 5/1/2014 | Completed. We've all experimented and interfaced with the PixyCam now, and familiarized ourselves with its basic operation. |
| 5.3 Install fail2ban | Seth | 9/1/2014 | 6/21/2014 | Fail2ban is installed, but not configured as of yet |
| 3.1 Breadboard prototyping | Alex | 9/5/2014 | 6/1/2014 | Started with half-wave rectifier circuit, and building up to the power amplification and conditioning |
| 6.3 Disable password login test - must log in with SSH key | Alex, Jared, Seth | 9/5/2014 | 6/21/2014 | Not done yet. Alex and Jared still neec to generate keys. |
| 6.5 Ping disabled test | Seth, Security Majors | 9/5/2014 | 6/21/2014 | The current router being used does nc support disabling ping. Either a new router is needed, or the firmware needs to be updated. |
| 12.1 Create status webpage, hosted somewhere else | Seth | 9/5/2014 | 9/5/2014 | Status webpage that pings the gateway is functional. Its currently hosted on one of Seth's pis, located at http://people.rit.edu/~srh7240/ctsn_sta tus . Although, there are improvement that can be made to it. |
| 3.2 PCB design | Alex | 9/12/2014 | 6/10/2014 | Boost converter library for Eagle complete, schematic started. Nick Conn has agreed to be a point of contact for us if we have difficulty. |

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|---|---|---|---|---|
| 6.4 White Hat Hacker Test | Seth | 9/18/2014 | 6/21/2014 | Waiting for keys to be generated. Seth will talk with some people this week to see if anyone is willing to attempt to hack the server. |
| 8.1 Use CAD tools to design sensor enclosure | Jared | 9/19/2014 | 7/1/2014 | |
| 10.1 Train camera for identifying walkers, bikers, and horses | Seth | 9/19/2014 | 8/1/2014 | |
| **11. Database Creation** | | 9/23/2014 | 9/14/2014 | |
| 11.1 Create mysql or mariadb database so data from trail can be saved to it | Jared | 9/23/2014 | 9/5/2014 | MariaDB is installed on the server, and is ready to go |
| 12.3 Link to database | Jared, Alex | 9/23/2014 | 9/21/2014 | Database library is readily available and easily linkable through Django framework |
| 8.2 Use 3D printer to print the enclosures | Jared | 9/26/2014 | 7/15/2014 | |
| **12. Website Creation** | | 9/26/2014 | 9/28/2014 | |
| 12.2 Create front end | Jared, Alex | 9/26/2014 | 9/14/2014 | Stub Django project is installed on the server and ready to be modified |
| 16.2 Activate website | Team | 9/29/2014 | 11/9/2014 | |
| **13. Website Testing (See Gantt Chart)** | Team | 9/30/2014 | 10/4/2014 | |
| **10. Sensor Software - Identify targets** | | 10/1/2014 | 9/1/2014 | |
| 10.2 Train camera to figure out what direction the target is going | Seth | 10/1/2014 | 9/1/2014 | |
| **3. Windbelt power module design** | | 10/2/2014 | 6/18/2014 | |
| 3.3 Ship design for stamping | Alex | 10/2/2014 | 6/18/2014 | |

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|---|---|---|---|---|
| 4.1 Solder on components | Alex | 10/3/2014 | 6/29/2014 | |
| **4. Windbelt power module construction and testing** | | 10/6/2014 | 6/30/2014 | |
| 4.2 Continuity tests | Alex | 10/6/2014 | 6/30/2014 | |
| **5. Server/Gateway setup** | Seth | 10/6/2014 | 7/1/2014 | The server is a Raspberry Pi located at ctsn.student.rit.edu. |
| 5.2 Interface XBee with Pi | Seth | 10/6/2014 | 7/1/2014 | The XBee did not arrive on time, so this slipped |
| **6. Server/Gateway testing** | | 10/6/2014 | 7/1/2014 | |
| 2.1 Configure XBees for DigiMesh and have them communicating in close proximity | Seth, Jared | 10/7/2014 | 6/1/2014 | |
| **8. Sensor Enclosure Design / Testing** | | 10/8/2014 | 8/7/2014 | |
| 8.3 Test (See Gantt Chart) | Jared | 10/8/2014 | 8/7/2014 | |
| 2.2 Range Test | Seth, Jared | 10/9/2014 | 6/9/2014 | |
| **2. Networking Architecture Configuration and Testing** | | 10/13/2014 | 6/15/2014 | The XBees did not come in on time, so this had to be pushed back. All Raspberry Pis have software on them so they can use uart to communicate with the XBees when needed for testing purposes. |
| 2.3 Small-scale trail deployment | Seth, Jared | 10/13/2014 | 6/15/2014 | |
| **15. Computer Vision Testing (See Gantt Chart)** | Alex, Seth | 10/13/2014 | 10/28/2014 | |
| 14.1 Sensors communicate target data with each other | Seth | 10/14/2014 | 10/4/2014 | |
| 7.2 Interface Pixy Cam with an XBee | Jared | 10/22/2014 | 6/22/2014 | |

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|---|---|---|---|---|
| **1. Contact Monroe County Discuss deployment options for sensor nodes.** | Jared | 10/28/2014 | 10/27/2014 | Not a priority until we complete more of the technical requirments. |
| **14. Target Data Communication** | | 10/28/2014 | 10/5/2014 | |
| 14.2 Sensors can communicate and write target data to database | Seth | 10/28/2014 | 10/5/2014 | |
| **9. Windbelt Testing (See Gantt Chart)** | Alex | 10/29/2014 | 5/27/2014 | Currently on iteration 3 of the WIndbel test fixture prototyping. Once complete, will be able to continue with testing. Very minimal tests have concluded that it is possible to run a diode in forward mode and get 150mV of DC current out of it with a 150 ohm load. This will be continued with a newer prototype that positions the magnet so that its poles are in line with the core of the coil, more effectively applying Faraday's Principle. |
| **7. Sensor hardware testing and integration** | | 10/31/2014 | 7/11/2014 | |
| 7.3 Integrate with existing power module | Jared, Alex | 10/31/2014 | 7/11/2014 | Will be done upon completion of the power module. |
| 17.1 Advanced II integration testing with focus on single node in controlled environment | Team | 11/5/2014 | | |
| 17.2 Advanced II integration testing with focus on single node in an outdoor environment | Team | 11/10/2014 | | |

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|---|---|---|---|---|
| **17.Integration Testing** | | 11/13/2014 | | |
| 17.3 Advanced II testing with focus on operation in outdoor environment for multiple nodes | Team | 11/13/2014 | | |
| **16. Deployment** | | 11/17/2014 | 11/9/2014 | |
| 16.1 Deploy nodes on trail | Team | 11/17/2014 | 11/5/2014 | |

## Current Milestones

| Milestone / Task | Team Member in Charge | Modified Completion Date | Original Completion Date | Comments |
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| 5.3 Install fail2ban | Seth | 9/1/2014 | 6/21/2014 | Fail2ban is installed, but not configured as of yet |
| 3.1 Breadboard prototyping | Alex | 9/5/2014 | 6/1/2014 | Started with half-wave rectifier circuit, and building up to the power amplification and conditioning |
| 6.3 Disable password login test - must log in with SSH key | Alex, Jared, Seth | 9/5/2014 | 6/21/2014 | Not done yet. Alex and Jared still need to generate keys. |
| 12.1 Create status webpage, hosted somewhere else | Seth | 9/5/2014 | 9/5/2014 | Status webpage that pings the gateway is functional. Its currently hosted on one of Seth's pis, located at http://people.rit.edu/~srh7240/ctsn_statu s . Although, there are improvements that can be made to it. |
| 3.2 PCB design | Alex | 9/12/2014 | 6/10/2014 | Boost converter library for Eagle complete, schematic started. Nick Conn has agreed to be a point of contact for us if we have difficulty. |
| **9. Windbelt Testing (See Gantt Chart)** | Alex | 10/29/2014 | 5/27/2014 | Currently on iteration 3 of the WIndbelt test fixture prototyping. Once complete, will be able to continue with testing. Ver minimal tests have concluded that it is |

| | | | | |
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| | | | | possible to run a diode in forward mode and get 150mV of DC current out of it with a 150 ohm load. This will be continued with a newer prototype that positions the magnet so that its poles are in line with the core of the coil, more effectively applying Faraday's Principle. |

## Next Milestones

| Milestone | Team Member in Charge | Modified Completion Date | Original Completion Date | Comments |
|---|---|---|---|---|
| 5.3 Install fail2ban | Seth | 9/1/2014 | 6/21/2014 | Fail2ban is installed, but not configured as of yet |
| 3.1 Breadboard prototyping | Alex | 9/5/2014 | 6/1/2014 | Started with half-wave rectifier circuit, and building up to the power amplification and conditioning |
| 6.3 Disable password login test - must log in with SSH key | Alex, Jared, Seth | 9/5/2014 | 6/21/2014 | Not done yet. Alex and Jared still need to generate keys. |
| 12.1 Create status webpage, hosted somewhere else | Seth | 9/5/2014 | 9/5/2014 | Status webpage that pings the gateway is functional. Its currently hosted on one of Seth's pis, located at http://people.rit.edu/~srh7240/ctsn_status . Although, there are improvements that can be made to it. |
| 3.2 PCB design | Alex | 9/12/2014 | 6/10/2014 | Boost converter library for Eagle complete, schematic started. Nick Conn has agreed to be a point of contact for us if we have difficulty. |
| **9. Windbelt Testing (See Gantt Chart)** | Alex | 10/29/2014 | 5/27/2014 | Currently on iteration 3 of the WIndbelt test fixture prototyping. Once complete, will be able to continue with testing. Very minimal tests have concluded that it is possible to run a diode in forward mode and get 150mV of DC current out of it with a 150 ohm load. This will be continued with a newer prototype that positions the magnet so that its poles are in line with the core of the coil, more effectively applying Faraday's Principle. |
| 8.1 Use CAD tools to design sensor enclosure | Jared | 9/19/2014 | 7/1/2014 | |

| | | | | |
|---|---|---|---|---|
| 10.1 Train camera for identifying walkers, bikers, and horses | Seth | 9/19/2014 | 8/1/2014 | |

# Status

## Difficulties

Currently we are addressing two major difficulties. First is to optimise the configuration of the windbelt. There are a number of parametrics and variables that need to be tuned to our specific requirements. While we have good guidelines for finding these values much experimentation is needed to validate the theoretical optimal values. Specifically, we need to find an optimum orientation for the coil to the plane of movement of the magnet.

The second major difficulty that we are working on is the integration of CV algorithms into the existing PixyCam firmware. This is probably the greatest hurdle that we need to overcome the entirety of the system. The documentation for the firmware is somewhat limited so a code review will be required to familiarise ourselves with the code base.

## Surprises

Alex was surprised at the drastic change in operation that was achieved by changing the alignment of the magnet to the coil on the windbelt. He was able to greatly improve magnitude of the output with a slight movement of the coil, and consistency of output by placing the coil and magnet closer to the end of the belt.

## Successes

Alex was successful in the construction of a second version of the windbelt, which gave good power outputs. The results are as follows:  150mV of DC voltage and positive current values coming out of the diode with only 1.5mA of AC current and about 620mV of AC voltage being generated by the coil for a 150 ohm load and 10pF of capacitance. The IN5817 was used for the diode.

Seth was also successful with his tests sending SMS messages with web server commands. We can utilize sending http requests to a web server to send SMS messages. This will allow us to be aware of the network and receive important messages about its status.

## Open Questions & Problems

Some question is arising as to whether the Windbelt will provide a viable source of renewable energy for this project's purposes. Version 3 of the testing prototype will most likely answer this question for good. Backup renewable energy sources have been considered, and solar energy seems to be the most suitable alternative due to its simplicity in implementation and access to existing application notes.

It is expected that future iterations of the design will generate larger amounts of current from the coil. The field emitted by the coil may cause EMI issues with adjacent components, and may also be a safety concern. Further investigation on these potential issues is underway.

OpenCV had many OS dependencies, as such it may not be optimal for the embedded platform that we are utilizing. There seems to be two options moving forward. The first is to investigate loading a full Unix-like OS on to the PixyCam; like ROS(Robot Operating System). This is probably non-optimal due to the somewhat limited computational power of the ARM Cortex-M. An ARM Cortex-A would probably be required to run such a "heavy" system.

The second option is to investigate other libraries that are lighter and don't have the OS dependencies that OpenCV currently has. Alternatives include: VXL (Vision-something-Library), VIGRA (Vision with Generic Algorithms) and IVT (Integrated Vision Toolkit). All of these option offer a C or C++ library with CV functions. The lightest and simplest toolchain, with the fewest dependencies is desired.

# Gantt Chart

| | Name | Duration | % Complete | Start | Finish |
|---|---|---|---|---|---|
| 1 | **Commuter Tracking Sensor Network Project** | **111d** | **20%** | **06/16/2014** | **11/17/2014** |
| 2 | **Contact Monroe County** | **7d** | **0%** | **10/20/2014** | **10/28/2014** |
| 3 | Discuss deployment options for sensor nodes | 7d | 0% | 10/20/2014 | 10/28/2014 |
| 4 | **Networking Architecture Configuration and Testing** | **9d** | **0%** | **10/01/2014** | **10/13/2014** |
| 5 | Configure XBees for DigiMesh and have them communicating in close proximity | 5d | 0% | 10/01/2014 | 10/07/2014 |
| 6 | Range Test | 2d | 0% | 10/08/2014 | 10/09/2014 |
| 7 | Small-scale trail deployment | 2d | 0% | 10/10/2014 | 10/13/2014 |
| 8 | **Windlbelt power module design** | **29d** | **0%** | **08/25/2014** | **10/02/2014** |
| 9 | Breadboard prototyping | 10d | 0% | 08/25/2014 | 09/05/2014 |
| 10 | PCB design | 5d | 0% | 09/08/2014 | 09/12/2014 |
| 11 | Ship design for stamping | 14d | 0% | 09/15/2014 | 10/02/2014 |
| 12 | **Windbelt power module construction and testing** | **2d** | **0%** | **10/03/2014** | **10/06/2014** |
| 13 | Solder on components | 1d | 0% | 10/03/2014 | 10/03/2014 |
| 14 | Continuity tests | 1d | 0% | 10/06/2014 | 10/06/2014 |
| 15 | **Server/Gateway setup** | **81d** | **29%** | **06/16/2014** | **10/06/2014** |
| 16 | Install software (Django, Apache, etc.) | 2d | 100% | 06/16/2014 | 06/17/2014 |
| 17 | Interface XBee with Pi | 4d | 0% | 10/01/2014 | 10/06/2014 |
| 18 | Install and configure fail2ban | 6d | 25% | 08/25/2014 | 09/01/2014 |
| 19 | **Server/Gateway testing** | **69d** | **14%** | **06/16/2014** | **09/18/2014** |
| 20 | Disable root login test | 1d | 100% | 06/16/2014 | 06/16/2014 |
| 21 | Set the SSH port to a non-standard port test | 1d | 100% | 06/17/2014 | 06/17/2014 |
| 22 | Disable password login test - must login with SHH key | 1d | 33% | 06/18/2014 | 06/18/2014 |
| 23 | Ping disabled test - looking into other options | 5d | 0% | 09/01/2014 | 09/05/2014 |
| 24 | White Hat Hacker Test | 9d | 0% | 09/08/2014 | 09/18/2014 |
| 25 | **Sensor Hardware testing and integration** | **35d** | **13%** | **09/15/2014** | **10/31/2014** |
| 26 | Begin playing with Pixy cam in USB tethered mode | 1d | 100% | 09/15/2014 | 09/15/2014 |
| 27 | Interface Pixy Cam with an XBee | 5d | 0% | 10/14/2014 | 10/20/2014 |
| 28 | Integrate with existing power module | 2d | 0% | 10/30/2014 | 10/31/2014 |
| 29 | **Sensor Enclosure Design / Testing** | **28d** | **0%** | **09/01/2014** | **10/08/2014** |
| 30 | Use cad tools to design sensor enclosure | 15d | 0% | 09/01/2014 | 09/19/2014 |
| 31 | Use 3D printer to etch out enclosure | 5d | 0% | 09/22/2014 | 09/26/2014 |
| 32 | Temperature test | 2d | 0% | 09/29/2014 | 09/30/2014 |
| 33 | Rain Test | 2d | 0% | 10/01/2014 | 10/02/2014 |
| 34 | Execute drop test | 2d | 0% | 10/03/2014 | 10/06/2014 |
| 35 | Fire test | 2d | 0% | 10/07/2014 | 10/08/2014 |
| 36 | **Windbelt Testing** | **48d** | **8%** | **08/25/2014** | **10/29/2014** |
| 37 | Early testing with focus on size | 10d | 28% | 08/25/2014 | 09/05/2014 |
| 38 | Early testing with focus on maximizing current production for varied fan speeds | 1d | 0% | 09/08/2014 | 09/08/2014 |
| 39 | Early testing with focus on maxmizing current production for varied wind angles | 1d | 0% | 09/09/2014 | 09/09/2014 |
| 40 | Intermediate I testing with focus on smoothing levels for a half-wave rectifier | 2d | 0% | 09/10/2014 | 09/11/2014 |
| 41 | Intermediate I testing with focus on smoothing levels for a full-wave rectifier | 2d | 0% | 09/12/2014 | 09/15/2014 |
| 42 | Intermediate II testing with focus on providing safe levels at the output of the boost c | 3d | 0% | 10/07/2014 | 10/09/2014 |
| 43 | Intermediate II testing with focus on battery discharge time and voltage levels | 1d | 0% | 10/10/2014 | 10/10/2014 |
| 44 | Intermediate II testing with focus on safe output levels from voltage regulation comp | 1d | 0% | 10/13/2014 | 10/13/2014 |
| 45 | Intermediate II testing with focus on providing safe voltage levels from secondary bc | 3d | 0% | 10/14/2014 | 10/16/2014 |
| 46 | Advanced I testing with focus on duration and level of charge on battery without MPF | 2d | 0% | 10/17/2014 | 10/20/2014 |
| 47 | Advanced I testing with MPPT enabled for a solar energy application with focus on b | 2d | 0% | 10/21/2014 | 10/22/2014 |
| 48 | Advanced I testing with boost converter configured for MPPT with focus on safe sign | 2d | 0% | 10/23/2014 | 10/24/2014 |
| 49 | Advanced II testing with focus on configuring the boost converter for use with MCUs | 3d | 0% | 10/27/2014 | 10/29/2014 |
| 50 | **Integration Testing** | **9d** | **0%** | **11/03/2014** | **11/13/2014** |
| 51 | Advanced II integration testing with focus on single node in controlled environment | 3d | 0% | 11/03/2014 | 11/05/2014 |
| 52 | Advanced II integration testing with focus on deploying a single node in an outdoor | 3d | 0% | 11/06/2014 | 11/10/2014 |
| 53 | Advanced II testing with focus on operation in outdoor environment for multiple nod | 3d | 0% | 11/11/2014 | 11/13/2014 |
| 54 | **Sensor Software - Identify Targets** | **23d** | **0%** | **09/01/2014** | **10/01/2014** |
| 55 | Train camera for identifying walkers, bikers, and horses | 15d | 0% | 09/01/2014 | 09/19/2014 |
| 56 | Train camera to figure out what direction the target is going | 8d | 0% | 09/22/2014 | 10/01/2014 |
| 57 | **Database Creation** | **2d** | **0%** | **09/22/2014** | **09/23/2014** |
| 58 | Create mysql or mariadb database so data from trail can be saved to it | 2d | 0% | 09/22/2014 | 09/23/2014 |
| 59 | **Website Creation** | **61d** | **86%** | **07/04/2014** | **09/26/2014** |
| 60 | Create front end | 4d | 0% | 09/23/2014 | 09/26/2014 |
| 61 | Link to database | 1d | 0% | 09/23/2014 | 09/23/2014 |
| 62 | Create status webpage, hosted somewhere else | 46d | 95% | 07/04/2014 | 09/05/2014 |
| 63 | **Website Testing** | **1d** | **0%** | **09/30/2014** | **09/30/2014** |
| 64 | Sanitation Test | 1d | 0% | 09/30/2014 | 09/30/2014 |
| 65 | Password Protection Test | 0.33d | 0% | 09/30/2014 | 09/30/2014 |
| 66 | User Login Test | 0.33d | 0% | 09/30/2014 | 09/30/2014 |
| 67 | White-hat hacker test | 1d | 0% | 09/30/2014 | 09/30/2014 |
| 68 | **Target Data Communication** | **20d** | **0%** | **10/01/2014** | **10/28/2014** |
| 69 | Sensors communciate target data with each other | 2w | 0% | 10/01/2014 | 10/14/2014 |
| 70 | Sensors can communicate and write data to database | 2w | 0% | 10/15/2014 | 10/28/2014 |
| 71 | **Computer Vision Testing** | **7.5d** | **0%** | **10/02/2014** | **10/13/2014** |
| 72 | Early - Image Sensor Component Testing | 0.5d | 0% | 10/02/2014 | 10/02/2014 |
| 73 | Early - Image Sensor Component Testing | 0.5d | 0% | 10/02/2014 | 10/02/2014 |
| 74 | Intermediate - Infrared Component Testing | 0.5d | 0% | 10/03/2014 | 10/03/2014 |
| 75 | Intermediate - CV Algorithm Component Testing | 0.5d | 0% | 10/03/2014 | 10/03/2014 |
| 76 | Intermediate - CV Algorithm Component Testing | 0.5d | 0% | 10/06/2014 | 10/06/2014 |
| 77 | Advanced- CV Algorithm Component Testing | 1d | 0% | 10/06/2014 | 10/07/2014 |
| 78 | Advanced - CV Algorithm and Infrared Integration Testing | 1d | 0% | 10/07/2014 | 10/08/2014 |
| 79 | Advanced - Computer Vision and Networking System Integration | 1d | 0% | 10/08/2014 | 10/09/2014 |
| 80 | Advanced - Computer Vision and Power Management System Integration Testing | 1d | 0% | 10/09/2014 | 10/10/2014 |
| 81 | Advanced - Computer Vision Acceptance Testing | 1d | 0% | 10/10/2014 | 10/13/2014 |
| 82 | **Deployment** | **36d** | **0%** | **09/29/2014** | **11/17/2014** |
| 83 | Deploy Nodes | 2d | 0% | 11/14/2014 | 11/17/2014 |
| 84 | Activate Website | 1d | 0% | 09/29/2014 | 09/29/2014 |