A Novel Approach to Cellular Tracking and Surveillance

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Abstract

Today, texting is one of the most popular forms of communication. However, texting can be abused and become addicting. Problems such as teenagers texting during school or texting while driving plague the world today. Therefore, a novel solution has been invented to help parents restrict their children from texting during inappropriate times. The system is comprised of a client, a MySQL database, and a website. The website provides a simple, easy-to use interface for the parent to set texting restrictions based on the time of day, the location of the phone, and the speed at which the phone is moving. These restrictions are written to the database managed by the pHpMyAdmin interface. When the user of the phone attempts to text, the J2ME program retrieves the latest restrictions from server, compares it to the phone's current status, and determines whether or not to allow the user to text. In addition to limiting text messaging, this three-part system also allows parents to track their children's locations in real-time, giving them full knowledge of their children's whereabouts. This product, as a whole, gives parents a flexible method of enforcing rules and aids them in controlling their rebellious teenagers.

The advent of text messaging has revolutionized the world, becoming one of the most popular forms of communication today. Many people opt to type out short messages on numeric or QWERTY keypads rather than talking on the phone. Text messaging is more discrete, and can be performed in almost any environment. The convenience of text messaging, however, comes with a price. Many teenagers, and even adults, are getting addicted to text messaging. In their minds, the vibration or notification of a received text message requires an immediate response. Such habits are slowly creating problems in the world today.

Two major problems arise when it comes to teenagers and texting. The first, and more serious, problem is driving while texting. Young, naïve sixteen year old teenagers drive down streets with little sense of danger or responsibility. Hormones push their insatiable need for speed. To compound the problem, some teenagers try to combine texting with an activity that requires 100 percent attention. This habit of driving while texting is unacceptable as it increases the risk of a crash or near crash incident by 23.2 times. Texting while driving has been shown to reduce reaction time by 35%, while driving under the influence of marijuana only slows reaction time by 21%. Tests have also shown that drivers who text, tend to drift out of their lanes more than other drivers under different influences. The dangerous implications of texting while driving are clearly visible, and, to make matters worse, nearly half of all drivers in Britain alone admit to text message while behind the wheel and 48 percent of Texas teens admit to texting while driving. Streets filled with inattentive drivers such as these are dangerous ones, and more and more fatal accidents will occur because of texting.

The other harmful effect of texting on teenagers is its naturally distractive characteristics. Texting can be performed silently and discretely. Many teenagers find ways to hide their phones from their teacher's view and text in class instead of paying attention. In fact, teenagers text so much that they can easily send and receive five thousand text

messages a month. Simply put, text messaging, as a whole, is a major distraction for teenagers that need to study and prepare for college. Some teenagers claim that they can multitask, but clearly, when they text their mind is focused on the text message at hand and not the class at hand. To make matters worse, many parents fail to control their children, as cell phones are almost a necessity for communication purposes. Clearly, parents are put between a rock and a hard place when it comes to attempting to control their children and their phones.

Evidently, text messaging is a great form of communication, but, when pushed too far, can have major consequences. Therefore, the purpose of this product is to put an end to the distraction of text messaging, both in cars and in the classroom. The product is a web-based control system for cell phones, stopping teenagers from texting during certain times of the day or when their driving based on their GPS speed. Comprised of a client program written in Java ME, a server with MySQL databases, and an IIS web server written in PHP, JavaScript, AJAX, and HTML, this product aims to make roads safer and help students focus in the classroom by enabling the parent to monitor their child from any computer or from the parent's own cell phone.

The first feature of the program is to limit texting while in school. This is accomplished through a J2ME program that runs on the child's phone. J2ME was chosen over other languages, such as C++, because it is the most ubiquitous mobile programming format. Almost every phone used today can run Java programs, as most games on phones are written in J2ME. This ensures most possible users will not have compatibility issues. The parent starts by setting time restrictions on the product's website, entering the start and end time of the texting restriction in military time (ie. 1000 = 10 o'clock AM). Not only can the parent set restrictions from the website, they can also set restrictions from their cell phone. The application has a built in feature that asks the parent for the new restrictions. Setting restrictions from the cell phone does not require going to the internet website. The

application only connects to the internet once – when sending the updated restrictions to the server. After the information has been submitted from the phone, it follows the same processing as the internet version. Once the parent presses submit, the data in the form is then written to a MySQL database through PHP code that runs a SQL query. Then, when the child attempts to text during school through the program, it requests these preset restrictions through J2ME's HTTPconnector class and determines whether or not the child should be allowed to text based on the system's time. When the child is able to text, the text message's details, such as destination, message, and date, are appended to a url and sent to the server through a GET method. The reason for this "invasion of privacy" is to make sure that the child does not attempt to bypass the program by using the phone's integrated messaging system. If the child does attempt to bypass the program, at the end of the month, the parent will discover a disparity between the number of texts in the phone bill and the number of texts recorded on in database and can discipline the child accordingly. This connection between the website and the child's phone simply allows the parent real time monitoring on their child's actions, thereby allowing the parent to stop their child from texting at inappropriate times. For those parents who cannot afford to have a data plan on their child's phone, there is an alternative. The program can be set to not require internet, as it has a feature that allows the parent to set restrictions on the phone itself. The set function is password protected, so the child cannot go in and change the settings. This method is not as convenient as real-time monitoring, but can also effectively stop the child from texting.

Accessibility is another one of the key features of this system. The parent is able to view the current restrictions from their phone and on the website. The child is able to view their current restrictions from their own phones for their own knowledge. An organized formatted table is displayed on the website with the days of the week, start and end restriction times. Above this table, the date and time of when the last restrictions were set

are shown. Below the current restrictions table is another table with textboxes to update the times. If an invalid time is entered, such as letters, the user will be prompted of the error.

Restricting communication comes with certain dangers, so safety features are implemented in the phone application. The product is designed to accommodate unusual or worst-case scenarios. For example, imagine that a child is kidnapped and unable to call for help because it would be obvious to the kidnappers. The child needs immediate help, and the only discrete form of communication is text messaging. However, what if the child was under restrictions or stuck in a car and moving above the set speed limit? The system has been designed so that, even under restrictions, the child has an option to send a text message. The phone program has a "send emergency text" feature where it is allowed to send a text message regardless of its restrictions. However, when this option is pushed, the parent will receive a copy of the sent text message. In the scenario above, the child would not care if the parent saw the text because it is a life or death situation. On the other hand, if the child is no danger at all and attempts to abuse this feature and send text messages while under restrictions, the parent would get copies of all the sent text messages and can act accordingly. Thus, this system creates an effective emergency text system that cannot be abused.

Another text restriction based feature is the ability for parents to monitor words sent through text messages. When the child sends a text message, whether under restrictions or not, the message will pass through a word filter. This word filter is composed of words set by the parent. To add words to the filter, the parent visits the website and simply types and submits the word to the database. Removing words is as easy as adding them. All the current words in the database are displayed in a formatted table with a checkbox. The parent checks the words he or she wishes to remove and submits the request. If the child sends a text message containing one of the words in the filter, the parent can tell the phone to either warn or the child of his violation of the word filter or to simply flag it

without a notification. The option of not notifying the child of his or her restrictions is a great method of gauging a child's behavior when he or she is not under parent supervision. This feature can be also implemented by the government as well. The government can use the system to scan phones for certain words, such as "bomb" or "robbery" or any other word deemed necessary to protect the nation. Overall, the system provides an automated word filtering system that allows the parent, or the government, to see what is stated in text messages. Of course, the system is flexible and the parent can set different word filters for different phones or one filter for many phones – all configurable via the website. The filtering process starts with the message being sent to the server. Once the message has been received, it is broken up into individual words and placed into an array. Each word in the array is compared to each word in the database. If a single word matches one in the database, the entire message is flagged and displayed to the parent on the website. The website shows a list of the recently flagged messages with the time, date, and intended recipient of the message.

In addition to texting restrictions based on time, texting is also be limited by the movement of the child. When the child starts the program on the phone, the program starts a GPS thread that requests satellites through the phone's integrated GPS receiver. If the phone does not have integrated GPS, a Bluetooth GPS receiver can be bought for twenty dollars and connected to the phone wirelessly. The GPS thread starts up invisibly to prevent the child from turning it off. When the child attempts to text, the program retrieves speed restrictions from the server (set by parents) in the exact same fashion that the text message restrictor does, and compares the restriction to the child's current speed based off of the GPS data. If the child's speed is above the limit, the program will instantly restrict texting on the phone. This system thereby completely stops the child from texting while driving.

Not only can this product stop the child from texting while driving, it also provides a method to which the parents can track their children's locations. Because GPS not only gives speed, but also latitude and longitude coordinates, the parents can view their children's locations through Google Maps. The child's phone's program constantly feeds GPS data to the server and, through Google Maps API and Javascript, the child's latitude and longitude data are geocoded and plotted onto a map onto the website. The map has the ability to show a street map or a satellite view map which gives the parent a visual idea of where the child is located. These points are then given a hover-over JavaScript attribute, so that the parents can simply hover over points to see the exact time and date that the child was at the particular position. The points also have an on-click attribute, where if the parent clicks on the point, the website displays Google's famous Street View next to the map. The default street view image will be the last plotted point, giving the latest view of the child's location. Since GPS cannot tell which direction the receiver is facing, Streetview always points north for easy use. This system, in a sense, forces the child to leave a "trail" that the parents can easily follow on any computer. This feature may seem extravagant, but it becomes especially important when teenagers get their own cars and start lying to parents about where they are going. With live tracking, this type of behavior is prohibited as the parents can view everything. Next to the map is a menu full of map settings. The parent is able to view points on a certain day. The parent cannot view just any day they wish. There must have been points plotted on that certain day. A dropdown menu retrieves the days which contain plotted points and adds it to the dropdown. If this option is selected, the Javascript will retrieve the points from the database on that certain day through searching and sorting. If that does not satisfy the parent, the parent also has the option to view a certain number of points, whether on all days or on a specific day. Similar to the show day method, the Javascript will return a certain number of points, specified by the parent. As the child's phone is feeding points to the server, the map may become outdated at times.

There is a feature which will enable the parent to automatically refresh the GPS map every X number of seconds. The automatic refreshing can also be disabled. With the map refreshing, the parent will constantly be viewing the most up to date map of the child's location.

In addition to lying to parents about destinations, teenagers have also been known to drive recklessly above speed limits. Through GPS tracking and plotting, the parent can view the child's speed at specific points on a map. This gives the parent the ability to determine the child's driving habits and can punish or reward accordingly. With this feature, parents can, hopefully, stop their kids from driving so aggressively, thus reducing the chances of accidents on the roads in the future, not only with text messaging, but also with speed limits.

The final feature of GPS tracking is geo-fencing. Geo-fencing is when the parents set a geographical barrier using a map on the website to create a "fence" for their kids. This is accomplished through the use of Google Maps API. The parent clicks various points on a map on the website, and the JavaScript obtains the latitude and longitude coordinates of each point from the Google maps variable and posts it into a form. The parents can click up to 10 points, creating any polygon they wish. Once the parent clicks the submit button, these points in the form as written to the database using a POST method. In a sense, these points create the vertices of the "fence" for the child. When the parent views the page after submitting, the JavaScript code will then access Google Maps API and link all these vertices together into a filled Google Maps polygon. The polygon will be shown on the same map as the tracking system. This way, the parent is able to view what time the child went outside of the boundaries. It also has a show/hide feature on the website to provide an ease of viewing the points and geofence. As the server receives GPS data from the phone, it checks whether or not the points are inside of the polygon. If the child is outside of the boundaries, the server will flag an alert on the website and instantly restrict the

child's texting privileges, or perform other actions specified by the parent. A button is located above the draw geofence map to remove the current geofence. The user will be asked to confirm the deletion and the current fence will be deleted.

The main advantage of this product is its accessibility. Unlike other products that aim to stop texting while driving through a program on the child's phone, this product allows the parent to set restrictions in real- time away from the child using a phone or a computer. The heart of the system is the website. Since the product is very marketable, the website is login based. The parent simply creates an account on the website for each phone she wants to register, and PHP code takes the username designated by the user and creates tables in the database accordingly using SQL queries. If at any time, during or after registration, there is a database missing or tables not present, an error message will appear warning the user to recreate them. The user clicks a link and all the tables and databases are checked and created. This method of login makes this product highly distributable as the users only need to register an account and download the phone program.

If a parent has multiple children and wants to view the "trail" of all of his or her children on one map, the parents can simply enter the account names of the children they want to view into a form. Upon pressing submit, the PHP code retrieves the proper tables of data, encodes it into JavaScript Object Notation format, and pushes it to JavaScript running Google Maps. If the parent has three children and wishes to track all of them at once, PHP and Javascript will retrieve the GPS locations from all three phones (MySQL tables) and plot them on the same map. Each phone will have its own colored trail and the hover-over information at each point. Similar to the single phone map view, the multiple phone view will have one large map with the trails of the multiple phones. Below the map, there are three smaller street views. These street view images will show the last points on all the phones, giving the most up to date information. When the user clicks a point on phone 1 on the map, the street view 1 will update to that point. If they click a point on trail

2, the street view 2 will update. This allows the user to view the locations of multiple phones on one map and view the street views of the multiple phones on the same web page. Currently, the maximum number of multiple phones is three, but is expandable to any number. This feature can aid in government uses as well. If a bank has been robbed, for example, the criminal's phone can be easily tracked through this program. Also, this could be used in upper government levels for tracking a large number of people and viewing all their locations on one map in real time. Businesses can use this feature to their advantage as well. Businesses that require employees to be at a certain location at a certain time can use this program to track their employees. The restrictions will be disabled so only the GPS tracking is active. This will ensure businesses that their employees are doing their jobs correctly and improve their customer service, etc.

The database portion of this product is absolutely vital, as it saves everything that is required to keep the product up and running. The design of the database was tough to decide on, as it must be able to handle more and more users over time. At first, an attempt was made to make a new database for every phone registered. However, this turned out to be very inefficient, especially when the product is distributed to more and more people. Instead, the number of databases was kept to a minimum. There are three types of databases: GPS, text message, and web based settings. In the GPS related databases, such as locations, geobox, and multiple phone tracking. All these databases have the GPS prefix for organization purposes. The locations database contains a table for each phone and stores the time the point was recorded, the latitude, longitude, speed, and day. The geofencing information is stored in the geobox database. When multiple phones are being tracked, the multiple phones database handles all the points. The text messaging databases are more simplistic than the GPS databases due to the less amount of information required. Three databases exist in the texting category: text message log, time restrictions, and word filter. Again, each phone has its own table in each of these databases. The message log

stores the time of message, the content of the message, and the message recipient. The final set of databases incorporate the website and its functions. The user login information and settings are saved into separate databases. The user can activate/deactivate entire features of the program, such as the GPS tracking or the text word filter. All three categories of databases are used in conjunction with each other to make the product work efficiently and effectively. The website connects all the databases together into an easy visual interface for the user. PhpMyAdmin manages the MySQL databases into an easy visual interface for the administrators. All the databases are listed with the tables and stored information.

Various tests were performed throughout the development of this product to ensure usability and practicality. The first test was performed to ensure that everything functioned properly within the virtual world. In order to simulate multiple phones, the J2ME emulator from Sun Microsystem's Wireless Toolkit was used. Each of these emulators was given a separate GPS track written in XML in order to simulate movement. Then the J2ME program was run on all of these phones at the same time, and everything was executed as planned. The IIS server received data from all the phones, processed the information, and placed them into their respective tables in the database. The Google Maps mash-up worked properly as it plotted and connected the paths of each respective phone. Texting restrictions worked as well, as the phones retrieved the proper restrictions from the server and determined whether or not they were allowed to text.

The second and more practical, test that was performed was a live test using a Nokia N85 Smartphone. This phone was chosen as the test phone because of Nokia's detailed support of J2ME applications and its standard keyboard layout. The J2ME program was wrapped into a .jad executable file and deployed onto the phone. The product was then tested properly over the course of a week. In order to ensure that everything functioned in real time, the website was constantly monitored. The texting restrictions were updated every hour to ensure that the phone was constantly linked to the website. The

phone behaved as expected, retrieving the proper restrictions every single time. As for GPS tracking, things did not run as smoothly as in the emulators. The phone required time to acquire GPS satellites from a cold start, and therefore, the tracking was not fully accurate as the system failed to track the first three minutes of the phone's movement. Though a problem, it wasn't detrimental to the product's overall goal as once the GPS thread in the J2ME program started and found satellites, no more hiccups in GPS data occurred. The website Google Maps GPS track worked perfectly, plotting in real time the position of the phone onto the map. Speed texting restrictions also worked properly, as the phone retrieved the limit from the server and restricted texting when its speed was higher than the limit.

Overall, the real-world test of the product was a success. All of the goals of the product were achieved, as the system prevented texting during school, texting while driving, and provided a detailed track of the phone's movement. Only a few problems occurred throughout the real-world test, such as when the phone lost 3G connection or GPS connection. However, these problems were very minor as they occurred only a few times. Due to budget limitations, a real world test of multiple phones was not possible, but a virtual emulation of multiple phones clearly displayed the system's capabilities of adding additional users.

Future additions to this product would be expanding its uses beyond parental control for teenagers. The truth is many adults themselves find it hard to resist typing out a text message on a numeric keypad while on the road. Recently, many states, such as California and Texas, have passed laws banning texting while driving, but these laws are tough to enforce. Hopefully, cell phone manufacturers, in the future, will provide a hook in their operating systems to help integrate this product. This product should be expanded to a governmental level in order to enforce driving while texting laws. Many view this as a limitation of freedom, but a system such as this can truly save lives. Texting while driving

accidents are the most deadly, as most of the time the driver is looking down at the phone and does not even have time to apply brakes before impact. Such a dangerous habit must be stopped, even if it means imposing a slight limitation on freedom. Another feature that this product also needs is better geo-fencing. At the moment, the parent can only set a solid region for the boundaries. In the future, hopefully the parent will be able to geo-fence streets, creating pre-set routes that they expect their children to take. This method of geo-fencing is more effective, as it clearly defines an area that the child must take. However, this method of geo-fencing is much more complicated, and will require more time to develop. Another feature that needs to be added to the product is Bluetooth GPS support. For those children who have phones that do not have GPS receivers, a Bluetooth GPS receiver is a viable, inexpensive replacement. In fact, a Bluetooth GPS receiver is a better implementation of GPS tracking. For example, with integrated GPS, even if the child is riding in someone else's car, he cannot text. The only way he can obtain texting privileges while in a car is if he gets permission from his parents via a phone call. However, Bluetooth GPS can easily solve this problem.

Cell phones are a necessity in today's technological world, but they are also being rapidly abused and used at improper times.

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