Project Proposal
Seizure Monitor- Entrepreneur Project
TEAM # 23

Kathleen Cooney, Adam Herman & Adam Markman
Client Contacts: Dr. Bennett jcbjr@engr.uconn.edu (860) 742 9202
Executive Summary

Team 23 proposes the funding for a seizure monitor device. Over three million Americans suffer from spontaneous seizures. Our proposed device could significantly improve the lives of these patients in many ways. First and foremost, the device serves to revolutionize patient safety for those who suffer from epilepsy and other seizure disorders. When a patient begins to experience a seizure, the alarm system is activated and thus alerts the caregiver of the medical situation. Patients who suffer from seizures can lose consciousness, vomit, or severely injure themselves. By using the seizure monitor device, a caregiver would be notified of the seizure and could therefore help by providing the necessary medical assistance. Secondly, the device can provide vital physiological information through specific measurements of seizure activity to the patient’s physician. The physician can learn more about the seizure’s duration, severity, frequency, etc. This information could be vital in providing the correct medical treatment. Not only does the device offer enhanced safety and medical treatment for the patient, but it is small in size and aesthetically pleasing, which will be attractive to the consumer market. Patients will be excited about buying a device that won’t detract from their daily life. Current devices consist of mattress pads and thus make vacations and sleepovers nearly impossible. The seizure monitor has incredible promise, and therefore Team 23 requests $______ to make this design idea a reality.

1 Introduction

1.1 Background (client and disability)

The Seizure Monitor Device does not have a particular client. However, the group has been interviewing extensively various doctors along with people who suffer seizures to get a better idea as to how do go about creating the Seizure Monitor Device. The group felt it was
important to both cater the project to the needs of patients who suffer from seizures and also to get the input of experts. Creating a project with advice from these individuals will hopefully lead to a better device for potential clients.

1.2 Purpose of the Project

The purpose of the Seizure Monitor Device is to create a watch that will be able to detect a seizure and notify a caretaker. The device will be worn by patients suffering from epilepsy to monitor seizures. Seizures which go unnoticed while a patient’s asleep can be extremely detrimental to one’s health, resulting in loss of consciousness, exhaustion, nausea, vomiting, and inadvertent injury. In the event of a seizure, the device will transmit a warning to signify to the caregiver that a seizure is in progress. The ideal product will be a small, wristwatch-like accessory which can and should be worn 24 hours a day. The monitor will catalog the time, duration, and severity of the seizure for evaluation by one’s doctor. The monitor will have Bluetooth communication for a close proximity auditory and visual warning system. This would allow the caregiver to recognize an onset of a patient’s seizure. Real time information will be transferred to the doctor or caregiver’s handheld accompanying device. The seizure monitor will function on rechargeable batteries to reduce waste. The size and wireless capacity of the device is unusual and differs significantly from current seizure monitors which lie under the patient’s mattress. The seizure monitor will also display the time and date to a screen on the front of the monitor.

1.3 Previous Work Done by Others

Currently, there have not been any previous Seizure Monitor Device created by UConn students. However, the idea of the Seizure Monitor Device came from a senior design project

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from Rochester Institute of Technology. The main goal of their project was to develop and validate a motion data collection system. This essentially would track when the person was having a seizure and record the time and duration of on a computer. This was communicated to the computer using an existing modified wireless communication system. The FSI evaluation kit included an accelerometer data collector, which was used as the motion monitoring device, and a data concentrator module, which was used as the base device. Their data concentrator module was capable of receiving data from up to 16 accelerometer data collectors. Upon activation, the motion monitoring devices will continuously transmit motion data, via a ZigBee network, to the base unit. The base unit then transmits the data via an Ethernet (UDP) connection to a personal computer that will collect the data.

1.3.1 Products

There are a few products currently available that are similar our proposed seizure monitor. The first one is the Medpage ST-2. The Medpage ST-2 is a monitor designed to detect and raise an alarm from a sleeping person experiencing regular muscular convulsions such as an epileptic seizure or convulsions caused by hypoglycemia in a diabetic person. The ST-2 monitor provides dual detection functionality, seizure monitoring and bed occupancy detection. A sensor is placed under the user’s mattress, bed or cot. During sleep movements from the patient are monitored by the ST-2 microprocessor. Prolonged irregular movements result in an alarm being generated by the monitor with a signal transmitted to the alarm pager or other alarm in use with the ST-2 monitor. The transmitter also has a call button and a socket that allows connection similar to a standard hospital nurse call switch. The transmitter also has some specialized easy operation switches for the physically disabled. Finally, it has built in tone alarms that can be set
to produce a sound alarm when a bed seizure monitor has detected a seizure or the person leaving their bed.

Another product is the MP5 - Complete System - Bed Motion Alarm for convulsive movement such as Epilepsy Seizures. This system works by detecting shaking or jerking movements such as those encountered during convulsive seizures as well as sounds/noises. It will not detect mild seizures, and should not be used for people under 56lbs. However, if the mattress is thick, or the bed is large, the user would need to use two sensors to offer the same system features and functions. The system is set up by placing the sensors between the mattress and box spring. It is essential that the box spring be under the heaviest part of the user’s body. From there, the pagers are turned on and given to the care takers and the sensitivity controls set. The bed monitor communicates with the wireless pagers up to a distance of approximately 328 feet.

Another product is the Emfit Nocturnal Tonic-Clonic Seizure Monitor. The Emfit Movement monitor consists of a flexible and durable bed sensor (L-4060SL), which is placed under the mattress, and a bed-side monitor (D-2090-2G). The Movement Monitor detects when a person has continuous quick-paced movements over a preset period of time and then triggers a notification. The system also notices light movements, thus making it equally suitable for small children. The control unit can be placed next to the bed or on the wall using the included fastening bracket. It is operated with 2 standard AA size 1.5 V batteries.
1.3.2 Patent Search Results

Implantable seizure monitor (United States Patent Application 20100210964) was a patent aimed at detecting seizure monitors. This is an implantable seizure monitor that can include at least one sensing electrode and an electronics module configured to detect, record and/or log neurological events. For example, the electronics module can be configured to detect brainwaves indicative of seizures, such as, for example, epileptic seizures, and to create a log indicating when such seizures occur. The implantable seizure monitor can include a cushioning member made of a soft material and configured to be implantable between the epidermis and cranium of a patient.

Another patent is the Brain Signal Telemetry and Seizure Prediction (Pub. No US 2008/0077039 A1). This patent details an ambulatory intrinsic brain signal processor circuit which is coupled to many different electrodes placed on different regions of the brain. The electrodes, in conjunction with a digital multiplexer, feed data wirelessly to and from a remote transceiver. There is a controller that allows the user to decide: which of the electrodes contribute data, the resolution of that data, and whether the data includes one or both of the neural action and local field potential data. Correct placement of the electrodes can help predict seizures.

2 Project Description

2.1 Objective

The seizure-monitoring device detects abnormal motion during an epileptic seizure and transmits a signal to an alarm system. The alarm system alerts the patient’s caregiver, and relays
the seizure information to a computer, PDA, or other mobile device, and documents the data for further analysis by a doctor or caregiver.

The seizure monitor will use an accelerometer to measure the changes in motion on a 3-dimensional axis. A surface-mount Bluetooth device will then transmit the seizure information to the alarm system. The monitor itself will be small in size, and will closely resemble a wristwatch. With an adjustable strap, the watch will be able to be used by all patients suffering from epilepsy. The device will also display the time-of-day for practical use by the user. By using a coin battery to operate the device, in conjunction with a surface-mount Bluetooth module, the watch will remain small in size and light in weight.

The alarm system will connect to the seizure monitor using a second surface-mount Bluetooth module. The incoming data will be analyzed and will sound an alarm if a seizure is detected. The alarm will include both sound and visual stimulation by using speakers and lights. This method triggers multiple senses to ensure that a seizure will not go unnoticed. The Bluetooth module will then send and document the seizure information, such as frequency and duration, along with a time stamp for further investigation by the patient’s doctor or qualified caregiver. The alarm system will resemble an alarm clock, with capabilities such as a time display and a snooze button.

Each component of the seizure-monitoring device has a practical use apart from monitoring seizure activity; the seizure monitor is in the form of a wristwatch and the alarm system is in the form of an alarm clock. These innovations will make the device aesthetically pleasing to the consumer, in order to increase the product’s marketability.
2.2 Methods

Team 23 will create a seizure monitor that will be able to detect a seizure and send information about the seizure to an alarm system, which will notify a caretaker. The system will document the seizure’s information in a computer as shown in *Figure 1*.

![Figure 1. Flow chart for seizure monitor](image)

The group will create a watch that the patient will wear to detect the seizures, as shown in *Figure 2*.

![Figure 2. Watch design](image)
Figure 2 shows the general design of the watch. The group chose to use a Velcro strap to clasp the watch together. Velcro was chosen because it is water proof, durable, and makes it so the watch can be used with any sized wrist. Velcro is also very easy to take off and is durable.

The group chose to use an analog clock face instead of a digital watch. This decision was based solely on the aesthetic style of the watch. The group wanted to have the watch to be worn and public and thought that an analog watch would make it seem less as a monitor. Thus, it would be less intrusive and not as noticeable in public.

The outside of the watch must also be water proof. If the seizure monitor is to be effective, it must be able to be worn while either doing the dishes or taking a shower. If the patient were to suffer a seizure during the shower, that can lead to a serious accident because no one may be able to hear them fall with the doors being closed.

The inner workings of the watch are very important. The group decided to use an accelerometer to detect the seizures, shown in Figure 3.

An accelerometer works by measuring the magnitude and direction of acceleration relative to freefall. The group plans to calibrate it so the accelerometer would be able to detect only seizures and not sudden movements of a person arm, such as if they are waving.
Accelerometer usually weighs about one gram so it will not feel very heavy. In addition, the device will have a 3-axis accelerometer to make it more accurate.

The watch will also use a surface mount Bluetooth, shown in Figure 4, to communicate with the computer, caretaker, and alarm clock.

![Surface mount Bluetooth](image-url)

*Figure 4. Surface mount Bluetooth.*

A surface mount Bluetooth was chosen because it needs very little power and is only 13.4mm x 25.8mm x 2mm.

The watch will also need a PCB board to create the circuitry in the watch. This circuit will first be created in a program such as MultiSim, converted to a PCB creating program such as UltiBoard, and then shipped to a company to produce.

To power the watch, a coin battery will be used. This battery will save space in addition to providing 3V to power the watch. There will also be an LED that will blink when the battery is low.
LabVIEW will be utilized by the computer, PDA, or other mobile device to communicate with the accelerometer in the watch and log when the patient has a seizure, shown in *Figure 5*.

![Seizure Monitor](image)

*Figure 5. Seizure Monitor Log*

As shown in *Figure 4*, the LabVIEW program will have a delete button and save button. It will monitor the time and date of the seizure along with the severity of it on a scale ranging from a minor seizure to a severe seizure.

The wristwatch-like seizure monitor will analyze the patient’s seizure activity, and the alarm system will detect if a seizure occurs. If the accelerometer recognizes the motions of a seizure, the alarm system will notify a caregiver using speakers and lights for both audio and visual stimulation so that no seizure goes unnoticed. The alarm system will resemble an alarm
clock, and boast features such as time of day and snooze capabilities. There will be two speakers in order to project sound 360°. There will also be two LEDs, which will increase light intensity and enable a multiple colored alarm. The speakers and digital time display will be taken from the PLL Digital Tuning Am/fm Pocket Radio and Alarm Clock with Built-in Hi-fi Speakers; an existing digital pocket radio as seen in figure 6.

Figure 6. PLL Digital Tuning Am/fm Pocket Radio and Alarm Clock with Built-in Hi-fi Speakers

A second PCB design will be implemented into the alarm system. This PCB will contain a microcontroller, which will be programmed using C-code in order to communicate with the LabVIEW program implemented in the computer, PDA, or mobile device. Using a microcontroller saves space and money compared to a design that uses a separate microprocessor, memory, and input/output devices. Another surface-mount Bluetooth will be used here to communicate with the seizure monitor and computer, PDA, or other mobile device.
The alarm will have the ability to use both battery and DC (wall outlet) power. This will provide the option of mobility as well as being economically stable by decreasing battery disposal. It will run on 9V batteries to increase life and efficiency.

For the alarm system enclosure, a SERPAC 153-I—G enclosure was selected. It has dimensions of 5.63 in L x 3.25 in W x 2.51 in H, which is large enough for all components, and practical in size for use as an alarm clock. The enclosure can be seen in figure 7.

![SERPAC 153-I—G Enclosure](image)

Figure 7. SERPAC 153-I—G Enclosure.

The alarm will be designed to beep at low frequency every minute to indicate the battery is running low, and a colored LED will also be lit.

3 Budget

There are few watches that the group found to be suitable for this project. The first watch is a Casio 30-Page Databank Velcro Watch that costs $22.99 off of amazon.com. It has an analog and digital watch which may be useful. Another watch that the group found was a Timex Men's
T5H421 Ironman 30-Lap Velcro Fast Wrap Watch which costs $30.23. This watch is water resistant up to 330 feet and only shows a digital interface. The watch batteries will be implemented into the seizure monitor as the power source.

The accelerometer costs $14.95 from pololu.com. It is a MMA7260QT 3-Axis Accelerometer ±1.5/2/4/6g triple-axis accelerometer that has an adjustable sensitivity from ±1.5 g to ±6 g.

The surface mount Bluetooth is a Bluetooth 2.1 Class 1 surface mount module with embedded antenna that costs $24.95 from www.semiconductorstore.com. It is the Bluetooth RN-41 model and is manufactured by Roving Networks.

There are many different PCB manufactures on the market. Some inexpensive ones are olimex.com. It is hard to get a price though on what type of PCB the group needs. However, this site was cheaper for a lot of different PCB than a lot of other sites. Another site that creates PCBs is www.batchpcb.com. This site has a $10 setup fee and charges $2.50/sq inch with no minimum order. An estimated $40 will be spent on PCBs.

The microcontroller costs $3.75. It is an ATmega8L-8PC 8 bit microcontroller with 8 kb of program memory and it runs with a speed of 8MHz.

The speakers and digital display for the alarm system costs $16.59. It is a PLL Digital Tuning Am/fm Pocket Radio and Alarm Clock with Built-in Hi-fi Speakers.

The alarm casing is priced at $6.56 and a quantity of 3 should be purchased for testing and other purposes. It can be found on mouser.com and is a SERPAC 153-I- -G enclosure.
The LEDs that are to be implemented into the alarm system are priced at $3.95 each. One of the lights will be colored red, and the other “cool white” for ultimate contrast and brightness. The cool white light draws 15 mA of current and the red light draws 16 mA of current when operating at 12 volts. The product name is the ULITE-x3 and is found at superbrightleds.com.

Size and weight will not be a concern with the alarm system, so 2 9-volt batteries will be utilized for maximum power output. A 12 pack of 9-volt batteries will allow for testing purposes as well as use in the final alarm system. 9V Duracell Procell Alkaline Batteries 12 per box PC1604 from all-battery.com were chosen and they cost $19.50.

A spreadsheet of items and their costs is shown below in Table 1.
<table>
<thead>
<tr>
<th>Item</th>
<th>Price</th>
<th>Quantity</th>
<th>Total</th>
<th>Lower 35% Threshold</th>
<th>Upper 35% Threshold</th>
</tr>
</thead>
<tbody>
<tr>
<td>Casio 30-Page Databank Velcro Watch</td>
<td>22.99</td>
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<td>22.99</td>
<td>14.94</td>
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<tr>
<td>Timex Men's T5H421 Ironman 30-Lap Velcro Fast Wrap Watch</td>
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<td>14.95</td>
<td>9.72</td>
<td>20.18</td>
</tr>
<tr>
<td>Bluetooth RN-41</td>
<td>24.95</td>
<td>2</td>
<td>49.9</td>
<td>32.44</td>
<td>67.37</td>
</tr>
<tr>
<td>PCB Boards</td>
<td>10 + 2.5/sq in</td>
<td>2</td>
<td>40</td>
<td>26.00</td>
<td>54.00</td>
</tr>
<tr>
<td>ATmega8L-8PC 8 bit microcontroller</td>
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<td>1</td>
<td>3.75</td>
<td>2.44</td>
<td>5.06</td>
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<tr>
<td>PLL Digital Tuning Am/fm Pocket Radio and Alarm Clock with Built-in Hi-fi Speakers</td>
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<td>2</td>
<td>33.18</td>
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<tr>
<td>SERPAC 153-I- -G enclosure</td>
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<td>19.68</td>
<td>12.79</td>
<td>26.57</td>
</tr>
<tr>
<td>ULITE-x3 LEDs</td>
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<td>2</td>
<td>7.9</td>
<td>5.14</td>
<td>10.67</td>
</tr>
<tr>
<td>9V Duracell Procell Alkaline Batteries</td>
<td>19.5/12 pack</td>
<td>1</td>
<td>19.5</td>
<td>12.68</td>
<td>26.33</td>
</tr>
<tr>
<td><strong>Total Cost</strong></td>
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<td></td>
<td><strong>157.35</strong></td>
<td></td>
<td><strong>326.81</strong></td>
</tr>
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</table>

*Table 1. Spreadsheet of items and their costs*
Conclusion

The seizure monitor device not only solves a biomedical engineering problem, but it also has high potential to be successful on the market. With over three million Americans suffering from seizures, the need to monitor these seizures is clearly present. The proposed device enhances the healthcare of patients suffering from seizures in two predominant ways. First off, it alarms the caregiver of the situation, and thus prevents the patient from becoming injured during an unnoticed medical emergency. Second, vital data recorded during the seizure will be sent to the physician, who can use this information to better diagnose and/or treat the patient. The trendy appearance of the watch will be extremely marketable. Once in manufacture, the seizure monitor device could be produced for significantly less than $400. When comparing the cost of the watch to the benefits of the device, Team 23 strongly believes that consumers will be willing to make the purchase.